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## The new normal? Climate variability and ecoviolence in sub-Saharan Africa

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The new normal? Climate variability and ecoviolence in sub-Saharan Africa

A Dissertation

Submitted to the Graduate Faculty of the  
University of New Orleans  
in partial fulfillment of the  
requirements for the degree of

Doctor of Philosophy  
in  
Political Science

by

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## **Dedication**

This dissertation is dedicated to my family, biological and chosen, who have loved me and cared me for along the way. I could not have done this without each and every one of you.

## **Acknowledgements**

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## **Abstract**

Climate change presents a wide range of concerns that can jeopardize international security. Among those concerns are neo-Malthusian worries of diminishing natural resources. Predictive models suggest that rainfall and temperature anomalies have the potential to reduce water basins, crop production, increase land degradation among other perils that threaten human security. This concern is particularly true in sub-Saharan Africa given the region's strong dependence on rain-fed agriculture. Despite strong claims from various world leaders and scientists of a direct climate-conflict nexus, little empirical evidence has been devoted to find a systematic causal pathway of this kind. What is more, the literature not explored the relationship between climate change and low-intensity forms of social unrest. Therefore, contrary to most of the literature that explores a direct climate-conflict relationship, this dissertation contributes to the literature along two lines. First, it explores the relationship between climate change and socio-political unrest. Second, rather than simply assume a direct relationship between climate shocks and conflict, this dissertation examines: a) the effects of climate change on food scarcity, and the impact of that scarcity, in turn, on the likelihood of social unrest and conflict, and b) the effects of climate change on land degradation, that the impact of that degradation, in turn, on the frequency of communal violence.

Keywords: conflict, resource scarcity, food security, climate change.

# ONE

## IN PURSUIT OF CORNUCOPIA

Since the time of Thomas Malthus, a longstanding fear among scholars and policy makers has been that population growth would eventually outpace agricultural production. Lack of food would then lead to undernourishment or, in the worst case, famine (Ehrlich 1968; Meadows et al. 1972). So far this “doomsday” scenario has not happened because technological advancements have been able to keep up with population growth. For instance, in the 1940s a pilot program sponsored by the Rockefeller Foundation and the Mexican government, the International Maize and Wheat Improvement Center (CIMMYT), developed higher per-acre yields of maize and wheat through agricultural technology and innovation, becoming known as the “Green Revolution.”<sup>1</sup>

While the Green Revolution is credited with saving over one billion lives, hunger is far from eradicated. According to the Food and Agriculture Organization of the United Nations’ (FAO) latest annual *State of Food Insecurity in the World* report, 795 million people do not have enough food to live a healthy and active life (FAO 2015). However, the number rises to about 850 million when short-term undernourishment from external shocks (e.g., droughts, recessions) and unequal household food distribution are included (De Schutter 2015). The idea that, on a planet with sufficient food, almost one billion people could go hungry (while another billion overconsume) led scholars to shift the food-security debate away from food production and towards the role of governments in distributing food. In his seminal work, *Poverty and Famines* (1981), Amartya Sen suggests that famines occur when there is a breakdown in the means of food acquisition by individuals—when individuals are unable to attain food through all legal means

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<sup>1</sup> For more information on the CIMMYT, please visit: <http://www.cimmyt.org/>

available: growing food, buying food, working for food, or being given food by others (Sen 1981:2). In other words, famines represent a failure of the state and political institutions, and are a phenomenon not associated with well-functioning polities with strong institutions, such as democracies. Until recently, the debate over food security had been dominated by these so-called *distributionists*; however, recent developments have revived Malthusian concerns about the future of food security.

Although innovations in agricultural technologies have been praised for increasing food production worldwide, neo-Malthusians have two main concerns about the future of food security. First, the production of several staple grains has already reached a plateau. In a recent study, Seppelt et al. (2014) find that global peak rates were reached for cassava, soybeans and wheat in 2011, and for maize and rice in 2007 and 2008, respectively. Neither new strains of genetically modified crops nor new fertilization techniques are increasing yields (The Economist 2016). According to the FAO, these five crops provide about 45 percent of global caloric intake (FAO 2013).

Second, neo-Malthusians point to climate change and argue that, as average global temperature continues to rise, crop production will decline in tropical regions. This argument is supported by the Fifth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), which suggests that climate change has the potential to cause starvation for large segments of the world population over the next 30 years. Simply put, as global temperatures continue to rise and rainfall becomes more erratic, crop yields in tropical areas will decrease or fail to materialize as the result of too much or too little rainfall. Not only is climate change projected to reduce crops in some parts of the world, but water basins and grasslands are also expected to decline.

In a 2015 report to the U.S. Congress, the Department of Defense recognized that climate change “is an urgent and growing threat to our national security, contributing to increased natural disasters, refugee flows, and conflicts over basic resources such as food and water.” The report further contends that some of these “impacts are already occurring.”<sup>2</sup> However, what are the causal links among climate change, basic resources and conflict? Does climate-induced resource scarcity or abundance increase the likelihood of conflict? If so, under what conditions? In an attempt to answer these questions, this dissertation examines the effects of climate change on food scarcity, and the impact of that scarcity, in turn, on the likelihood of social unrest and conflict.

While neo-Malthusian arguments have been chastised as “alarmist” by scholars who favor political institutions as the primary explanation for food scarcity, only a handful of large-N studies have attempted to resolve this debate. The purpose in this dissertation is not to choose a side, but rather to incorporate both institutional and environmental paradigms to develop a more comprehensive way to examine resource scarcity and its potential social repercussions.

Sub-Saharan Africa is selected because it proves fertile ground to investigate potential theoretical links in two ways. The region is projected to experience the largest population growth by 2050, and it will be among the most impacted regions as a result of climate change and variability in the next fifteen years.<sup>3</sup> The remainder of this chapter is organized as follows. First, I will explain the concept of basic resources used in this dissertation and the causes of scarcity. Second, an argument is made for the importance of climate change in decreasing basic resources, particularly in sub-Saharan Africa. Finally, I provide a roadmap for the rest of this dissertation.

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<sup>2</sup> Congressional Report. 2015. “National Security Implications of Climate-Related Risks and a Changing Climate.” Accessed [January 3, 2016] at: <http://archive.defense.gov/pubs/150724-congressional-report-on-national-implications-of-climate-change.pdf>

<sup>3</sup> Sea level is not expected to strongly affect human security until 2080–2100, when the rise in sea level could reach 60–80 cm, assuming a 2°C warming increase.

## **Causes of scarcity: *political institutions, demand and supply***

Humans have three basic metabolic needs: air, food and water. For the purpose of this research, only food and water are of importance, given that their fulfillment is dependent upon two natural resources—land and freshwater—along with their shared creation: crops. In short, basic human needs are dependent upon ecosystems that allow for the development of three basic resources: fertile land, freshwater and crops. Fertile land is important not only for growing crops, but also for the expansion and sustainability of grasslands in rural areas that are essential for the livelihood of pastoral communities. Likewise, freshwater is not only crucial for human consumption, but also for the nourishment of vegetation and crops. Finally, crops are essential because they are the main source of caloric consumption for people.

Basic resources can become scarce in three different ways. First, demand-induced scarcity is caused by either population growth or an increase in per capita consumption of a resource (Homer-Dixon & Blitt 1998). For instance, as population growth continues, food systems will face additional pressure to produce more food. Sheer population growth is, however, not the only reason to produce more food. For instance, economic prosperity in China, India and some parts of Africa is driving an increase in demand for eggs, meat and dairy products, boosting pressure to grow more feeder grains for livestock. This puts greater pressure on land use, which often results in overgrazing as well as large areas of forests being cleared out in order to keep up with livestock and human needs.

Second, institutionally induced scarcity (often called *structural scarcity*) arises from the intentionally *or* unintentionally unequal distribution of resources among a population and often occurs when a resource is concentrated in the hands of a few. This can result from ineffective institutional arrangements or struggles among social groups over the allocation of the commodity

(Sen 1981; Boyce 1987). Structural scarcity has been the primary reason why hunger has persisted in poorer regions of the world since the “Green Revolution” took off.<sup>4</sup> Unintentional distribution failures mostly occur when poor governments do not have the capacity to move resources from parts of the country with abundance to areas that are facing scarcity. Food, for example, is perishable and heavy, so countries with poor infrastructure often move food from farms to cities at a very high cost. However, when droughts occur, the movement of food proceeds in the opposite direction, from city warehouses to rural areas, and the cost of transportation to remote areas increases (Ó Gráda 2015).

On top of this, lack of political will can hinder or worsen distribution efforts. Political leaders in all political systems risk removal from office due to social unrest. To avoid removal from office, governments in developing countries tend to develop an urban bias—the inclination to be more responsive to the policy concerns and preferences of urbanities at the expense of rural dwellers (Hendrix 2012). As Robert Bates (1981:114) points out, for political leaders the cost is “high in terms of loss of support in the urban areas; and their political benefits are low in terms of their ability to secure support from the countryside.” Therefore, this bias incentivizes political leaders to invest in policies that disproportionately favor urban dwellers who are closely concentrated near to the seat of government power, and face lower costs to acting collectively against the leader (Bates 1981; Stasavage 2005).

Intentional failures to distribute resources mostly occur during times of armed conflict. Using food or water as a means to subvert an enemy is not a modern development. Since medieval times, a common tactic during long-term conflicts has been to cut off food or water supply lines warring towns and villages. As a consequence, prices go up, trade is disrupted, local deliveries do

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<sup>4</sup> World Food Program: *What causes hunger?* Accessed June 10, 2016 at: <https://www.wfp.org/hunger/causes>

not take place, supermarkets may close, and markets stop functioning because farmers are unable to get their product across enemy lines. The most recent example of this is likely taking place in the ongoing Syrian conflict. For instance, the World Food Program (WFP) reports that people in the town of Madaya are eating grass, boiling leaves and making stew from almost nothing due to a food blockade by government forces and rebels alike.

Finally, supply-induced scarcity results from a disruption to the total quantity of production in the supply chain by degradation or depletion of environmental resources. Environmental change often reflects long-term degradation caused by human activity (e.g., pollution), but this is not always the case.<sup>5</sup> For instance, natural hazards and disasters are major temporary causes of food insecurity. The FAO estimates that between 2003 and 2013, natural hazards and disasters affected more than 1.9 billion people worldwide (FAO 2015). Ethiopia, for instance, is currently facing its worst drought in 50 years, leaving millions of people in need of food in a country where about 40 percent of the population is undernourished.<sup>6</sup> By some estimates, the drought has killed 90 percent of crops in areas and at least one million livestock. While hazards such as tropical storms, floods and drought are a normal part of nature, climate change is expected to multiply the frequency and intensity of these hazards, which will increase the short-term scarcity of basic resources in some parts of the world. In short, the problem is about to get worse.

## **Why climate change and variability matter**

Climate variability refers to short-term variations in temperature and precipitation around the mean. Climate change refers to a long-term or permanent change in mean conditions. Climate and

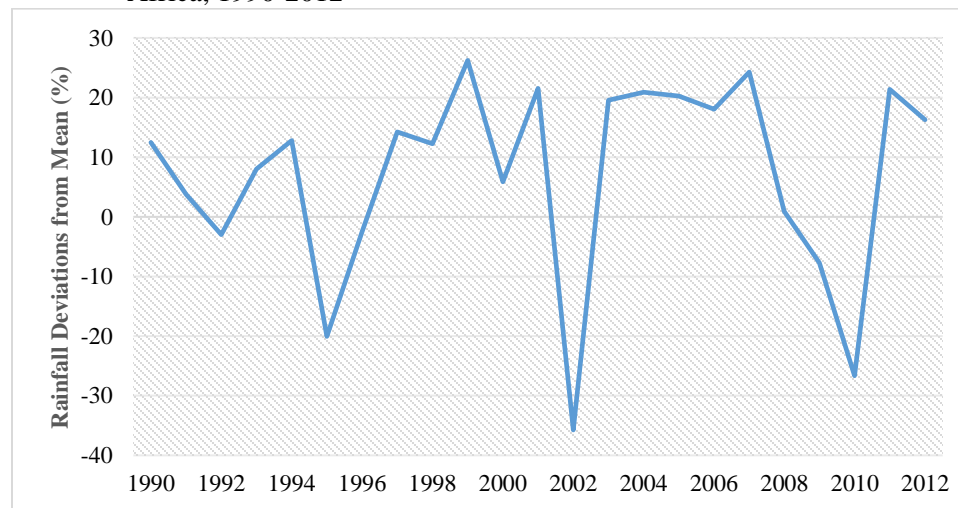
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<sup>5</sup> For reasons other than demand of a resource

<sup>6</sup> Food Security Portal. Country profile: Ethiopia. Accessed June 3, 2016:  
<http://www.foodsecurityportal.org/ethiopia>

rainfall variability are known to be extreme in large parts of Africa (Adano & Witsenburg 2009). Overall, the planet has warmed by about 0.8°C since pre-industrial times.<sup>7</sup> Climate researchers have concluded with high confidence that temperatures will continue to increase over the next decades, due largely to anthropogenic activities (IPCC 2014; Cook et al. 2013). The IPCC predicts that climate change will affect different social and environmental systems as temperatures and sea levels continue to rise, and as erratic rainfall reduces water availability in some parts of the world (IPCC 2007, 2014).

Figure A. Annual rainfall deviation (%) from the mean (1093.25mm) for sub-Saharan Africa, 1990-2012



*Author's calculations*

The IPCC points out that climate change is already having negative impacts on the environment. For instance, in sub-Saharan Africa, some observable effects include increased land and water degradation (IPCC 2014; World Bank 2013). Given the great variability of rainfall in the region over the last 25 years (Figure A), this erratic rainfall has had strong effects on the availability of basic resources. Moreover, rainfall deviations from the mean (whether below or above) can temporarily reduce or degrade resources. For example, too much rainfall can remove

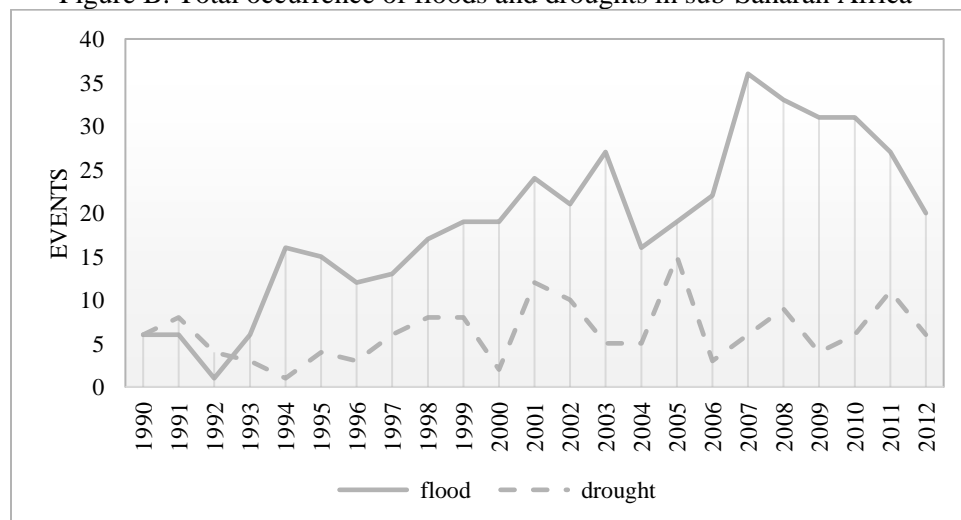
<sup>7</sup> Warming in northern latitudes has been greater, however (IPCC 2007, 2014).



soil from one location and deposit it in another, depriving land of its nutrients and capacity to sustain vegetation.

Similarly, the distribution of resources can temporarily be affected by erratic rainfall when infrastructure such as roads, bridges and warehouses is damaged. Heavy and persistent rainfall often damages and/or destroys bridges and roads, which limits access to affected areas and makes the distribution of resources harder for national and international relief agencies. Figure B shows a steady increase in the number of floods from 1990 to 2012 in sub-Saharan Africa. In fact, between 2003 and 2013, natural hazard events in Africa lead to economic losses of about \$13 billion in the crop sector due to flooding and storm damage, and \$11 billion in livestock losses attributable to drought (FAO 2015).

Figure B. Total occurrence of floods and droughts in sub-Saharan Africa



Source: The International Disaster Database.

According to the United States National Oceanic and Atmospheric Administration (NOAA), the global land temperature for 2015 was 1.33°C (2.39°F) above the 20<sup>th</sup> century average, beating the previous records in 2007 and 2010. This is the largest margin by which an annual global temperature has been broken and it is expected to be surpassed in 2016 (NOAA 2015). The rapid changes of climate change and variability can have profound and different

consequences for countries around the world. For instance, in 2015, a severe heatwave claimed more than 1,000 lives in Karachi, Pakistan, while a severe drought caused food shortages in Ethiopia.

So what impacts, if any, does climate change have on human societies? This research focuses on the social consequences from scarcity of land and crops via temperature and precipitation anomalies. Both land and crops are considered crucial, given their direct impact on the livelihood of millions of people in the region. First, the importance of land is crucial for grasslands to flourish in rural areas. It is estimated that around 12 million hectares of productive land become barren due to drought every year (UNCCD 2014). While land that is used to grow crops can be rejuvenated by using fertilizers or agricultural techniques such as crop rotation to renew soil nutrients, land under no direct human care depends solely on climatic elements to receive its nutrients (Reich et al. 2001). For this reason, the concern here is not with the effect that land degradation has on crop production when climate shocks occur, but rather the potential effects that climate shocks have on land degradation, and in turn, this degradation has on communal violence. Land degradation is defined as “the reduction in the capability of the land to support a particular use” (Bullock & Houérou 1995: 6). Higher levels of land degradation reduce grassland that limit the amount of feed for the livestock of pastoral communities. As these communities depend on their herds for income and nourishment, a decrease in grassland as a result of high levels of land degradation leaves pastoralist communities particularly vulnerable to weather shocks. While human activities such as deforestation and overgrazing are critical causes of land degradation, rainfall (its amount, duration, intensity, and the frequency of high-intensity events) and warming temperatures (which prevent the sustained growth of vegetation) are also key causes

of land degradation. In summation, this research considers land scarcity (or degradation) to be crucial only in rural areas where soil revitalization is not practiced.

Second, climate change's impacts on agriculture are arguably among the most critical for sub-Saharan Africa countries, given the region's strong dependence on rain-fed agriculture. Therefore, anthropogenic climate change has the potential (and is expected) to significantly impact regional food productivity. Current projections of climate change impacts on tropical crop yields are, on average, negative. In Southern Africa, for instance, the NOAA noted that by November 2014, the lack of precipitation in Mozambique, Malawi, Zambia and Zimbabwe had led to soil deterioration, only to witness a complete reversal of weather anomalies one month later. Rainfall brought crippling precipitation surpluses that revived the soil, only to destroy it again by depriving the soil of oxygen with the excess of water (Di Liberto 2015). By their estimates, "25,000 hectares of cropland were impacted in Malawi, 65,000 hectares in Mozambique, 9,900 hectares of rice fields were flooded in Madagascar, and an additional 7,900 hectares of crops damaged in the region."<sup>8</sup> When climate shocks occur, they have repercussions for the livelihoods of millions of people.

This dissertation proposes that, under certain circumstances, a scarcity of land or crops from climate shocks can cause low-intensity forms of social unrest. Scholars of conflict processes have long debated whether resource scarcity or abundance lead to intra- and inter-state conflicts. As the literature stands today, scarcity of renewable resources is closely associated with a higher likelihood of low-intensity conflict, and non-renewable resource scarcity has been associated with large-scale violence (DeSoysa 2002). However, there continues to be little consensus on the climate–conflict nexus (for a critical review, see Salehyan 2008; Nordås & Gleditsch 2007). A

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<sup>8</sup> Published by the Famine Early Warning Systems Network <http://www.fews.net>

superior understanding of whether, and under conditions, climatic shocks contribute to violent conflicts is fundamental not only for scientific research, but also to better prescribe adaptation policies that can mitigate the occurrence of violent conflict. For instance, if the interaction between climatic shocks and crop scarcity does play a role in sparking social unrest, the region will have to mitigate the effects of climate change in the coming decades. First, crop production will need to vastly increase in order to keep up with current population trends. Second, research and technological development efforts need to improve. Finally, people may have to adjust diet quality and diversity to better meet needs in terms of energy—all of which must be achieved with minimal environmental costs (e.g., deforestation). Expecting to increase crop production solely by expanding croplands is not only not ineffective, but also environmentally perilous (Griffon 2006). For instance, if we keep the current crop yield constant for sub-Saharan Africa and expand the potentially available cropland to its maximum, crop yields would barely be sufficient to meet the projected increase in demand while resulting in the complete deforestation of the region (Berg et al. 2013).

This dissertation contributes to the existing literature on the climate–conflict nexus by exploring an interactive effect between crop/land scarcity and climatic shocks that can contribute to violent conflicts (Hendrix & Glasser 2007; Salehyan 2008; Theisen 2012). First, it tackles the assumption that the climate–conflict nexus is a direct link from climatic anomalies towards conflict. This theoretical streamlining wrongly assumes that people in poor countries respond to climate shocks by attacking each other or rebelling against the state (Releigh et al. 2014). Second, it challenges the overwhelming focus on explaining civil wars as the main outcome of climatic conditions by looking at low-intensity forms of social unrest that are short of full-blown civil wars.

## **Organization of Dissertation**

My dissertation is organized as follows. Chapter 2 reviews two sets of literature, the first on climate change and renewable resources, and the second on natural resources and conflict. The chapter concludes by offering the theoretical approach that is used in this dissertation. Careful consideration is placed on the role of economic grievances as potential triggers for social unrest, as well as the role of political institutions in subduing or tolerating distinct forms of collective action. Moreover, while some scholars (Burke et al. 2009; Hsiang et al. 2013) studying the climate-conflict relationship have recently argued for the exclusion of control variables (e.g., economic development) that may plausibly be affected by climatic factors and produce bias coefficients, this dissertation attempts to resolve this dispute, especially by drawing upon others who argue that control variables are necessary to place “the relative causal weight of climatic factors in context and to address the confounding effect factors that may also trend over time” (Devlin & Hendrix 2014:32).

Before I examine the influence of climatic factors, in Chapter 3 I examine whether poor access to water and food are associated with an increased likelihood of popular protests. I examine this nexus at the micro-level by using 2005–2013 survey data from the Afrobarometer. Much of the debate over access to water and food has failed to be incorporated into the literature on protest participation. The purpose of this chapter is to fill this gap. It is important to note that this chapter does not examine food or water riots alone, but rather all forms of self-reported participation in popular protest. This is done to account for times when access to water or food may not be the principal motivation for protest participation, but poor access can still exacerbate previously held grievances.

Chapter 4 introduces the role of climatic shocks and their possible impact on social unrest via declines in crop production. Contrary to the previous one, this chapter explores if supply induced scarcity (of food in this case) increases the frequency of social unrest events in the region. That is to say, rather than assume that climatic shocks by themselves increase the likelihood of conflict, this chapter explores whether the actual interaction between precipitation and/or temperature variability and crop production increase the frequency of social unrest. I refrain from explaining civil war as the main outcome of interest and shift the focus towards low-intensity forms of social unrest.

Similarly, chapter 5 examines the role that climatic shocks have on communal violence via land degradation. Across Africa, about 50 million pastoralists and up to 200 million agro-pastoralists live in arid and semi-arid zones (Kamuanga et al. 2008).<sup>9</sup> Both communities depend on land fertility to feed livestock or cultivate crops for their livelihoods. While land degradation is a slow-moving process, continuous temperature and precipitation anomalies have the potential to deteriorate topsoil and exacerbate the process of land degradation and desertification. Therefore, in this chapter I suggest that continuous climate shocks worsen land degradation, which reduces fertile land to feed livestock. Given a smaller “pie” for livestock feed, pastoral communities will seek to maximize their gains from a limited pool of resources, increasing the frequency of communal violence.

Finally, Chapter 6 offers a summary of the findings from the previous three empirical chapters and discusses their academic and policy implications, followed by concluding remarks. Subsequently, the references utilized throughout this dissertation are presented as well as an

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<sup>9</sup> Pastoralists are exclusively herders. Agro-pastoralists engage in a mixture of herding and agriculture.

appendix with supplemental materials. Overall, throughout the chapters in this dissertation, I expect to find that in non-climate scenarios (chapter 3), poor access to renewable resources increases the likelihood of popular protest. Similarly, I expect to find that the interaction between climate shocks and basic resource scarcity increases the frequency of low-intensity social unrest and communal violence in sub-Saharan Africa.

## TWO

### CLIMATE SHOCKS AND SOCIAL UNREST IN SUB-SAHARAN AFRICA: A THEORETICAL APPROACH

Scholars of conflict processes have yet to fully examine the causal nexus between climate shocks and low-intensity social unrest. The various outcomes that climate shocks will have on social coherence need to be further incorporated into the research agenda to better understand and mitigate social breakdown. For instance, as basic resources dwindle as the result of climate shocks, will social unrest become the new normal? The answer to this question motivates this research.

Social unrest does not occur by chance. People do not simply wake up one day by the whimsy of the gods and decide to protest, riot or march. Rather, individuals choose to participate with the motivation to address a wrong that has been done to them by the government (Brockett 2005). Although the laundry list of grievances against governments can be long and complex, because some resources such as water, food and fertile land are among the basic survival needs for our species,<sup>10</sup> I propose that under certain conditions, scarcity of these basic resources can cause social unrest.

There are four critical reasons why sub-Saharan Africa is the best region to conduct such a study. First, the region stands apart in its strong dependence on rain-fed agriculture—only four percent of total cropland is irrigated (IFPRI 2010). Second, more than half of the total global population growth between 2015 and 2050 will occur in Africa. Growing at a pace of 2.55 percent annually, 1.3 billion people will be added to Africa by 2050—an increase from 1.2 billion today to about 2.5 billion (UN DESA 2015). Third, the amount of per capita renewable internal fresh

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<sup>10</sup> According to NASA, the five basic survival needs are: oxygen, water, food, sleep and shelter.



water has been in decline for the past two decades and is expected to further decline in the near future (Pietersen & Beekman 2006). Finally, about 500 million hectares of land are estimated to have undergone land degradation in Africa since the 1950s—45 percent of which was caused by water erosion (IFAD-GEF 2002).

This chapter constructs an argument to explain why individuals decide to partake in low-intensity social unrest when basic resource stress occurs. I am interested in both the micro (individual) and macro (state-centric) processes. With this in mind, this research has three main goals. The first is to assess whether limited access to water and food makes people more prone to protest. This assessment is done in Chapter 3 by examining Sen's preposition that weak institutions are the key reason behind food shortages. The second goal is to explore the nexus between climate shocks, crop stress and social unrest. Moving away from Sen's preposition, Chapter 4 investigates the interactive effect, if any, that climate shocks and cereal yields have on peaceful and violent episodes of social unrest. Doing this will allow me to discern if a dual-track process for resource scarcity has begun to unfold. In other words, have some basic resources become harder to acquire due to structural-induced scarcity *and* supply-induced scarcity causes? The final goal of this dissertation is to investigate the causal links between climate shocks, land degradation and communal violence. While Chapter 5 continues to examine a potential interactive effect between climate shocks and basic resources, two important shifts take place. First, moving away from food production, this chapters examines the interactive effect between climate shocks and land degradation. Second, the dependent variable changes from protest to another form of low-intensity unrest: communal violence. These modifications allow me to examine the effects that climate shocks are having on other basic resources such as land fertility.

This chapter is structured as follows. Section one provides a review of the literatures on climate-change resource scarcity and climate-change conflict. Section two offers my theoretical contribution by combining both sets of literature and addressing their main gaps. Section three postulates potential alternative arguments, and the final section presents an overall conclusion.

## **Literature Review**

### ***On climate change and resource scarcity***

There is both a robust literature and international consensus showing that anthropogenic-induced climate change is underway. The Fifth Assessment Report (AR5) of the IPCC argues that greenhouse gas emissions and other anthropogenic activity, driven mainly by population and economic growth, are “extremely likely” to be the dominant source of the observed linear increase in global temperature.<sup>11</sup> For the 1880–2012 period, the average global temperature increased 0.85°C. Similarly, NASA indicates that global sea levels increased nearly 8 centimeters (3 inches) from 1992 to 2015.<sup>12</sup> Using current emission trends, estimates project an increase in global temperature between 1.4°C and 2.5°C by 2050. A warmer planet further increases sea level, decreases Antarctic ice sheets, increases ocean acidity, and leads to erratic rainfall patterns (IPCC 2007, World Bank 2012, 2013).

According to the U.S. Energy Information Administration (EIA 2015), the African mainland has contributed the least amount of greenhouse emissions worldwide.<sup>13</sup> Nevertheless, the region will be the hardest hit by the changing climate. Overall, Africa has become warmer over the last 50–100 years, with changes varying by region (IPCC 2014). As a rule of thumb, wet

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<sup>11</sup> AR5 is the most comprehensive and up-to-date report on climate change by the IPCC. AR5 and previous reports can be found at: <http://www.ipcc.ch/>

<sup>12</sup> NASA’s data on sea-level rise is available at: <http://climate.nasa.gov/vital-signs/sea-level/>

<sup>13</sup> The U.S. Energy Information Administration. Accessed [August 12, 2015]at: [www.eia.gov](http://www.eia.gov)

regions are likely to become wetter and dry regions are likely to get drier. For example, Northern Africa has experienced an increase in heatwaves per year, while Western Africa has seen an increase in extreme rainfall and floods. Eastern Africa has experienced erratic precipitation patterns that result in heavy rainfall and/or droughts over the last 60 years, while Southern Africa has experienced an increase in extreme heat and rain-deficit conditions (IPCC 2007, 2014; Funk et al. 2008; Yabi & Afouda 2012; Haensler et al. 2013).

Aside from the already observed impacts on various ecosystems due to population increases, overfishing, and land cover change from grassland or forest to croplands, climate variability will further influence ecosystems through fire, pest outbreaks and extreme weather events. Moreover, it is important to acknowledge that warming is very likely to continue in Africa for the next 20 to 50 years, regardless of reductions in greenhouse gas emissions, due to the emissions already emitted into the atmosphere.

According to a report by the National Academy of Science (2011), warmer temperatures increase water evaporation, which helps to “boost the total amount of water vapor in the atmosphere by seven percent for every 1°C of warming.” This means that in wet areas, atmospheric moisture can increase rain and snow, whereas in dry areas it can exacerbate the impact of drought. Overall, the report estimates that countries between the 30° N and 30° S parallels, including most of sub-Saharan Africa, are expected to have reductions of 5–10 percent in precipitation for every degree of warming.

The effects of climate change are diverse and complex. The IPCC (2007) projects that by 2020, between 75 and 250 million people in Africa will be exposed to water stress, and some countries will experience declines in rain-fed agriculture of up to 50 percent. As temperatures continue to rise, agricultural production—one of the principal economic sectors in terms of

employment share and regional GDP—will stagnate and possibly reverse the improved performance of the agricultural sector over the last decade in sub-Saharan Africa (Nin-Pratt et al. 2012). As temperatures increase and rainfall becomes erratic, crop yields in Africa are estimated to drop by 5–10 percent per degree of warming (National Research Council 2011).

Crops yields, especially cereals, are crucial to the nourishment of the sub-Saharan African peoples.<sup>14</sup> Using household survey data from 19 sub-Saharan countries, Chauvin et al. (2012) find cereals to be the most purchased food item for both rural and urban households. Moreover, agricultural sales are among the most important source of income for rural dwellers—and less so for urban dwellers who tend to be more dependent on wages.

### ***On natural resources and conflict***

After the United Nations described the potential role of natural resources—particularly diamonds—in civil strife in the 1990s, academics began to examine the potential nexus between resources and conflict. The result was a large body of literature that can be loosely divided into two camps: scholars focused on the relationship between resource *abundance* and conflict, and those interested in the relationship between resource *scarcity* and conflict.

Collier & Hoeffler (1998; 2004) were among the first scholars to find a statistical correlation between natural resources and civil war. Their findings suggest that resource wealth increases the likelihood of armed conflict. However, other scholars found no correlation between resource wealth and civil war when using alternative datasets or measurements of resource wealth. Using the same measurement of resource abundance as Collier and Hoeffler, Fearon and Laitin (2003) and Fearon (2005) find no clear evidence that primary commodity exports increase the likelihood of civil war. Fearon (2005) suggests, however, that there is a relationship between oil

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<sup>14</sup> Cereals include, but are not limited to wheat, rice, barley, maize, millet, and sorghum.

and armed conflict—a conclusion similar to that of DeSoysa (2002), who finds the total availability of natural resources to be unrelated to conflict, while the availability of mineral wealth is. Ross (2004: 37-38) similarly finds “oil, gemstones and drugs to be strong indicators for the onset of civil conflict, while other primary commodities—in particular, legal agricultural commodities—do not have an effect on civil war.” Over time, it became clear that the broader the definition of natural resources, the less these resources are related to civil war onset (DeSoysa & Neumayer 2007). The literature suggests non-renewable resources to be more closely associated with large-scale violence, given their high resale value.

Three overlapping theoretical relationships seek to explain these so-called “resource wars.” The first theoretical relationship, *conflict resources*, highlights opportunity as a key factor between resource wealth and armed conflict. This framework proposes that resource bounty provides rebels with the opportunity to loot resources in order to finance rebellion or to provide the prospects for personal enrichment (Collier & Hoeffler 1998, 2004; Le Billon 2001). This model, however, fails to consider that rebel behavior can also be motivated by poverty and inequality. Originally, Collier & Hoeffler (1998) supported the idea that rebellion was the consequence of personal gains (greed), and as a result, individuals would rebel when there was an opportunity to loot resources that would lead to self-enrichment. Later, the authors modified their argument to claim that armed conflicts’ onset can occur due to revenue flows in the form of primary commodity exports (Collier & Hoeffler 2004).

The second theoretical relationship, *resource curse*, emphasizes institutional vulnerability as a key factor between resource abundance and conflict. Because resource rents can be an important part of government revenue, countries with abundant resources tend to underperform economically due to “exposure to high price fluctuations, declining terms of trade and natural

capital depreciation...” (Le Billon 2008). Politically, resource rent effects often lead to high levels of political corruption and weak governance. As a result, these countries tend to depend on resource exports to boost economic growth, leaving the state vulnerable to rebel capture when the opportunity arises via failing economic growth or political transitions (Fearon & Laitin 2003; Auty 2007; Le Billon 2008).

The final theoretical relationship, *resource conflicts*, highlights individual grievances as a key factor between resource scarcity and conflict. This relationship mainly focuses on renewable resources and their impact on livelihood (Homer-Dixon 1999). Working from the belief that there are enough renewable resources available for everyone, the central assumption is that resource control or discrimination (usually by elites) exacerbates grievances, increasing the risk of conflict. Although time has been kind to scholars who focus on resource abundance, time has not been so gracious to scholars interested in resource scarcity. There are some studies that find no relationship between resource scarcity and conflict. Bates et al. (2003) find no significant relationship between political instability and environmental variables. Similarly, Binningsbø et al. (2007:235), using a broad measurement of scarcity, find a poor relationship between resource scarcity and conflict. In fact, their results suggest that, contrary to neo-Malthusian arguments, that “a higher consumption of the earth’s resources per capita is associated with peace,” rather than conflict. These results have led critics of neo-Malthusian scholars to formulate two arguments against the resource-scarcity conflict relationship. On one hand, some argue that the relationship ignores too many intervening non-environmental variables (Le Billon 2001; Theisen 2008; Brown 2010; Hendrix 2011). On the other, cornucopians or resource optimists, posit that the solution for scarcity lies in technological innovation, as it has in the past (Lomborg 2003; Juul 2005).

Nevertheless, there are those who do find a positive association between resource scarcity and conflict (Home-Dixon 1999; Kahl 2006; Raleigh & Urdal 2007; Urdal 2008; Fjelde & Uexkull 2012). The scarcity debate is an old one. Originally, the argument was demand-induced: population growth would outpace food production. In this vein, Urdal (2005: 430) initially found that “countries experiencing high population growth are not at a greater risk of conflict compared to countries with low levels of population pressure.” In a later study that uses subnational geographical data, Raleigh & Urdal (2007) find both high levels of land degradation and water scarcity to be related to increased conflict, although the increases in risk are small. Contesting this argument, Tir and Diehl (1998) lend support to the cornucopian argument by finding that countries with a high level of technological development are better able to mitigate the effects of population growth on conflict formation.

Nowadays, the discussion has shifted towards a supply-induced argument (or a combination of both): climate change-induced environmental degradation, along with population growth (e.g., urbanization and more mouths to feed), reduces the availability of renewables such as water and food (Hendrix & Glaser 2007). This new line of reasoning suggests two broad causal mechanisms in which climate-induced declines in resources can lead to conflict. First, fewer resources result in direct confrontation among social groups for livelihood. This argument, however, is too general. It treats the climate-conflict path as a *direct* one, overlooking specific questions about which natural resources tend to have stronger value for individuals and communities thereby making them more likely to participate in social unrest. This lack of specificity regarding how resource scarcity’s impact on conflict processes is among the central

reasons why there is little consensus among neo-Malthusian scholars (Salehyan 2008; Gleditsch 2012).<sup>15</sup>

Second, conflict can result from environmentally-induced migration. Reuveny (2007) sets forth four causal mechanisms by which migration can result in violent conflict: competition for resources, ethnic tensions, and distrust among origin and host areas. Along this line of reasoning, Gleditsch et al. (2007) believe that refugees might bring organizational structures, social networks and ideas that can mitigate the probability of conflict. However, the climate-induced migration-conflict relationship continues to be under-researched, particularly in large-N studies.

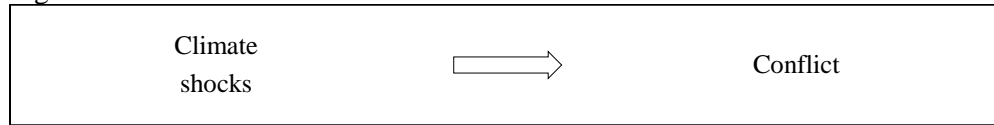
There are two big gaps in the literature. The first deals with the focus on civil war as the sole outcome of the climate-conflict nexus. Storm surges, droughts, heatwaves and flooding are among the greatest threats to natural resources, particularly in developing countries. The fact that the climate is changing is hardly new. What is novel is how the interconnectedness between climate variability and human security may have already begun to emerge, albeit slowly. If governments fail to mitigate the various and complex effects of climate change, people will react—not always be peacefully. The civil war literature suggests that the short-term costs from climate change mainly results in displays of public discontent with the goal of taking over or changing the composition of the central government. However, in terms of resource scarcity, armed conflict further decreases resource availability rather than increase it (Maxwell & Reuveny 2000). Instead anecdotal and empirical evidence indicates that in times of scarcity, public displacement of discontent often take the form of protests, marches, riots and the like (Berazneva & Lee 2013). Whereas it is not always the case, recent history suggests that such low-intensity conflicts can escalate to full-blown civil wars, as in the cases of Libya and Syria (2011), which resulted from the Arab Spring.

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<sup>15</sup> For a more comprehensive review please refer to the *Journal of Political Geography*, Volume 26, Issue 6, August 2007 and the *Journal of Peace and Research*, Volume 49, Issue 1, January 2012 for specific arguments on the topic.



Figure C. Climate-conflict nexus



The second gap in the literature is the persistence in examining a direct climate-conflict relationship (Figure C). Most studies on climate & conflict *assume* that climate change influences other factors (e.g., economic growth, water & food scarcity, energy, etc.), which in turn lead to conflict. But this assumption has two caveats. First, this assumption falls prey to a one-size-fits-all approach that treats all risk factors equally. However, economic growth stagnation and water scarcity, for instance, have different causal mechanisms that can lead to conflict. Second, correlations are not transitive (Gleditsch & Nordås 2014). A statistical correlation that establishes a link from A to B and from B to C is not sufficient to establish a link from A to C.<sup>16</sup> Two recent studies using this two-stage approach find much support for the A to C link (Koubi et al. 2012 and Bergholt & Lujala 2012).

To fill these gaps in the literature this dissertation: 1) uses low-intensity social conflicts as the principal outcome of interest, 2) it focuses specifically on the scarcity of basic resources as key risk factors for low-intensity conflict, and 3) rather than using a two-stage process, it directly tests the A–(climate change)–B(basic resources)–C (social unrest) link.

### **Climate variability, basic resources and social unrest: a theoretical framework**

Scarcity of a basic resource can occur at the household, city, regional, national, continental or global level. From country to country, the natural resource endowment determines how much a country can produce for its population. Institutions, primarily governments and their policies,

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<sup>16</sup> For example, assume that A= climate change, B= economic growth stagnation (or decline), and C= conflict.

formulate the systems that produce and distribute resources among the population, as well as export and import resources when there are excesses or shortages.

The Global Footprint Network, an international think tank, measures the balance between how much people demand from nature (ecological footprint) and the capacity of ecosystems to regenerate what people demand from those surfaces (biocapacity).<sup>17</sup> By their estimates, in 2015, Africa reached the point where it no longer had any biocapacity reserves left, but it had yet to experience a deficit in biocapacity. However, these calculations do not include the present and future impacts of climate and rainfall variability on the region's biocapacity, which are expected to exacerbate the situation.

However, as previously mentioned, increased environmental scarcity (or abundance) alone fails to account for short-term causes that “trigger” civil strife (Gleditsch 1998). As accurately pointed out by Hendrix & Glaser (2007:3), “environmental changes are so gradual that determining theoretical and empirical thresholds that, once crossed, trigger violence is extremely difficult.” De Soysa (2002) was among the first to test the causal links emanating from the neo-Malthusian literature. Using a static operationalization of natural resource endowment, his findings suggest that armed conflict is more likely at both extremes: when renewable resources are very abundant or very scarce.

A small number of *indirect* studies propose that rainfall variability affects armed conflict via economic growth. Miguel, Satyanath & Segenti (2004) find that in sub-Saharan Africa, wetter years are positively associated with income growth, and have a negative impact on the likelihood

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<sup>17</sup> The Global Footprint Network defines ecological footprint as “the area of land and water it takes for a human population to generate the renewable resources it consumes and to absorb the corresponding waste it generates, using prevailing technology. In other words, it measures the ‘quality of nature’ that we use and compares it with how much ‘nature we have.’” Biocapacity is a measurement that determined how large the material metabolism of human economies is compared to what nature can renew. Further information is available at: <http://www.footprintnetwork.org/en/index.php/GFN/>

of armed conflict. However, Koubi et al. (2012) find no statistically significant impact for the effect of climate variability on economic growth, despite the fact that economic growth in sub-Saharan Africa has increased since the beginning of the 21<sup>st</sup> century (Cho & Bienvenue 2014).

### *Economic grievances as “triggers”*

Economically, sub-Saharan Africa is not the same today as it was 25 years ago. For instance, the regions annual GDP growth was 1.6 percent in the 1990s, compared to the 5.1 percent growth in 2015—a trend that is expected to continue. Moreover, during the 1990s real GDP per capita in purchasing power parity (PPP) was \$1,615, compared to \$3,513 in 2015. This economic growth has helped alleviate poverty in the region, but this is not to say that sub-Saharan Africa is poverty free, in fact it remains the poorest region in the world.

According to a 2016 World Bank report from household surveys, the proportion of people living below than the international poverty line of \$1.90 a day, dropped from 57 percent in 1990 to 43 percent in 2012 (Beegle et al. 2016).<sup>18</sup> However, given the continuous population expansion in the region the number of people living below the poverty line increased by more than 100 million (Ibid). By some estimates, about 15 percent of the region’s population was able to climb the socio-economic ladder over the last decade, a modest but significant achievement.<sup>19</sup> The biggest shift occurred with people transitioning from extreme poverty (<\$2.00 a day) towards low income (\$2.01–\$10.00).

While this shift is good news, it is also a frail development. This “rising poor” segment is not to be confused with a middle class. Recent household-panel survey data indicates a substantial likelihood of falling back into poverty when individuals lack skills, education or assets (such as

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<sup>18</sup> In 2011 international purchasing power parity.

<sup>19</sup> Pew Research Center utilizes 2011 purchasing power parity dollars.

land) to sustain their economic level above the poverty threshold. What is more, these individuals are *more likely* to fall back into poverty “if they are hit by unemployment, illness, a disability, *extreme climate events* or conflict” (ODI 2014). In a region where the majority of the population is employed by the agricultural sector—which in turn depends heavily on rainfall—climatic shocks have the potential to make people fall back into poverty. As described by Bates (1981), the issue that most frequently drives Africans to militant action is the erosion of their purchasing power. This argument hinges on two basic assumptions. First, despite the callousness of the assertion, people in extreme poverty (\$2.00 or less) are, in a sense, used to living without being able to afford adequate nourishment. Second, this segment of the population is more likely to be targeted by domestic and international welfare programs aimed at reducing hunger. In other words, individuals who repeatedly lack food or water have adapted to their situation and cannot be mobilized to protest for two reasons. First, the loss of economic affluence is not a “trigger” among the poor, their likelihood of their participation in social unrest is low.<sup>20</sup> Second, impoverished individuals should be less likely to partake in social unrest due to the various physiological effects of malnutrition.

Thus, I argue that when climatic shocks occur and threaten economic prosperity, feelings of relative deprivation closely follow. On the one hand, feelings of relative deprivation can develop from inter-group, inter-individual or temporal comparisons (Sayles 1984). Inter-group and inter-individual deprivation has its roots on comparisons made of a group’s or individual’s socio-political and economic circumstances with those of more advantaged groups or individuals (inequality). On the other, feelings of relative deprivation can also steam from temporal changes in well-being (e.g., income) that generate a sense of harm (Hendrix & Haggard 2012).

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<sup>20</sup> Even though social unrest may be initiated by so-called “rising poor,” the extremely poor will surely follow suit should unrest continue.

Figure D. Theoretical approach for this research

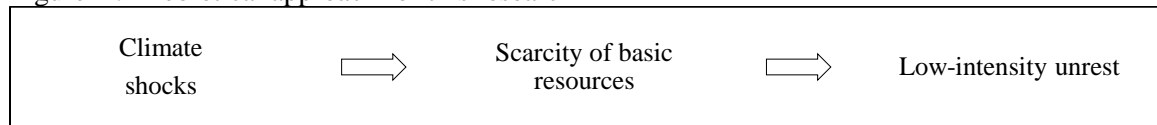


Figure D summarizes the causal mechanisms offered in this dissertation. When climate shocks occur, the capacity of basic resources like food, water, and grazing land can decline. After years of economic growth in sub-Saharan Africa, people's expectations for well-being have steadily increased. Thus, when individual's economic capabilities are not able to keep up or even decline as a result of climate shocks, feelings of economic frustration can motivate individuals to exhibit aggressive behavior that can culminate in social unrest. In effect, those individuals who were able to improve their economic situation will fear falling back into poverty.

While poverty, inequality, social exclusion, and other sources of grievances are present in most societies, not every country experiences episodes of conflict. However, access to basic resources such as water and food are fundamental needs for human survival. Moreover, the agriculture sector employs up to 60 percent of Africa's labor force. Thus, a good harvest provides income security for many. Because climate shocks result in a sudden reversal of fortunes, we can expect individuals that have risen out of poverty and fear falling back into it, to develop a sense of relative deprivation that will incentivize them to participate in low-intensity forms of social unrest.

To summarize, I argue that when those who have modest economic means to secure renewable resources fail to do so—either because of poor institutional access or as a result of climate shocks that limit them— will experience intensified feelings of temporal deprivation toward the state that can lead towards social unrest participation. Consequently, it is not the poorest of the poor who are most likely to participate in low-intensity social unrest, but rather those who over the last 20 years have managed to climb the economic ladder.

## **Institutions matter**

It is important to mention that not every case of scarcity results in conflict. Giordano et al. (2005) argue that limiting the debate to demand- or supply-induced scarcity is too narrow. The authors do not deny the importance and potential effects of resource scarcity; however, their primary focus is to examine whether countries with poor institutions are at greater risk of international conflict. However, weak institutions do not only increase the risk of international conflict, but also have an important role to play in preventing conflicts within countries (Bennett et al. 2001; Elhawary 2007). When food prices rise, for example, socioeconomic and political grievances exacerbate a general sentiment that the government has failed. Availability and affordability of basic resources is an unequivocally essential aspect of the social contract between constituents and political leaders. Therefore, declines in renewables have a clear political consequence.

Political institutions play an important role. On the one hand, governments can embrace market liberalization in a relatively comprehensive and sustained manner, with intervention mostly limited to regulating the playing field, investing in infrastructure, encouraging diversification of food consumption patterns, and principally relying on private trade to stabilize prices (Jayne et al. 2010; Gouel 2013). On the other, governments can implement a more partial liberalization process, in which the private sector operates but governments also intervene in food markets, mainly through marketing boards and discretionary trade policy tools such as export bans, changes in import tariff rates, and direct government importation (Minot 2014). Chapoto and Jayne (2009) argue that countries that embracing market liberalization (e.g., Mozambique and Senegal) are more likely to increase food production, whereas countries whose governments directly intervene (e.g., Zambia, Tanzania and Kenya) have had a stagnant food production sector. While in fact government intervention can stagnate food production, such intervention can also mitigate food-

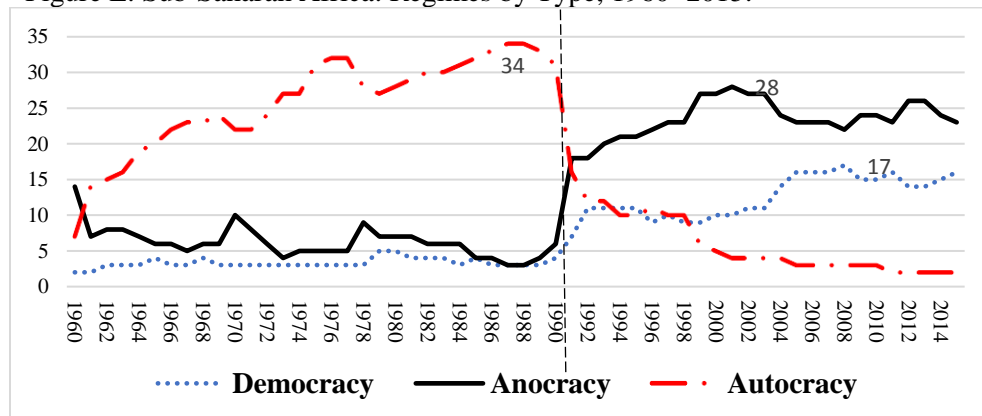
related social unrest. For instance, during the 2007–2008 food riots Mozambique and Senegal experienced food riots while Zambia, Tanzania and Kenya did not (Berazneva & Lee 2011).

Moreover, political institutions can play an important role in the mitigation of conflict, particularly non-violent conflict. Two dominant approaches address the question of different levels of coercion and popular protest: the inverted-U hypothesis and the backlash hypothesis. The first view argues that lower levels of repression open new opportunities for challengers to collectively act to make claims against the state (Eisinger 1973; Tilly 1978; Tarrow 1994). Eisinger (1973) sought to explain why some U.S. cities experienced riots during the 1960s while others did not. Focusing on the “openness” of urban governments that allowed for more conventional ways to expose grievances, he found that by being more accessible (open) towards individuals expressing their discontent, cities could discourage social unrest, while cities with less access for constituents to express grievances experienced more unrest. Five years later, Tilly (1978) built on Eisinger’s work by making national comparisons. Both scholars support the relationship between political opportunity and social unrest to be a curvilinear one. On one side, “open” regimes provide frequent access to their constituents to express their grievances vis-à-vis institutions; this allows for the prospect of social unrest to become less appealing given that less costly venues exist to achieve their goals. In other words, democratic countries have strong institutions where public officials are more likely to mitigate and respond to constituent grievances; however, when these mechanisms fail, protests, riots and demonstrations serve as counteractive responses. On the other end of the curve, “closed” regimes tend to be highly repressive and usually prevent their citizens from developing the organizational means to express their grievances. They are also less inclined to observe citizens creating disruption in the streets. Such repression deters popular mobilization and stifles it should it occur (Goodwin 2001). In

light of these two extremes, social unrest occurs when there is space for tolerance by a polity and when individuals are neither sufficiently free to make regular claims, nor so repressed as to prevent them from trying to do so.

The second approach claims the opposite; repression, in fact, facilitates social unrest. While some scholars claim that repression can dissipate mobilization efforts (Zwerman et al. 2000), others argue that repression can lead to new mobilization via backlash events that foster a collective sense of “defiance and increase organizational solidarity among diverse and loosely connected movements” (Stockemer 2012: 205; Meyer & Staggenborg 1996; Brockett 1995; Choi 1999). When elites use repressive techniques to diffuse mobilization, these techniques sometimes fail and backfire, opening political opportunities for mobilization. A backlash can occur around police brutality or media censorship or other kinds of repressive events that are perceived as unjust and can generate public outrage without necessarily being directly linked to collective action (Hess & Martin 2006). However, two conditions must be met for a repressive event to generate a backlash. First, the audience must perceive the event to be unjust and second, information about the event must be broadly communicated to targeted audiences that are substantial enough for public officials to take their outrage into consideration.

Figure E. Sub-Saharan Africa: Regimes by Type, 1960–2015.



Source: POLITY IV



As depicted in Figure E, hybrid regimes have been the dominant regime type in sub-Saharan Africa since the end of the Cold War. According to the typology of authoritarian regimes developed by Barbara Geddes (1991), the region is plagued by so-called *personalist* regimes.<sup>21</sup> Personalist regimes tend to have narrow support bases (Geddes 1991, 1999). In order to sustain the longevity of the regime, personalist leaders distribute benefits and patronage to their support bases in order to appease them and avoid challenges to the regime, often disenfranchising and provoking excluded elite groups and the general population. Therefore, those excluded from the leader's benefits are more likely to challenge the regime, even when the penalty for unsuccessful attempts may be high.

With this in mind, I argue that there are two key reasons why hybrid regimes are more likely to experience protest when renewable resources decrease. First, most hybrid regimes have institutions and elections similar to those in democracies. These institutions allow for citizens' grievances to be voiced while strategically allowing the formation of some opposition groups and political parties that can help sustain an illusion of control and progress. This signals to the citizenry that dissent is tolerated and in some cases, concessions from the government are not far-fetched.

Second, because the survival of political leaders in personalist regimes is dependent on the distribution of benefits and patronage to their support base, political leaders in these regimes are more vulnerable to economic and external shocks that reduce the amount of benefits available to distribute (Bates 1981; Geddes 1991, 1999). Therefore, in times of renewable resource shortages from climatic shocks, political leaders will ration renewable resources in order to shield

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<sup>21</sup> Regimes where political leaders successfully draw support from the organization that brought them to power while limiting their supporters' influence on policy and personal decisions (Geddes 1991).

their support base from scarcity and its harmful outcomes. By doing this, political leaders are able to appease their support base and avoid challenges to the regime, giving no systematic preference to the rest of the population.

However, when climatic anomalies disrupt the supply of a renewable resource such as water or food, the demand of that renewable remains constant, or in some cases, increases. Therefore, when climatic shocks occur and political leaders ration, structural scarcity is exacerbated, further limiting the accessibility of resources to consumers (Homer-Dixon & Blitt 1998). When restrictions on renewable resources increase, deepened economic grievances can heighten and trigger episodes of social unrest.

**Alternative argument: *Technological innovation***

Economic optimists argue that, in response to profit opportunities, entrepreneurs will develop new technologies to *prevent* scarcity of renewable resources. Human ingenuity is commonly portrayed as the savior that will introduce technological innovations to mitigate scarcity. An often cited example is the development of crop breeding technologies that increased per-acre grain production and sparked the Green Revolution of the 1960s. To be able to feed a growing global population on a warming planet, we will need a second Green Revolution. There are two competing approaches on how to successfully achieve this goal. The first approach advocates to continuing and improving work on crop genetic techniques to design drought- and flood-resistant crops. The second approach champions a more organic approach: crop rotation. Planting a greater variety of crops adds nutrients to the soil, decreases pest cycles (reducing pesticides use), and helps to mitigate the effects of erratic climate when farmers do not depend on a single crop. A more nutrient-rich soil

and a lower pest cycles has been shown to increase crop production in some sub-Saharan countries (TerAvest et al. 2015).

While crop rotation may be a more economically viable option for small-scale farmers in sub-Saharan Africa, anecdotal evidence suggests that most African governments currently favor new crop modification technologies. In 2015, only Burkina Faso, South Africa, Egypt and Sudan had released genetically modified crops in to their national markets. However, because most African countries lack the necessary technological ingenuity to develop these technologies themselves, their acquisition is largely dependent on for-profit corporations.<sup>22</sup> Once the technologies are successfully introduced into national markets, farmers can purchase the seeds. However, to sustain profits, most corporations require farmers to sign agreements stipulating that they cannot save and replant seeds produced from the purchased seeds. Therefore, seeds must be purchased on a yearly basis.

Deploying new agricultural tools to sub-Saharan Africa has two downsides. First, genetically modified seeds tend to be more expensive than non-genetically modified seeds. On average, farming households have an annual income of \$2,989 and an average of six people per household. By contrast, non-farm workers have, on average, smaller household sizes and twice the income (Tortora 2014). Second, these technologies have begun to fail, sparking concerns about how else these technologies may fall short. For instance, corn rootworms have begun to adjust and weeds have become more resistant to pesticides (Royte 2013). There is no doubt that an African Green Revolution is in the works. What form it will take remains to be seen.

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<sup>22</sup> Ingenuity is defined as ideas applied to solve a practical social and technical problems (Homer-Dixon 1995).

## **Research Expectations**

I borrow from the literature on conflict and environmental security and apply it to determine whether scarcity of basic resources, caused by climate change, has already begun to negatively impact social cohesion in sub-Saharan Africa. I have three key expectations for this research. First, in order to gauge if a two-track scenario between structural & supply-induced scarcity is now unfolding, the first empirical chapter tests for structural-induced scarcity. I then examine for a supply-induced scarcity and its potential effect of two distinct types of low-intensity forms of social unrest: peaceful & violent unrest and communal violence. I expect that the introduction of an interaction variable to the climate-conflict nexus will help clarify the causal mechanism that scarcity of resources from climate change can lead to various conflict processes. If it is the case that climate change has begun to negatively impact resource scarcity, and in turn, that scarcity increases the likelihood of low-intensive forms of unrest, several policy implications will be suggested.

Second, I expect wealthier countries to be more likely to experience social unrest. Bearing in mind the economic prosperity of the region that has lifted millions out of poverty since the turn of the century, I believe that when climate shocks befall economic grievances arise and/or intensify as a result of temporal changes in income. Finally, I expect hybrid regimes who selectively tolerate public displays of dissent against the regime to be more likely to experience social unrest. It has been suggested that among the reasons why hybrid regimes tolerate dissent is to collect information about the citizenry who would otherwise may fear speaking against the state (Wintrobe 1998). In other words, dictators can never truly know what their subjects think of them (Hendrix et al. 2009). Because of this, rulers in hybrid regimes tend to rely on the support of a narrow base of followers who receive preferential treatment in times of instability as well as punish

defection. For instance, during the ongoing 2016 drought facing Zimbabwe, President Mugabe made good on his threat to take farm land from party defectors. The seized land given to party loyalists, citing the need to expand crop production (Onishi 2015). All hypotheses and main dependent variables are displayed in table 2.1.

Table 2.1—Summary of hypotheses

Chapter	Hypotheses	Testing for/Dependent variable
<b>Three</b>	<p>H1: People who go without enough water or food will be more likely to protest, compared to those who report otherwise.</p> <p>H1a: People who seldom go without water or food will be more likely to protest, compared to those who always go without these basic needs.</p> <p>H2: People who report being employed in any sector of the economy, compared to those who report being unemployed, will be more likely to protest when access to food or water is limited.</p>	<p>Structural-induced scarcity  <i>Outcome:</i> protest participation</p>
<b>Four</b>	<p>H1: The interaction between extreme deviations from average <i>rainfall</i> patterns and cereal yields should be associated with an increase in the frequency of violent and peaceful unrest.</p> <p>H2: The interaction between extreme deviations from average <i>temperature</i> patterns and cereal yields should be associated with an increase in the frequency of violent and peaceful unrest.</p>	<p>Supply-induced scarcity  <i>Outcome:</i> peaceful &amp; violent unrest</p>
<b>Five</b>	<p>H1: Land degradation should be positively associated to the frequency of communal violence.</p> <p>H2: <i>Precipitation</i> deviations from average patterns should increase the frequency of communal violence.</p> <p>H3: The interaction of extreme deviations from average rainfall patterns and land degradation should be associated with an increase in the frequency of communal violence.</p> <p>H4: Above-average <i>temperature</i> years should increase the frequency of communal violence.</p> <p>H5: The interaction between above-average <i>temperature</i> years and land degradation should be associated with an increase in the frequency of communal violence.</p>	<p>Supply-induced scarcity  <i>Outcome:</i> communal violence</p>

Since record keeping began fifteen of the sixteen warmest years in the planet have occurred since 2001, with 2016 predicted to be the warmest yet. Finding that climate change has already begun to negatively impact basic resources, and as a result of that scarcity, increased the frequency of low-intensity conflict can have significant impacts for scholars and policy makers alike. If neo-Malthusian scholars are correct, a warmer planet could mean less resources for a growing population over the next 25 years. With this in mind, one important question is raised: will conflict become the new normal in resource scarce societies?

Each of the following chapters addresses different pathways by which scarcity of basic resources can spark social unrest. Chapter three begins with an analysis of structural-induced scarcity of food and water at the micro-level, and potential triggers conducive towards popular protest. Shifting towards a more state-centric approach, chapter four examines whether temperature and precipitation anomalies have begun to negatively impact crop yields, and in turn, this scarcity increased the frequency of violent and peaceful unrest. The fifth chapter examines the potential role of precipitation and temperature anomalies on communal violence via land degradation in sub-Saharan Africa, where state institutions are unable to reach in order to mitigate conflict episodes.

## **THREE**

### **ACCESS TO BASIC RESOURCES AND POPULAR PROTEST**

Access to water and food across sub-Saharan Africa lags behind all other regions in the world. While this phenomenon is not a recent development, the 2007–2008 and 2011 spikes in food prices, which culminated in demonstrations and riots throughout 48 countries across the world, have invigorated the debate regarding food prices and social unrest (Weinberg & Bakker 2014; Bellemare 2014). However, much of the current research on access to basic resources is limited in two ways. First, current arguments have focused mostly on food access while largely ignoring access to clean water for household use. Second, academic research has failed to incorporate access to basic resources such as food and water into the literature on protest participation. This research addresses these gaps within the literature.

This chapter makes two contributions to the literature on food insecurity and protest participation. First, it uses a broad measurement that incorporates all aspects that can limit access, not only price increases. This is done to better grasp whether overall poor access to food and water can be good motivators for participation in social unrest. Previous literature examining this nexus has largely focused on food prices as the main motivation for protest participation (van Weezel 2013; Smith 2014). Second, this research builds on previous literature by investigating the relationship between protest participation and access to food and water by using three cross-national Afrobarometer surveys. Doing this allows for a more precise way to gauge whether changes in access to food or water within countries influenced protest participation at three distinct points in time.

## Access denied

Africa is home to some of the most water-deprived and nutritionally insecure people in the world. UN-Water defines water security as when “populations have access to safe, sufficient and affordable water to meet basic needs for drinking, sanitation and hygiene, to safeguard health and well-being, and to fulfill basic human rights (WWAP 2015).” However, in sub-Saharan Africa, 30 percent of the total population does not have adequate access to an improved source of drinking water (WWAP 2015).<sup>23</sup> Similarly, about 20 percent of the region’s population is undernourished.<sup>24</sup> The FAO defines food security “as a situation when all people, at all times, have the physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and preferences for an active and healthy life.”<sup>25</sup>

Access to a basic resource such as water or food has four dimensions: economic, physical, socio-political and climatic. The economic dimension refers to the ability of individuals or households from being unable to purchase water, food, or the necessary items to produce enough food, as well as the presence or absence of social safety nets that can provide such access for those who could not otherwise do so (Hendrix & Brinkman 2013). The physical dimension can be explained by a situation where food is poorly distributed from one part of the country to another due to poor infrastructure such as storage facilities, roads, port facilities and the like. As shown in table 3.1, Africa lacks a robust transportation infrastructure. The percentage of paved roads out of the total road network is lower in most sub-Saharan African countries than in any other region in the world (World Bank, 2013a).

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<sup>23</sup> World Bank Indicators, 2015 [improved water source] at: <http://data.worldbank.org/indicator/SH.H2O.SAFE.ZS>

<sup>24</sup> World Bank Indicators, 2015 [prevalence of undernourishment] at: <http://data.worldbank.org/indicator/SN.ITK.DEFC.ZS>

<sup>25</sup> For more information, please visit: <http://www.fao.org/economic/ess/ess-fs/en/>



Table 3.1 Infrastructure in selected African countries

	<b>Paved roads over total roads (%)</b>	<b>Road density (per 100 km<sup>2</sup> of land area)</b>	<b>Rail lines density (per 100 km<sup>2</sup> of land area)</b>
<b>Benin</b>	9.5 (2004)	16.6 (2004)	0.7 (2008)
<b>Botswana</b>	32.6 (2005)	4.4 (2005)	0.2 (2012)
<b>Burkina Faso</b>	20.6 (2011)	5.6 (2011)	0.2 (2012)
<b>Burundi</b>	10.4 (2004)	44.3 (2004)	<i>n/a</i>
<b>Cameroon</b>	10.1 (2010)	10.5 (2010)	0.2 (2012)
<b>Chad</b>	1.0 (2000)	3.1 (2006)	<i>n/a</i>
<b>Congo</b>	7.1 (2009)	5.0 (2009)	0.2 (2007)
<b>DRC</b>	1.8 (2004)	6.5 (2004)	0.2 (2012)
<b>Ethiopia</b>	13.7 (2007)	4.0 (2007)	0.1 (1991)
<b>Gabon</b>	12.0 (2007)	3.4 (2007)	0.3 (2012)
<b>Ghana</b>	12.6 (2008)	45.9 (2009)	0.4 (2008)
<b>Kenya</b>	7.0 (2011)	27.7 (2011)	0.3 (2006)
<b>Madagascar</b>	16.3 (2011)	6.4 (2011)	0.1 (2008)
<b>Nigeria</b>	15.0 (2004)	20.9 (2004)	0.4 (2007)
<b>Niger</b>	20.6 (2008)	1.5 (2010)	<i>n/a</i>
<b>Tanzania</b>	14.9 (2009)	9.1 (2011)	0.3 (2006)

*Source: World Development Indicators*

The socio-political dimension exists when the physical and economic components are present but people are deprived from accessing enough food or water. For instance, this deprivation can result from poor government policies that interfere with markets, inhibit trade and discourage farmers from expanding production. Similarly, corruption can limit access to these necessities. In many sub-Saharan countries, government officials often profit by selling grain reserves to a middlemen, who then sells the grain to the local markets at higher prices, making it less affordable for consumers.<sup>26</sup> Furthermore, access can be limited based on the identification with a particular social group or gender. For example, a recent empirical study conducted in southwestern Ethiopia, for example, revealed that girls were more likely than boys to be undernourished in food-insecure households (Hadley et al. 2008).

Erratic climatic conditions are the final dimension that can limit access to food and water. Drought or flooding conditions can temporarily decrease the amount of food available at the local,

<sup>26</sup> Corruption's role in Kenyan food crisis: <http://news.bbc.co.uk/2/hi/programmes/newsnight/9624731.stm>

regional or national level, making food scarcer. Similarly, when precipitation is lower than average for long periods of time, the flow of streams and rivers declines, water level in lakes and reservoirs falls, and the depth of water wells increases. Thus, when dry conditions persist, water supply can temporarily decrease access to water for large segments of the population. In a region where hundreds of thousands often go without enough food to eat and clean water for household use, what, if any, are the social consequences?

### **The micro consequences of poor access to water and food**

Do people protest when poor access to food and water occurs? Anecdotal evidence from across the world suggests that they do. In 2007, hundreds of farmers protested in several rural districts of West Bengal, India, over a shortage of food brought on by extensive corruption in the food distribution system. According to India's Central Bank, about 28 percent of the population in West Bengal lived below the poverty line in 2011—a number that climbed to 36% by 2013.<sup>27</sup> To improve food access in the region, the central government allowed private vendors to sell heavily subsidized food to the rural population. The entire distribution system is controlled by politically supported private contractor, which often leads to high levels of corruption. According to a government-sanctioned report, most of the rural poor in the area were not receiving regular supplies of the food to which they are entitled—only six percent of poor villagers received their rations. The report further found that about 35 percent of rice and 87 percent of wheat meant to be delivered to the region got diverted into open markets or stolen. As a result of the scheme, rural dwellers who were able to pay were paying higher prices for low quality-food.

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<sup>27</sup>Reserve Bank of India. 2011-2013. "Number and Percentage of Population Below Poverty Line" Retrieved [July 19, 2016] at: <https://www.rbi.org.in/scripts/PublicationsView.aspx?id=15283>

Poor access to water can also result in episodes of social unrest. In February 2016, protesters in Modimolle, South Africa, a town of about 40,000 residents located 115 miles away from Johannesburg, took to the streets to demonstrate their anger over a four-month shortage of water in the area. Local newspapers reported that protesters had complained for months to the authorities, who ignored their complaints about the lack of piped water and the poor quality of the water being delivered to them by tankers (Fuku 2016). Residents were further incensed by accusations that the local government had been discriminating against the poor when it was discovered that suburban residents in the area were receiving clean water from the government.

Most recently, evidence from Venezuela shows how poor government policies can turn into a full-blown food crisis. The 2014 drop in oil prices, which account for almost half of the country's export income, the government has been unable to produce or import enough food for the country. As predicted by the law of supply and demand, food scarcity saw prices skyrocket to the point that 72 percent of monthly wages are being spent on food (Casey 2016). As a result, peaceful and violent protest events have become all too common in the streets of major cities around the country.

While these cases may appear isolated (and in some occasions extreme), they corroborate the theory that limited access to basic needs such as food and water can increase the likelihood of social unrest events. But under what conditions? Poor access to a basic resource can lead to acute or chronic food or water insecurity. *Acute* insecurity refers to the temporary gaps in access that result from the collapse of any of the four dimensions that lead to access: economic, physical, socio-political and climatic. By contrast, *chronic* insecurity is a constant lack of sufficient and safe food or water to maintain a healthy and active lifestyle and is mostly caused by extreme poverty. As shown in table 3.2, data from the last four Afrobarometer survey rounds indicate around half

of the sampled population had, at least once, gone without enough food to eat or without enough clean water for household use during the previous year. Undoubtedly, poor access to food and water is the most basic form of deprivation that can be experienced by any person, but is this limitation of access enough to motivate protest participation? All three anecdotal cases presented above have one thing in common: the realization that an injustice was being committed by the governments, either by creating it or failing to prevent it. In most cases, the decline in access to food or water often resulted in people having to spend even more of their income to bridge the gap, and few things drive people to militant action more than the erosion of their purchasing power (Bates 1981).

Table 3.2 Over the past year, how often, if ever, have you or anyone in your family gone without enough [water/food]? (%)

	2005/2006 (Round 3)	2008/2009 (Round 4)	2011/2013 (Round 5)	2014/2015 (Round 6)
<b>Food</b>				
Never	46.7	43.9	46.6	53.0
At least once	53.0	56.0	53.3	46.9
Missing/unknown	0.3	0.1	0.1	0.1
<b>Water</b>				
Never	51.7	51.7	49.5	54.4
At least once	48.1	48.2	50.3	45.6
Missing/unknown	0.2	0.1	0.2	-

Source: Afrobarometer<sup>28</sup>

Popular protests do not occur by chance. Protests are not the result of a curious planetary alignment; rather, individuals choose to participate in them. For some time, scholars have suggested that poverty (Collier et al. 2003), lack of schooling (Collier 2000; Brett & Specht 2004), and unemployment (Goldstone 1991, 2001) are strong stimuli for an individual's motivation to participate in civil strife. However, these mechanisms remain empirically unclear at the micro-

<sup>28</sup>Afrobarometer Data, Rounds 3–6, 2005–2015, is available at: <http://www.afrobarometer.org>. Samples usually include either 1,200 or 2,400 cases. A randomly selected sample of n=1200 cases allows inferences to national adult populations with a margin of sampling error of no more than +/-2.8% with a confidence level of 95 percent. With a sample size of n=2400, the margin of error decreases to +/-2.0% at a 95 percent confidence level.

level and require further examination, particularly in Africa (see Justino 2009 for mixed micro-level evidence). The first task here is to find whether a statistical relationship exists between poor access to food and water and protest participation. Because poor access to basic resources is the most basic form of deprivation, I argue that when individuals have experience limited access that threatens their livelihoods, feelings of relative deprivation closely follow. Particularly those feelings rooted in inter-group and inter-individual comparisons (Sayles 1984). Therefore, to test this I hypothesize that:

H1: People who go without enough water *or* food will be more likely to protest, compared to those who report otherwise.

The second task is to examine which individuals, if any, are more likely to protest: those who seldom go without access or those who constantly do so. Theoretically, people who report always going without food or water suffer from chronic insecurity due to extreme poverty. I argue that chronically insecure people should be less likely to protest than acutely insecure people. This argument hinges on two basic assumptions. First, despite the callousness of the assertion, people in extreme poverty (\$2.00 or less per day) are, in a sense, more used to living without being able to afford adequate nourishment. Second, this segment of the population is more likely to be targeted by domestic and international welfare programs aimed at reducing hunger. In other words, individuals who normally lack food or water have adapted to their situation and cannot be as mobilized to protest. That is to say, impoverished individuals should be less likely to partake in social unrest due to the various physiological effects of malnutrition. Thus, the following corollary hypothesis is proposed:

H1a: People who seldom go without water *or* food will be more likely to protest, compared to those who always go without these basic needs.

The final task is to gauge whether economic grievances play a role in protest participation. The opportunity cost model suggests that participation in social unrest should decrease as incomes rise; essentially, participation is regarded as a problem of unemployment. However, recent literature on popular protest in Africa finds that employed individuals have more to lose by *not* participating (Snow & Oliver 1995; Van Zomeren et al. 2008). In a region where households spend a high percentage of their income on basic needs, fluctuations in access to water or food are often accompanied by the need to spend even more income to acquire such resources. For instance, in 2008, Algerians, Cameroonians, Kenyans, Nigerians and South Africans spent 43%, 40%, 44%, 40% and 20% of their total annual incomes on food, respectively.<sup>29</sup> Therefore, one should expect individuals who are accustomed to a stable increase in their wellbeing by being employed to be the first to take to the streets when poor access to food or water diminishes, rather than those who have nothing to lose. The reason for this is that those individuals with a stable (or improved) economic situation will fear poverty (or falling back into poverty). Thus, I hypothesize that:

H2: People who report being employed in any sector of the economy, compared to those who report being unemployed, will be more likely to protest when access to food or water is limited.

## Research Design

I test my hypotheses using survey data from three distinct Afrobarometer surveys. The summary of main sample statistics is displayed in table 3.3. Overall, the sample includes data from almost 86,000 respondents from sub-Saharan Africa between 2005 and 2013. Afrobarometer surveys have increased the number of countries included with every passing round; therefore, not every country

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<sup>29</sup> USDA/Economic Research Service, 2008.

appears in every wave. I examine 18 countries from the third round (2005–2006), 20 countries from the fourth round (2008–2009), and 29 countries from the fifth round (2011–2013). Each survey round is examined independently to better gauge all dimensions that can lead to poor access

Table 3.3 Summary of main sample statistics

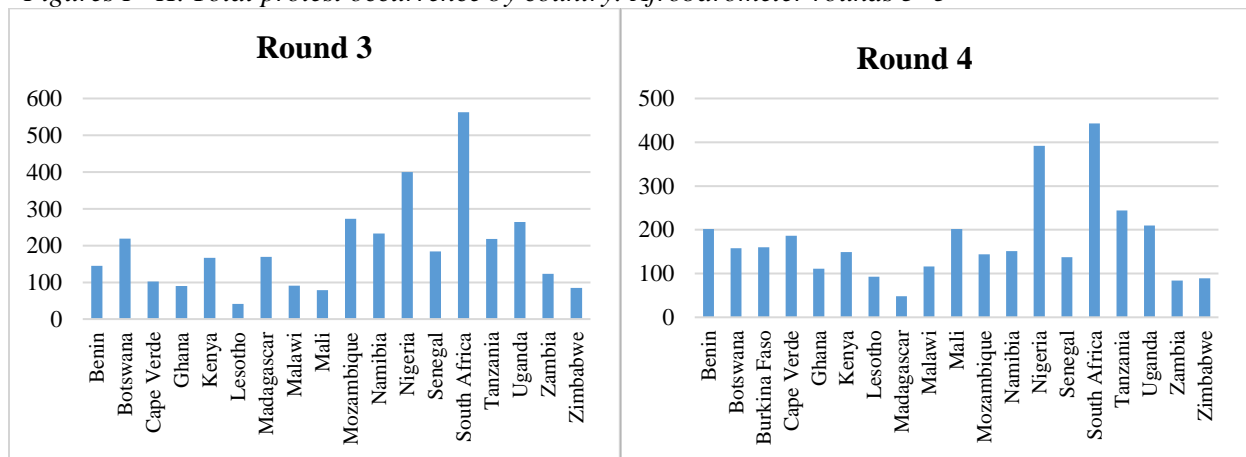
	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
<b><i>Round 3</i></b>				
Protest/march attendance	0.13	0.34	0	1
Food access	1.11	1.25	0	4
Water access	1.13	1.38	0	4
Employment status	0.59	0.83	0	2
Membership association	0.46	0.84	0	3
Interest in public affairs	1.86	1.08	0	3
Regime	1.16	0.55	0	2
Age	36.62	14.81	18	130
Gender	0.50	0.50	0	1
Education	3.140	1.99	0	9
Urban dweller	0.38	0.48	0	1
<b><i>Round 4</i></b>				
Protest/march attendance	0.12	0.33	0	1
Food access	1.14	1.22	0	4
Water access	1.07	1.32	0	4
Employment status	0.52	0.78	0	2
Membership association	0.67	0.95	0	3
Interest in public affairs	1.76	1.11	0	3
Regime	1.21	0.56	0	2
Age	36.33	14.50	18	110
Gender	0.49	0.50	0	1
Education	3.14	2.02	0	9
Urban dweller	0.37	0.48	0	1
<b><i>Round 5</i></b>				
Protest/march attendance	0.08	0.28	0	1
Food access	1.12	1.23	0	4
Water access	1.19	1.38	0	4
Employment status	0.32	0.46	0	1
Membership association	0.67	0.96	0	3
Interest in public affairs	1.65	1.11	0	3
Regime	1.11	0.53	0	2
Age	37.08	14.61	18	105
Male	0.49	0.50	0	1
Education	3.20	2.06	0	9
Urban dweller	0.37	0.48	0	1

to water or food without over estimating the spike in food prices during 2008–2009 and 2011. To analyze the relationship between access to food or water and protest participation, I use a logistic regression, given the binary nature of the dependent variable, and multilevel random effects given that the data are based on survey responses of individuals nested within countries. This method allows me to control for cross-country variance and to correct for clustering in the data.

### *Dependent variable*

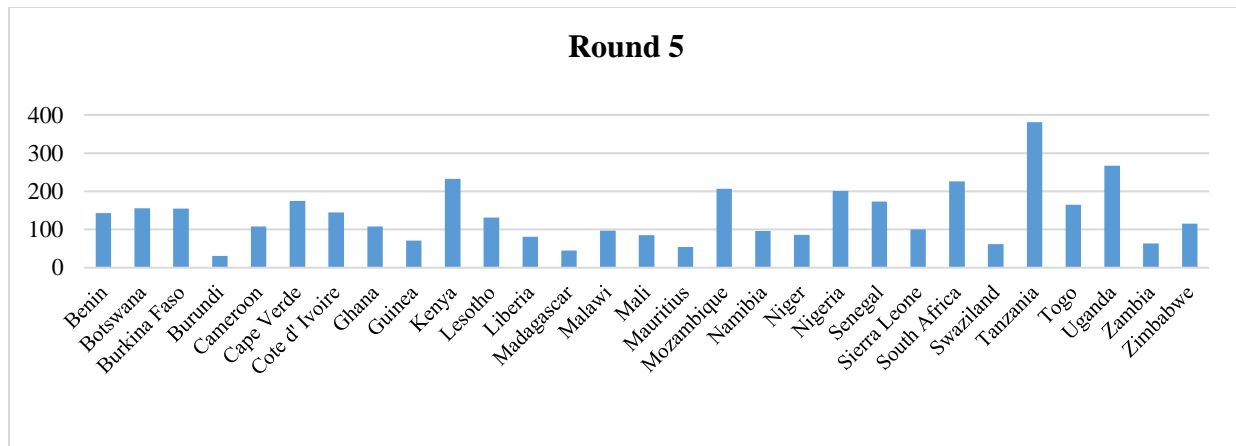
The dependent variable is protest participation. It is important to note that the dependent variable is not only limited to food or water riots, which is admittedly a limitation of this study. Given the complexly interwoven socio-political, physical, economic and climatic factors and access to food and water, the dependent variable encompasses all types of protest. Building on previous research, protest participation is a binary variable coded 1 for individuals who report having attended a protest or a march during the previous year, and 0 if otherwise. Figures F–H display a comparison of protest occurrence by country in each Afrobarometer sample used in this study.<sup>30</sup>

*Figures F–H. Total protest occurrence by country: Afrobarometer rounds 3–5*



<sup>30</sup> All Afrobarometer questions and the coding scheme used are located in the appendix.





### *Independent variables*

The main independent variables are access to food and water. Access to each resource is coded from 0 to 4, where the lowest number represents people who report never going without water or food. The highest number reflects those who report always going without enough water or food. This variable is labeled “access to basic need.” I expect the coefficient of both independent variables to be positive and significant, indicating that, *ceteris paribus*, people with limited access to food or water are more likely to protest than those with uninterrupted access.

Another variable of interest is employment status. Afrobarometer respondents are not asked to report their income, due to the high number of individuals who operate in informal networks where cash transactions are unrecorded and difficult to measure (Bratton 2008). Therefore, employment status is used to account for peoples’ economic condition for two reasons. First, people who report being employed, regardless of employment sector, are more likely to have a steady income source and therefore a better opportunity to purchase water and food. Second, contrary to the literature on protest participation that suggests that employed individuals are *less likely* to protest,<sup>31</sup> I argue, as others have before me, that employed individuals are *more likely* to

<sup>31</sup> The literature suggests two reasons for this. First, employed individuals have less free time. Second, employed individuals may be unwilling to risk their employment situation given the potential risks associated with participation (e.g., arrest) (McAdam 1986; DiPasquale & Glaeser 1996).

protest for two reasons. First, when water and food prices increase due to poor access, employed individuals become fearful of being unable to adequately provide for themselves and/or their household if they fall (or fall back) into poverty.<sup>32</sup> Second, workers are more likely to belong to civic organizations, workers' unions or farmers' associations, which allows for the spread of grievances among like-minded people (Bratton et al. 2005).

Several controls are included in the analysis. First, I control for four individual factors: education, age, gender and residential location (urban or rural). A plethora of U.S. studies have linked education to increased political participation. Empirical studies suggest that education is positively associated with political participation (Verba et al. 1995; Rosenstone & Hansen 1993). However, the relationship between education and political participation is less established in Africa (see Bratton et al. 2005; Kuenzi 2006; Dionne et al. 2014). To avoid the possibility of omitted variable bias, I control for education in the analysis.

Age has been found to be a strong determinant of participation in protest and broader variations of social unrest, including armed conflict (Wiltfang & McAdam 1991; Goldstone 2001; Urdal 2014). Young people, particularly the poor and unemployed, have been shown to be more prone to join armed groups as an alternative way to generate income (Collier 2000), among other reasons. Theoretically, young people have fewer of the time constraints usually associated with full-time employment and family responsibilities. Therefore, I expect young individuals to be negatively associated with protest participation.

The literature on political violence (Mesquida & Wiener 1996; Elbadawi & Sambanis 2000), as well as that on criminal violence (Neapolitan 1997; Neumayer 2003), has embraced the notion that men are more likely to participate in acts of violence than are women. It has been

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<sup>32</sup> This does not imply that poor people are excluded from protest participation or that they do not join the middle class in protesting for a perceived public good.

proposed that young men are more hostile due to high testosterone levels (Goldstein 2001; Hudson & den Boer 2004). However, in sub-Saharan Africa, women provide most of the labor in collecting water, dominate the agricultural sector and carry primary responsibility for raising children. They are therefore more likely to be highly sensitive to changes in food and water access. As a result, I do not have any expectations regarding the directionality of this variable. To control for gender, a binary variable indicating whether the respondent is a man or a woman is coded 1 or 0 respectively.

Urban dwellers ought to be more affected by poor access to food and water, given their greater dependence on income to make ends meet and compared to rural dwellers who can directly access water and food from or around their land. Moreover, city-life proximity helps to spread emotions of anger and frustration, intensifies these feelings, and allows them to linger longer in the mind of individuals through constant reinforcement (Jasper 2007). I expect urban dwellers to be more likely to protest than their rural counterparts, since mobilization is easier in densely populated areas (Bates 1981; Bratton et al. 2005).

Second, I include two controls for an individual's civic interest: membership in a civic association or community group and an individual's interest in public affairs. Baron A. Putnam (2000: 35) argues that political knowledge and interest are "critical preconditions for active forms of participation." Individual awareness of one's political surroundings has been empirically suggested to increase propensity to participate in protests (Verba et al. 1995). Individuals who are interested in politics are more likely to be aware of the perils facing their communities, and therefore more likely to respond to potential rising threats, by participating in political activities, including protests (Schussman & Soule 2005). It has also been postulated that individual participation in a civic association has a twofold effect on the likelihood of protest participation. First, it leads individuals to have an emotional attachment to the group and to develop a "collective

group identity.” This group identity serves as a strong motivator to act on behalf of the group, including an obligation to protest (Polletta & Jasper 2001; Opp 2012). Second, it has been empirically proposed that group organizations facilitate the successful allocation of resources required for mobilization (McCarthy & Zald 1977; Aslaidis 2012).

Finally, to control for structural opportunities, a measurement of regime openness is included in the analysis. The impact of regime openness is described as an inverted U-shaped form. More open (or democratic) political systems and strongly closed political systems are less likely to experience popular mobilization, due to their tolerance for dissent and for fear of reprisals, respectively (Tarrow 1994; Hegre et al. 2001). To control for the inverted-U hypothesis, I include the respondents’ evaluation of their political system.

## **Results and discussion**

Table 3.4 reports the coefficients for the effect that access (or lack thereof) to food or water have on an individual’s likelihood to protest in sub-Saharan Africa. For ease of interpretation, the results are presented as logged odds, which is estimated by exponentiating the constant term. The results clearly support the main hypothesis (H1) that people who go without enough water *or* food are more prone to participate in protest. With a one-unit increase in poor access to food, the odds of protest participation increase by a factor of 1.05 (round 3), 1.07 (round 4), and 1.06 (round 5), holding all other variables at their mean value. Food access is statistically significant across all models at  $p < 0.01$ . Similarly, with a one-unit increase in poor access to water, the odds of protest participation increases by a factor of 1.04 (round 3), 1.06 (round 4), and 1.03 (round 5), holding all other variables constant. Water access is statistically significant at  $p < 0.05$  in round 3 and  $p < 0.01$  in rounds four and five.

Table 3.4- Coefficient effects for protest participation

	<b>Round 3</b> <i>2005–2006</i>		<b>Round 4</b> <i>2008–2009</i>		<b>Round 5</b> <i>2011–2013</i>	
	Food (1)	Water (2)	Food (3)	Water (4)	Food (5)	Water (6)
Access to basic need	0.052*** (0.017)	0.039** (0.015)	0.070*** (0.017)	0.060*** (0.015)	0.066*** (0.015)	0.038*** (0.013)
Employment status	0.092*** (0.024)	0.086*** (0.024)	0.066*** (0.025)	0.062** (0.025)	0.059 (0.038)	0.052 (0.038)
Member of organization	0.311*** (0.022)	0.313*** (0.022)	0.468*** (0.019)	0.467*** (0.019)	0.376*** (0.017)	0.377*** (0.017)
Interest in public affairs	0.266*** (0.022)	0.263*** (0.022)	0.214*** (0.020)	0.215*** (0.020)	0.164*** (0.017)	0.164*** (0.017)
Regime	0.066* (0.039)	0.055 (0.039)	-0.122*** (0.036)	-0.128*** (0.036)	-0.152*** (0.035)	-0.157*** (0.035)
Age	-0.009*** (0.001)	-0.009*** (0.001)	-0.011*** (0.001)	-0.011*** (0.001)	-0.012*** (0.001)	-0.011*** (0.001)
Male	0.336*** (0.043)	0.337*** (0.043)	0.166*** (0.040)	0.166*** (0.040)	0.252*** (0.036)	0.251*** (0.036)
Level of education	0.071*** (0.012)	0.068*** (0.012)	0.068*** (0.012)	0.064*** (0.012)	0.100*** (0.010)	0.096*** (0.010)
Urban dweller	0.060 (0.051)	0.059 (0.051)	0.197*** (0.043)	0.202*** (0.043)	0.166*** (0.039)	0.164*** (0.039)
Constant	-2.459*** (0.120)	-2.424*** (0.118)	-2.725*** (0.134)	-2.696*** (0.132)	-3.035*** (0.124)	-2.992*** (0.123)
Observations	20,013	20,020	23,802	23,818	41,760	41,763
Random effects	YES	YES	YES	YES	YES	YES
Number of countries	18	18	20	20	29	29

Logit model with standard errors in parentheses \*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

I find mixed support for corollary hypothesis H1a, which postulates that people who rarely go without food *or* water are more likely to protest compared to those who always go without either basic need. The predicted probabilities for each category are presented in table 3.5. In terms of access to food, the probability of protest participation is highest among those who report always going without food, compared to those who report having poor access to food just once or twice. Thus, as far as food access goes, I find that people who face chronic food insecurity are more likely to protest than those facing acute food insecurity. When turning water access, the opposite pattern emerges: people facing acute water insecurity are more likely to protest compared to those facing chronic water insecurity. These results support the idea that when access to basic resources is limited, feelings of relative deprivation drive people to the streets.

Table 3.5. – Marginal effects of access to food and water on protest participation (%).

<b>ROUNDS 3-5</b>		
<i>2005–2013</i>		
	<b>Food</b>	<b>Water</b>
<i>Never</i>	39.0	39.5
<i>Once or twice</i>	43.9	46.0
<i>Several times</i>	44.3	44.0
<i>Many times</i>	42.4	43.6
<i>Always</i>	51.6	44.6

These results seem to suggest that citizens place a hierarchical value on a temporary disruption to water and food access. In other words, people tend to be more sensitive to short-term disruptions to water access than food. Instinctively, clean water ranks highest for two reasons. First, lack of water will cause death before lack of food. Second, lack of water can force people—particularly women—to search for and drink contaminated or dirty water that often leads to illnesses such as diarrhea, cholera and typhoid. According to the World Health Organization (WHO), in 2012 about 284,298 people died from malnutrition and more than double that number died from diarrhea in Africa (WHO 2012). The statistics are grimmer when only children under

five are considered—malnutrition was responsible for 54,775 infant deaths and diarrhea led to three times as many deaths (Ibid).

Despite the fact that other variables have a powerful role in predicting individuals' motivations to protest, limited access to both basic needs remains significant across all three models, suggesting that poor access to water *or* food are strong predictors of protest participation in sub-Saharan Africa. These results support Sen's (1976, 1981) expectation that food insecurity prevails when there is a decrease in an individual's entitlement to food.

Contrary to the assertions of DiPasquale and Glaeser (1996), who argue that *unemployment* is related to high-risk activism, I find evidence in line with Bratton et al. (2005), who find that it is employed individuals who more likely to protest. In terms of poor access to food, the odds of a person being employed during round 3 are 1.09 and during round 4 are 1.06 times larger than a person who was unemployed, holding all variables constant ( $p < 0.01$ ). The same odds are depicted in terms of poor access to water for the same survey rounds. However, employment status is not statistically significant for either basic need during survey round 5. Therefore, I therefore find mixed support for hypothesis H2, which claims that employed people, not the unemployed, should be more likely to protest as a result of poor access to water or food.

The control variables, for the most part, behave as expected. Higher levels of education and urban dwellers, mostly young and male, are strongly associated with and statistically significant for increases in the likelihood of protest participation (Resnick & Casele 2011; Dionne et al. 2014). The four indicators are consistent with recent African scholarship (e.g., Bratton et al. 2005). Similarly, two factors related to civic interest show a strong tendency for individuals who belong to a community group and are interested in public affairs being likely to protest. The directionality of these variables is as expected and statistically significant (at  $p < 0.01$ ).

Moreover, the findings show some support for the inverted-U hypothesis linking protest participation and regime type. Regime is negatively associated with protest participation through models 3 to 6 (survey rounds four and five), though the relationship is not significant in the first two models. This indicates that institutional coherence matters for deterring protest participation, a finding consistent with the literature (Hegre et al. 2001; Hendrix & Salehyan 2012). Additional models that exclude the highest amount of protest occurrence in each survey round confirm the robustness of the main findings.<sup>33</sup>

## Conclusion

Although the cross-sectional data used in this chapter only provides three snapshots in time and is admittedly a limitation of this study, the results successfully describe the mindset of the sampled population from 2005 to 2013. I close this chapter by revisiting the question that I began with: Do people who have inadequate access to water and food display a higher propensity to participate in protest, compared to those who have uninterrupted access? The answer is yes. Sub-Saharan citizens with poor access to either basic need are more likely to protest.

The results presented here suggest two main and important findings. First, chronically-food-and-water insecure people are more likely to protest than those facing acute food insecurity. Second, between 2005 and 2009 job holders were more likely to protest than their unemployed counterparts. Thus, hinting that it is employed individuals who become concerned about impoverishment (or falling back into poverty) who are more prone to protest.

To conclude, the findings from this chapter suggest that structurally induced food and water scarcities facing the region are strong motivators for people to take to the streets in sub-Saharan

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<sup>33</sup> All robustness models in this monograph are included in the appendix.



Africa. Given the evidence presented, it seems important that policy makers take the necessary steps to increase accessibility to food and water for all segments of the population. This could entail an increase in quality and quantity of infrastructure such as roads, bridges and ports, a continuation of robust economic growth in the region that includes a reduction in income inequality, and the strengthening of political institutions that can reduce corruption among public officials.

As climate change and rainfall variability begin to have both short- and long-term impacts on the availability of crop yields and water basins, the potential for environmentally induced scarcity increases. If inadequate distribution of resources is the norm in most sub-Saharan countries, how will future climatic shocks further impact the social distribution of resources and social cohesion? If governments are already unable to equally distribute renewables among all segments of the population when there are enough resources to go around, how will these governments react when the availability of food and water declines due to climate change and variation? Climate shocks have the potential to worsen the already dysfunctional, structurally induced scarcity of food and water by decreasing availability of resources. In other words, climate change can provide the *coup de grâce* to an already fragile distribution system, that in turn, can increase the frequency of social unrest. Therefore, in the next chapter, I explore whether climate shocks have begun to increase the frequency of social unrest in Sub-Saharan Africa as a result of declines in crop production.

## FOUR

### CLIMATE VARIABILITY, CROP PRODUCTION AND SOCIAL UNREST

Scientific consensus that the planet is warming has increased the level of interest in the social consequences of climate change. Aside from depleting Arctic sea ice and rising sea levels, temperature and rainfall variability are expected to increase. Dry regions will become drier and wet ones wetter. However, the relationships between rainfall and temperature variability and various conflict processes are controversial. These are often based on the idea that deviations from mean temperature or rainfall averages will lead to a scarcity of basic resources such as water and crop yields, particularly in developing countries (World Bank 2007, 2014).

President Obama (2015) has cautioned that “severe weather events lead to displacement, scarcity, stressed populations; all increase likelihood of global conflict” (Hackman (2015). Similarly, in 2007 U.N. Secretary General Ban Ki Moon suggested that a decrease in rainfall had resulted in resource scarcity that sparked resource conflicts between farmers and herders in South Sudan—a clash that later escalated into a civil conflict (Ki-Moon 2007). Despite such claims, academic consensus on the climate-conflict relationship remains elusive (for a review, see Mildner et al. 2011; Gleditsch 2012). The majority of the literature that explores the climate-conflict nexus has narrowly focused on rainfall variability as the principal predictor of political violence, and on armed rebellion as the primary outcome from this relationship. Nordås & Gleditsch (2007) have urged scholars to reconsider the kind of political violence expected to result from climate change and to further disentangle the causal chains between conflict and climate change. This chapter undertakes both recommendations.

So far I have examined the nexus between poor access to resources and protest participation at the micro-level. The empirical results lead me to claim that people who experienced poor access to water or food from 2005 to 2013 were more likely to protest, particularly employed individuals. While poor access to resources is not new, an environmental-induced drop in basic resources may emerge from a warming planet, creating a potential dual-track between structural and supply-induced scarcities that can further exacerbate food insecurity in many parts of the world, particularly in sub-Saharan Africa.

The FAO estimates that if the aggregate amount of calories from all the food produced annually were equally distributed among the total population of the planet, each person would obtain 2,750 calories—more than the 2,100 minimum daily energy requirement.<sup>34</sup> Nevertheless, by the end of 2015, the WFP estimated that 795 million people worldwide did not have enough food to live a healthy lifestyle.<sup>35</sup> It is clear then, as famously conveyed by Sen (1982), that existing structural failures can prevent large segments of the public from having access to enough food.

Food production conditions south of the Sahara are dismal. The region does not produce enough food to feed its growing population. As a result, most sub-Saharan countries depend on large amounts of food imports to fill this gap (Rakotoarisoa et al. 2012). For instance, from 2000 to 2005 the region imported 43 percent of all its grains (FAO 2008). Moreover, in 2011, increased food demand pushed the region's total agricultural imports from all suppliers to \$43 billion—\$16 billion more than India, a country with a much larger population.<sup>36</sup>

The IPCC suggests that warmer temperatures and erratic rainfall in sub-Saharan Africa will reduce yields for staple cereals such as rice, maize and wheat. Yields in the region are expected to

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<sup>34</sup> FAO: <http://www.fao.org/docrep/x0262e/x0262e05.htm>

<sup>35</sup> World Food Program Fact Sheet: <http://www.wfp.org/content/hunger-map-2015>

<sup>36</sup> Data from UN Comtrade Database. Note: Nigeria, Angola and South Africa accounted for 39 percent of all imports, the remaining countries accounted for the other 46 percent of all imports.

drop between 5–15 percent for each degree of warming (Solomon et al. 2011). Examining the future effects of climate variability on food production in sub-Saharan Africa, a recent study finds evidence of a 15 percent yield decline for rice, a 34 percent decline for wheat and a 10 percent decline for maize by 2050 when compared to non-climate change scenarios (Nelson et al. 2009). In order to successfully mitigate future scarcity scenarios and their potential social consequences, political scientists have begun to examine and debate the potential effects that temperature and rainfall anomalies will have on renewable resources.

Using the Social Conflict in Africa Database (SCAD) and data from 38 sub-Saharan countries, this chapter examines the relationship between rainfall and temperature deviations, cereal yields, and social unrest in sub-Saharan Africa from 1990 to 2012. Of particular interest are the potential impacts that deviations from average temperature and rainfall patterns have on cereal yields, and their influence on low-intensity social unrest that is short of full-blown civil war.

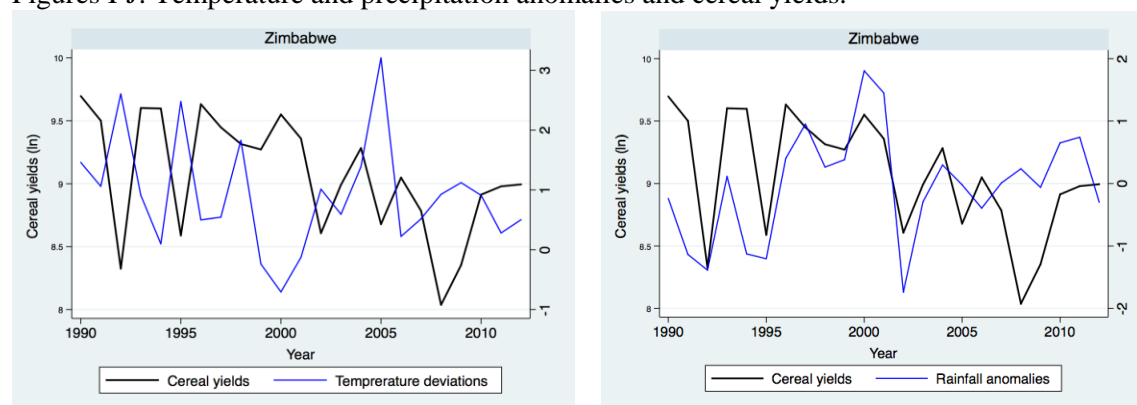
## **Climate variability and cereal yields**

Temperature and rainfall variability are known to be extreme in large parts of Africa (Adano & Witsenburg 2009). It is well established that human activity linked to fossil-fuel burning has a major impact on the global environment (IPCC 2007, 2014; Stern 2008). Food production is heavily dependent upon ecological systems that are now experiencing rapid changes. Sub-Saharan Africa has a range of climate risks that can have far-reaching socio-economic and political consequences. Even if warming is limited to 2°C, the goal set by the 2015 Paris Agreement, substantial risks remain. As warming continues these risks will only worsen.

**Temperature** has two extremes that can affect crop yields: cold and heat. Tropical regions, like most of sub-Saharan Africa, are expected to experience a shortening of their growing season due to longer dry spells. Temperatures above those tolerated by the physiology of crops decrease

yields (Jalloh et al. 2013). Yearly temperatures in the region are already above ideal conditions for wheat production during the growing season, and maize reductions have also been observed in areas above certain temperature thresholds (World Bank 2013). This situation is expected to worsen by soil erosion—due to the inability of vegetation to survive harsh conditions. With a warming of 0.8 °C so far, longer drought trends and land drying have been observed (World Bank 2012). Figure I shows the juxtaposition between temperature anomalies and cereal yields in Zimbabwe from 1990 to 2012. With the exception of 2008,<sup>37</sup> there is a visible opposite pattern between both indicators: cereal yields decrease during warmer than average years.

Figures I-J: Temperature and precipitation anomalies and cereal yields.



Warmer temperatures will also put pressure on water availability across the region. Turning back to Zimbabwe, Figure J shows a close pattern between precipitation anomalies and cereal yields: years with above average precipitation experience an increase in cereal yields. Low **precipitation** levels are not the sole cause of crop declines. The opposite is also true. The NOAA noted that in November 2014, the lack of precipitation in Mozambique, Malawi, Zambia and Zimbabwe had led to soil deterioration, only to witness a complete reversal of weather anomalies

<sup>37</sup>In 2008 the country experienced one of its worst food crisis due to a combination of poor weather, inflation, a shortage of seeds and fertilizers and a political crisis.

a month later. Rainfall brought crippling precipitation surpluses that revived the soil, only to destroy it (Di Liberto 2015). By their estimate, “25,000 hectares of cropped land were impacted in Malawi, 65,000 hectares were affected in Mozambique, 9,900 hectares of rice fields were flooded in Madagascar, and an additional 7,900 hectares of crops were damaged in the region.”<sup>38</sup>

The overwhelming majority of sub-Saharan countries have made no significant improvements in irrigation technologies (FAO 2002). The irrigated area of sub-Saharan Africa makes up only 8 percent of the total cultivated area—two thirds of which is located in Madagascar, South Africa and Sudan.<sup>39</sup> This is a relatively low number when compared to Asia’s 37 percent and 14 percent in Latin America of irrigated crops (Liang 2008). The lack of irrigation systems leaves crops to the whims of weather fluctuations. However, some crops are more sensitive to rainfall than others. For instance, maize is highly sensitive to water stresses and needs a gross rainfall between 500–800 mm/season to mature, while sorghum is more tolerant to water shocks and only requires 400–650 mm/season to mature (Critchley & Siegert 1991). The vulnerability of both staple grains is of particular concern given their high nutritional impact in the region. By some estimates, “maize accounts for between 30 to 50 percent of low income household expenditures in Eastern and Southern Africa” (Idoko et al. 2013: 58).

## **Climate variability, cereal yields and social unrest**

This chapter focuses on unorganized low-intensity forms of social unrest such as violent events and peaceful protests.<sup>40</sup> It should not be assumed that these types of conflicts are less significant

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<sup>38</sup> Published on Famine Early Warning Systems Network <http://www.fews.net>

<sup>39</sup> It is important to note that SSA has the estimated irrigation potential to increase from its current 6 million hectares to 42.5 million (Kadigi et al. 2012).

<sup>40</sup> The dependent variable is not the count of food riots per se, but rather the total per country annual count of unrest, regardless of the first issue mentioned as the source of the tension/disorder.

than civil wars simply because of their lower number of human casualties and limited damage to infrastructure. Indeed, they can be quite disruptive. For instance, in 2016, thousands of rural landowners who lost crops after two years of drought protested in northern India to demand relief from the federal government. During the process, the protesters damaged the Munak Canal—which delivers 60 percent of the drinking water to New Delhi. About 10,000 soldiers were dispatched to control the protesters. Clashes between soldiers and protesters resulted in at least 15 deaths and hundreds of injuries.<sup>41</sup> Although these events are usually less deadly than armed rebellions, they cost lives and can disrupt basic government functions, and can escalate into full-blown civil wars.

In 2011, the Heidelberg Institute for International Conflict Research found that 35 percent of all conflicts in sub-Saharan Africa were over resources: 16 non-violent disputes, 9 violent crises and 7 wars.<sup>42</sup> Scarcity of renewable resources has been found to increase the likelihood of low-intensity conflict, whereas non-renewable resources have been associated with large-scale violence (DeSoysa 2002). The literature on environmental security has been overwhelmingly focused on identifying a direct link between climate conditions and conflict (Barnett & Adger 2007; Raleigh & Urdal 2007; Hendrix & Salehyan 2012). Two distinct approaches dominate most of this literature. The first approach typically uses rainfall anomalies as a proxy for climate change and a second approach uses temperature anomalies.

The “rainfall approach” identifies four direct causal mechanisms to explain the climate-conflict nexus. The first mechanism is a ‘zero-sum’ scenario that deals with scarcity. This link proposes that periods of above-average decreases in precipitation *increase* the probability of

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<sup>41</sup> For more on the northern India protests see <http://www.theguardian.com/world/2016/feb/22/india-caste-protesters-accept-offer-to-end-riots-and-water-crisis>

<sup>42</sup> HIIK reported a total of 91 conflicts in SSA for 2011. The report is available at: [http://www.hiik.de/de/konfliktbarometer/pdf/ConflictBarometer\\_2011.pdf](http://www.hiik.de/de/konfliktbarometer/pdf/ConflictBarometer_2011.pdf)

conflict. The argument contends that social groups will compete for scarce resources imposed by climate change (Home-Dixon 1999). Conversely, a second argument suggests that a decrease in below-average rainfall is more likely to see a *decrease* in conflict, given that there is little to fight for (Raleigh & Kniveton 2012). This line of thought assumes that relative gains from engaging in conflict during drier periods are too low to justify conflict participation. Freshwater scarcity, for example, has played an important role in this nexus. One neo-Malthusian argument theorizes that water scarcity will increase the probability of so-called “water wars” (Klare 2001). Exploring this argument, Tir & Stinnett (2012) find that water scarcity does increase the likelihood of militarized conflict, but that institutionalized agreements can mitigate this effect. Similarly, by focusing on Central Asia’s Syr Darya water allocation problems, Bernauer & Siegfried (2012) find that climate-change induced interstate conflicts over water scarcity are unlikely.

A third causal mechanism shifts the focus from ‘scarcity’ to abundance. The assumption is that abundance of rainfall *increases* the likelihood of conflict, given that it can prompt rent-seeking and recruitment of participants (Hendrix & Salehyan 2012; Buhaug 2010). However, this argument assumes a desire to take over the state as the primary goal behind the conflict. Finally, there is a scenario where abundance of rainfall can lead to a *decrease* in the probability of conflict, given that individuals and groups are self-sufficient and therefore less likely to take part in conflict.

Given that sub-Saharan countries remain highly dependent on rain-fed agriculture for both personal income and economic growth, with agriculture accounting for more than 50% of GDP and up to 90% of employment across much of the continent, the common focus on precipitation makes sense (Hendrix & Glaser 2007; Burke et al. 2009). However, most of the growth was due to cropland expansion rather than per-acre production increases. According to Chauvin et al. (2012:67), “agricultural GDP growth in sub-Saharan Africa averaged 2.3 percent per year in the



1980s and 3.8 percent per year in the 2000s.” However, focusing solely on rainfall can prove shortsighted. Recent studies stress the particular role of temperature in explaining past spatial and temporal variation in agricultural yields and economic output in the region (Schlenker & Lobell 2009). It is also possible that temperature variations could have already played a role in past (and can influence future) conflict outbreaks; however, few studies have explicitly considered the role of temperature in these cases.

Thus far, political science research embracing the “temperature approach” has been too narrow. Anticipating the social consequences of a warming world is hard, mostly because it is unclear whether rising temperatures will systematically increase the likelihood of violent conflict (Landis 2014). Even though some research shows temperature variations to be directly associated with violent conflict, there is poor understanding of the causal mechanisms for this relationship (Hsiang et al. 2013). For instance, Hsiang et al. (2011) find that the probability of new civil conflicts arising in tropical latitudes doubles during El Niño/Southern Oscillation (ENSO) years, relative to La Niña events. Their results led them to claim that ENSO years might have had a role in 21 percent of all civil wars since the 1950s, although their results are not generalizable to gradual trends in average temperature or particular characteristics of man-made climate change. By their own admission, Hsiang et al. (2011:440) claim that “generalizing our results to global climate changes other than ENSO will require an understanding of the mechanisms that link conflict to climate.”

In more recent work, Hsiang et al. (2013) find that warmer temperatures increase the frequency of intrapersonal violence (e.g., murder, assault) by 4 percent, and intergroup violence (e.g., riots, civil war) by 14 percent. The authors’ findings have been strongly criticized, as well as their argument that the inclusion of socio-political, economic and demographic covariates are “bad

controls” due to their potentially endogenous links between them and weather indicators (Becker 2013). However, ignoring socio-political and other key factors that are well documented to influence conflict reduces “conflict to an immediate and unmediated function of physical, biological and physical-geographical signals” (Raleigh et al. 2014: 76).

The climate-conflict nexus has two important gaps. First, the literature overwhelmingly focuses on civil war as the principal outcome for scarcity and abundance scenarios. Second, most arguments focus on a *direct* link between climatic shocks and conflict processes. Such narrow focus on a direct relationship fails to investigate clear-cut causal pathways that result from climatic conditions (for some exceptions, see Miguel et al. 2004; Koubi et al. 2012; Delvin & Hendrix 2014). This one-track linkage of the climate-conflict literature on sub-Saharan Africa is mostly based on two assumptions. The scarcity argument assumes that, because most sub-Saharan countries remain highly dependent on rain-fed agriculture for both personal income and economic growth, temperature or precipitation anomalies negatively affect crop yields, which results in conflict. However, this assumption has been scarcely scrutinized and is often taken as a fact (see Hendrix & Glaser 2007). The second assumption is that poor people—regardless of whether they are farmers or not—will take to the streets as a result of crop declines. Both of these assumptions and their consequences are vastly under researched.

For instance, under these two assumptions, Burke et al. (2009) find that warmer years increase the likelihood of civil war by 4.5 percent and then cause a 0.9 percent increase in conflict incidents the following year. The authors suggest that poor farmers are more likely to participate in armed rebellion in warmer years. However, the authors do not include crop production or a proxy measurement to support their assumptions. Before arriving to such conclusions, it is important to first establish a link for the assumption that either temperature or precipitation

variations from the mean are associated with social unrest via crop failure in sub-Saharan Africa.

Thus, my main hypotheses are:

H1: The interaction between extreme deviations from average *rainfall* patterns and cereal yields should be associated with an increase in the frequency of social unrest.

H2: The interaction between extreme deviations from average *temperature* patterns and cereal yields should be associated with an increase in the frequency of social unrest.

At present, economic motivations for conflict are well documented in the conflict literature (see Blattman & Miguel 2010). Therefore, the second step in the climate-crops-conflict nexus is to identify the role that economic motivators play in the strongly agro-dependent African economies. Economic triggers that result from low crop yields via climatic shocks have two important implications. First, climatic shocks can further strain the distribution of resources from governments to large segments of the population. Second, climatic shocks limit the amount of auto-consumption and income for farmers and often increase food prices for urban-dwellers.

In a region where 15 percent of the population was able to leave extreme poverty behind over the last decade and about 85 million people are employed by the agriculture sector, climatic shocks can generate short-term economic instability that increases the risk of poverty (or falling back into poverty) for large segments of the population. Both scenarios have the potential to worsen economic grievances among urban and rural populations, increasing their disposition to participate in social unrest.

## **Research Design**

Due to the highly skewed distribution of events from the Social Conflict in Africa Database (SCAD) dataset, I employ a negative binomial model with robust standard errors clustered in countries. Table 4.1 provides summary statistics. The robustness of the results is explored by

excluding South Africa and Madagascar, given their developed irrigation infrastructure. The robustness check does not alter the main findings.

Table 4.1 Summary of main sample statistics

	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
<b><i>Dependent variables</i></b>				
Total events	7.49	15.40	0	240
Violent events	4.85	12.44	0	219
Peaceful protests	2.64	4.58	0	39
<b><i>Environmental factors</i></b>				
RAIN	0.07	0.98	-2.87	4.67
RAIN <sup>2</sup>	0.98	1.58	5.07	21.86
RAIN*log cereal yields	0.74	9.18	-25.75	45.35
RAIN <sup>2</sup> *log cereal yields	9.12	14.97	0.0004	212.08
TEMP	0.93	0.85	-1.86	3.84
TEMP <sup>2</sup>	1.60	2.13	8.97	14.80
TEMP*log cereal yields	8.62	7.95	-17.22	37.34
TEMP <sup>2</sup> *log cereal yields	14.84	19.85	7.46	143.69
<b><i>Controls</i></b>				
log GDP per capita <sub>(t-1)</sub>	22.28	1.30	18.77	26.48
Polity2	0.45	5.32	-10	9
Polity2 <sup>2</sup>	28.93	23.93	0	100
log total population <sub>(t-1)</sub>	15.34	2.77	3.01	18.94
Civil war occurrence	0.21	0.41	0	1
Time trend	11.95	6.62	1	23

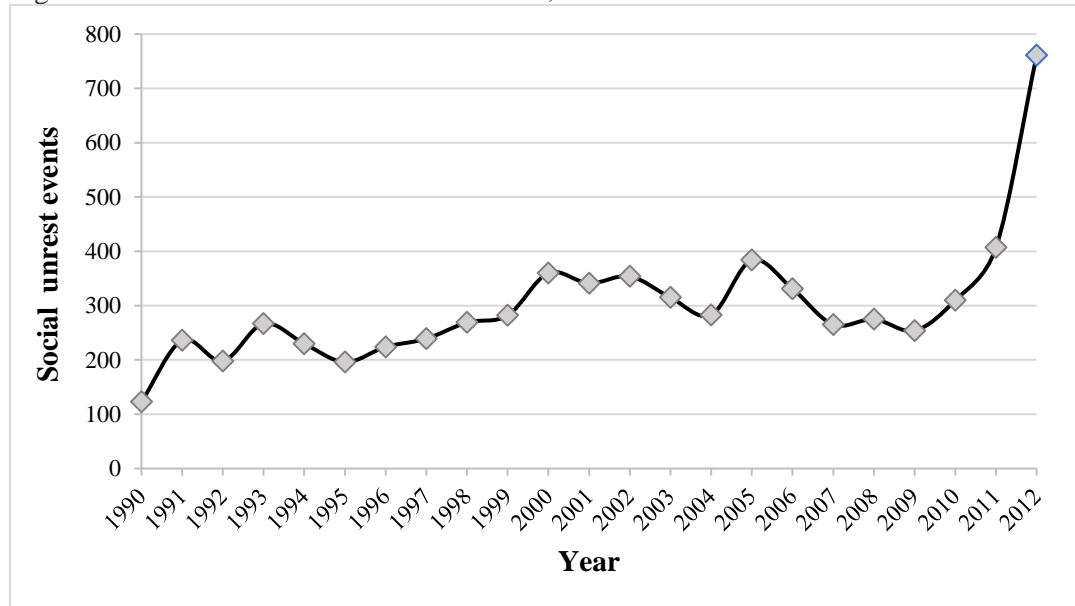
### ***Dependent variables***

Three dependent variables are used for low-intensity conflict: total events, violent events and nonviolent events. Social unrest variables are from the SCAD.<sup>43</sup> Total events is the sum of violent and non-violent events. Violent events are those where the actors initiating the event act to cause damage to property or people such as riots, government repression, anti-government violence and

<sup>43</sup> SCAD collects events from the Associated Press and Agence France Presse newswires that contain detailed event information such as duration, magnitude, actors and targets. A total of 6,305 events have been coded for African countries with a population of more than one million.

both intra- and inter-governmental violence. Nonviolent events are those not intended to cause harm to property or people. A lagged dependent variable is also included for all dependent variables to account for the possibility of past episodes of unrest influencing future ones. Figure K displays the distribution of social unrest in sub-Saharan Africa over time.

Figure K. Social unrest in sub-Saharan Africa, 1990-2012.



### ***Independent variables: cereal yields and climate shocks***

#### ***Cereal yields***

Cereals are the most important source of nutrition in sub-Saharan Africa in terms of purchases and auto-consumption (Chauvin et al. 2012). Therefore, to examine disruptions to yearly cereal yields, I use a country-level aggregate of total cereal yields intended for human consumption from FAOSTAT. The natural logarithm of cereal yields is used to correct for outliers in the data. Unlike food price statistics, which are historically more often related to structural conditions such as corruption and targeted government interventions (e.g., subsidies), domestic cereal production is intrinsically related to rainfall and temperature patterns (Smith 2014; Weinberg & Bakker 2014).

### *Climate change proxies*

Both covariates are estimated using 0.5° latitude/longitude gridded data from the Climate Research Unit (CRU) of the University of East Anglia.<sup>44</sup> Yearly data for each sub-Saharan country is transformed into moving standardized cumulative rainfall and temperature, RAIN and TEMP. This is defined as the total precipitation and recorded mean temperature of  $n$  years (current year minus year  $n-1$  year), minus the moving average of the equivalent period over the previous 30 years. This varies from the percentage change in annual rainfall from a single previous year (Hendrix & Glaser 2007), the Standardized Precipitation Index (Guttman 1999) and specific temperature anomalies like ENSO because the base period for the long-term mean and standard deviation is the 30 years prior to the year of interest, rather than the total period. This controls for the expectations of farmers regarding previous rainfall and temperature patterns that may affect cereal yields (Sovey & Green 2011). Undeniably, these variables do not account for the potential cross-border effects of rainfall and temperature anomalies in one country on the agricultural conditions of downstream countries. However, in the case of rainfall, this is minimal in Africa where irrigation infrastructure is lacking and agriculture is almost entirely rain-fed. Finally, precipitation and temperature variability do not affect every sub-Saharan region equally. I also include the squared term of both variables. Finally, given the main interest of this chapter, an interactive variable is introduced to account for the potential effects between both climate proxies and cereal yields on the frequency of social unrest.

### *Control variables*

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<sup>44</sup> The monthly data is added to obtain the total yearly precipitation per country.

The inclusion of control variables remains controversial among climate-conflict researchers. One side advocates that the inclusion of control variables may be influenced by climatic factors that can lead to biased results (Burke et al. 2009; Hsiang et al. 2013). They argue that researchers should instead use panel fixed effects and/or time trends to identify the causal impact of contemporaneous climatic variations. The other side argues that the exclusion of variables previously identified in the literature is necessary to balance the causal weight of climatic factors (Buhaug 2010; Theisen 2012; Salehyan & Hendrix 2014). To make the results comparable to the existing collective mobilization literature, I include several controls in the analysis, as well as a time trend to proxy overall technological advancements in agriculture.

Several studies find that economic growth decreases the likelihood of political violence and peaceful protest (Miguel et al. 2004; Collier & Hoeffler 2004). However, climatic shocks have been shown to strongly influence short-term income fluctuations, particularly in agrarian economies (Bergholt & Lujala 2012). This relationship is presently unfolding in Ethiopia. In 2015 Ethiopia was among the fastest growing economies, but after battling the worst drought in 30 years, the IMF has downgraded the country's projected 2016 GDP growth from 8.1 percent to 4.5 percent—with recovery expected to 7 percent in 2017 (IMF 2016).<sup>45</sup> As government demands to shift economic resources to emergency food programs while economy shrinks, these assistance programs can be a source of social unrest if implemented correctly and further mislead food markets and suppresses local production (Hendrix & Brinkman 2013). Moreover, in times temporary of acute food insecurity via climate shocks, abrupt short-term declines in economic performance are likely perceived as increased deprivation for a large number of people (Gurr 1968; Hendrix et al. 2009). As economic in the face of temporary adverse changes in their economic

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<sup>45</sup> World Economic Outlook, April 2016. <http://www.imf.org/external/pubs/ft/weo/2016/01/index.htm>

well-being. Therefore, to control for the association between climatic shocks and social unrest vis-à-vis temporal changes in welfare, I include the natural logarithm of GDP per capita (in 2005 US\$).

It is important to acknowledge that not all cases of food scarcity culminate in protests, marches or riots. Political institutions play two important roles in the mitigation of social unrest. First, governments with strong institutions (e.g., democracies) are more likely to provide broader access to food for their citizens, while states with weak institutions may not have such a broad reach. Second, strong institutions are able to resolve non-violent events over resource scarcity before they escalate by providing alternative conduits for the expression of grievances (Mildner et al. 2011). Moreover, sub-Saharan African has been dominated by so-called hybrid regimes since the early 1990s. Because the survival of political leaders in these regimes are more likely to depend on the support from of a narrow base of supporters, political leaders have a compulsion to appease their base.<sup>46</sup>

With this in mind, there are two key reasons why hybrid regimes are more likely to experience protest when renewable resources decrease. First, most hybrid regimes have institutions and elections similar to those in democracies. These institutions allow for citizens' grievances to be voiced while strategically allowing the formation of some opposition groups and political parties that can help sustain an illusion of control and progress. This signals to the citizenry that dissent is tolerated and in some cases, concessions from the government are not far-fetched.

Second, because the survival of political leaders in personalist regimes is dependent on the distribution of benefits and patronage to their support base, political leaders in these regimes are more vulnerable to economic and external shocks that reduce the amount of benefits available

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<sup>46</sup> See Barbara Geddes (1999) for a typology of authoritarian regimes.



to distribute (Bates 1981; Geddes 1991, 1999). Therefore, in times of cereal shortages from climatic shocks, political leaders will ration renewable resources in order to shield their support base from scarcity and its harmful outcomes. By doing this, political leaders are able to appease their support base and avoid challenges to the regime, giving no systematic preference to the rest of the population.

Therefore, in the face of climatic shocks that decrease crop production, political leaders will choose to ration in order to strategically distribute the limited resources among their base, while systematically neglecting the rest of the population. For this reason, I expect hybrid regimes to be associated with an increase in the frequency of social unrest. To capture the capacity of the state to distribute resources among the population, I include Polity2 and its squared term to capture the potential inverted U-shaped effect of a regime's ability to tolerate dissent.<sup>47</sup>

Most countries in sub-Saharan Africa are net food importers. Trade data on all agricultural import value is introduced to the model. Values from FAOSTAT are expressed in thousand U.S. dollars. Agricultural imports can be a double-edged sword. On one hand, the higher the food imports, the *less* susceptible a country will be to crop shortages. On the other, higher food imports make countries *more* susceptible to international food price shocks (Hendrix & Haggard 2012). For these reasons, I have no expectation for the directionality of this covariate.

The occurrence of civil war can obscure the reporting of other forms of collective action, and sometimes the conflict itself can be the cause of large demonstrations, as was the case for Liberia in 2003 (Hendrix & Salehyan 2012). Furthermore, this variable accounts for the negative impacts that an ongoing conflict has on cereal production. Total population increases are

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<sup>47</sup> Polity2 differs from Polity in the way it treats regime interruptions, replacing observations of (-66, -77, -88) with conventional Polity scores. Polity2 subtracts the Polity AUTOC score from the DEMOC score, producing a 21-point scale ranging from 10 (strong democracies) to -10 (strong autocracies).

considered a strong determinant of social unrest (Urdal 2005; 2014). First, larger populations are believed to be more difficult to control and increase the number of potential rebels (Fearon & Laitin 2003). Second, neo-Malthusian concerns posit that populous countries will experience a quicker degradation and scarcity of natural resources (Renner 1996; Gleditsch 2001).

## **Results and Discussion**

The results in table 4.2 report the coefficient estimates for the effects of both climatic proxies and cereal yields on the frequency of total events in sub-Saharan Africa from 1990 to 2012. The first three models are the most parsimonious in order to examine the climate-crops-unrest nexus. Model 1 tests the relation between rainfall deviations, cereal yields and social unrest. Contrary to Hendrix & Salehyan (2012), the results indicate that neither higher- nor lower-than-average rainfall patterns are associated with the frequency of social unrest in sub-Saharan Africa. Similarly, the interaction term between rainfall deviations and cereal yields is not associated with the frequency of social unrest in the region. This suggests that rainfall deviations in either direction have yet to substantially affect cereal production in the region. I find no support for hypothesis 1.

Model 2 independently tests the association between temperature anomalies, cereal yields and social unrest. The results show two promising findings. First, they indicate the existence of a curvilinear relationship between temperature anomalies and social unrest, all else being equal. The covariate  $TEMP^2$  is positively and statistically significant (at  $p > 0.5$ ), suggestive of warmer-than-average years being more prone to a higher number of social unrest events. Moreover, the results show a statistically significant (at  $p < 0.5$ ) association between the interaction term  $TEMP^2$  and cereal yields with an increased count of unrest.

Table 4.2 (DV-total events) Climate change, cereal yields and social unrest

	Model 1	Model 2	Model 3
Lagged DV	0.056*** (0.010)	0.055*** (0.009)	0.055*** (0.010)
log total cereal yields	0.239 (0.183)	0.264 (0.193)	0.244 (0.198)
RAIN	0.372 (0.508)		0.269 (0.512)
RAIN <sup>2</sup>	0.086 (0.318)		0.016 (0.291)
RAIN* log cereal yields	-0.035 (0.054)		-0.025 (0.054)
RAIN <sup>2</sup> * log cereal yields	-0.004 (0.032)		0.003 (0.030)
Total cereal imports (US\$1000)	0.186*** (0.059)	0.185*** (0.059)	0.185*** (0.060)
TEMP		-1.903 (1.380)	-2.142 (1.387)
TEMP <sup>2</sup>		1.104** (0.486)	1.245*** (0.469)
TEMP* log cereal yields		0.194 (0.156)	0.222 (0.156)
TEMP <sup>2</sup> * log cereal yields		-0.114** (0.054)	-0.130** (0.053)
Constant	-3.149* (1.736)	-3.308* (1.821)	-3.174* (1.899)
Observations	915	915	915

Negative binomial with robust standard errors, clustered by country \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The results from model 2 have two important implications. First, they supports the notion that above warmer-than-average years have already begun to negatively impact cereal yields in sub-Saharan Africa, exacerbating the food insecurity situation in the region. Second, declines in cereal yields during warmer years are conducive to a higher frequency of social unrest. As a robustness check, model 3 includes both climate change proxies to account for omitted variable bias. None of the previous results are altered.

Table 4.3 Temperature anomalies, cereal yields and social unrest			
	Model 4 <i>Total events</i>	Model 5 <i>Violent events</i>	Model 6 <i>Peaceful events</i>
Lagged DV	0.043*** (0.008)	0.060*** (0.013)	0.104*** (0.016)
<b><i>Food production</i></b>			
log total cereal yields	0.337 (0.248)	0.391 (0.241)	0.284 (0.302)
<b><i>Environmental factors</i></b>			
TEMP	-1.301 (1.449)	-1.178 (2.136)	-1.559 (2.201)
TEMP <sup>2</sup>	0.927* (0.499)	0.695 (0.867)	1.132 (0.753)
TEMP*log cereal yields	0.126 (0.158)	0.117 (0.233)	0.148 (0.234)
TEMP <sup>2</sup> * log cereal yields	-0.093* (0.055)	-0.069 (0.094)	-0.115 (0.079)
<b><i>Controls</i></b>			
log GDP per capita <sub>(t-1)</sub>	0.172* (0.094)	0.226** (0.098)	0.134 (0.088)
Total cereal imports (US\$1000)	0.075 (0.080)	0.065 (0.095)	0.120 (0.075)
Polity2	-0.001 (0.012)	0.017 (0.016)	-0.012 (0.014)
Polity2 <sup>2</sup>	-0.005** (0.002)	-0.007** (0.003)	-0.003 (0.002)
log total population <sub>(t-1)</sub>	-0.037 (0.024)	-0.046 (0.028)	-0.009 (0.020)
Civil war occurrence	0.090 (0.130)	0.180 (0.169)	0.031 (0.120)
Time trend	0.021** (0.010)	0.010 (0.014)	0.025** (0.010)
Constant	-6.102*** (2.269)	-7.966*** (2.103)	-6.586** (2.792)
Countries	38	38	38
Observations	846	846	846
Negative binomial with robust standard errors, clustered by country **** p<0.01, ** p<0.05, * p<0.1			

Table 4.3 includes the environmental factors previously found to be associated with social unrest in the previous table and introduces several socio-political and economic controls. Each model examines different categories of social unrest. The results show that, *ceteris paribus*, warmer-than-average years are associated and statistically significant with the frequency of total events (at

$p < 0.01$ ). This is line with recent literature suggesting that temperature increases amplify rates of human conflict (for a review, see Hsiang et al. 2013).

The interaction term between  $TEMP^2$  and cereal yields is also statistically significant with the frequency of total events (at  $p < 0.1$ ). The interaction term is negative, suggesting that this interaction decreases the frequency of social unrest. However, in non-linear models the sign of the coefficient for an interaction term may give a misleading signal about the "direction" of the interaction. As recommended by Berry et al. (2010), the CLARIFY software (King et al. 2003) is used to evaluate the substantive effects of the interaction term on total events when holding all other variables at their mean values. This is achieved by calculating the effects of moving from the 5<sup>th</sup> to 95<sup>th</sup> percentile on the  $TEMP^2$  measure when cereal yields are less than average.

The predicted probabilities are reported in table 4.4. At the 5th percentile (-2 standard deviation), the interaction between  $TEMP^2$  and less-than-average cereal yields is associated with a 21.8% increase in the probability of experiencing one event of social unrest—whether peaceful or violent. Moving to the 95th percentile (+2 standard deviation), the probability of a peaceful or violent event occurring declines to 18.7%. Thus, the likelihood of experiencing one episode of social unrest event declines when temperature during warmer-than-average years are highest and cereal yields fall below average. However, this decrease shifts when two and three social unrest events are considered. At the 5th percentile, the probability of a country experiencing two social unrest events is 10.8%. This likelihood rises to 15.9% when  $TEMP^2$  is held at the 95th percentile and cereal production is below average. Therefore, higher temperatures during warmer-than-average years decrease cereal production, the higher the probability of a country experiencing two or three social unrest events. In summation, total events are more sensitive to a drop in cereal yields during years reporting above-average temperatures. I find support for hypothesis 2.

Table 4.4 Interaction effects between temperature<sup>2</sup> and cereal yields on total events

	TEMP <sup>2</sup> at 5 <sup>th</sup> percentile	TEMP <sup>2</sup> at 95 <sup>th</sup> percentile
<b>Pr (1 event)</b>	21.8%	18.7%
<b>Pr (2 events)</b>	10.8%	15.9%
<b>Pr (3 events)</b>	5.9%	14.0%

All control variables, for the most part, perform as expected. Starting with economic prosperity, GDP per capita is positive and statistically significant for total events (at  $p < 0.1$ ) and violent events (at  $p < 0.05$ ). In terms of magnitude and strength, the largest effect is reported for violent events, although environmental factors are not significant (model 5). The results show that countries with higher GDP per capita are more likely to experience a higher frequency of social unrest and supports recent research on political participation in sub-Saharan Africa (Barnes & Burchard 2012; Dionne et al. 2014). This result may appear insignificant. However, it suggests that countries with higher GDP per capita are more sensitive to social unrest via a drop in cereal yields during warmer-than-average years.<sup>48</sup>

The squared term of Polity2 is negatively associated and statistically significant (at  $p < 0.05$ ) for models four and five. The results from model four support the notion that institutional incoherence is conducive to a higher count of total and violent events, but not peaceful protests. This is consistent with previous literature suggesting that social unrest episodes are more likely to occur when there is space for toleration by a polity and when individuals are neither sufficiently free to make regular claims, nor so repressed as to prevent them from trying to do so for fear of

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<sup>48</sup> In a more optimistic view, the African Development Bank suggests that Africa now has the fastest-growing middle-class in the world, and by 2060 the Bank expects the 1 billion Africans to join the middle-class. The report is available at: <http://www.afdb.org/>

repression (Hegre et al. 20011; Geddes 1999). Surprisingly, the total amount of agricultural imports has no discernable effect on the frequency of social unrest. Similarly, more populous countries and the occurrence of civil war have no statistical association with the frequency of social unrest.

These results suggest three main findings. First, contrary to recent studies that examine the direct nexus between climate change and conflict, I find temperature proxies, rather than rainfall ones, to be associated with conflict (Theisen 2012; Hendrix & Salehyan 2012). That is, warmer-than-average years are more likely to increase the frequency of social unrest south of the Sahara. Second, in line with Lesk et al. (2016), I find that warmer-than-average years decrease cereal yields, which in turn increases the frequency of social unrest. This is not surprising, since cereals are the most important component in food purchases and auto-consumption for both urban and rural populations in the region (Chauvin 2012). Third, contrary to the literature on collective action, which suggests that lower levels of GDP per capita increase the likelihood of conflict, I find wealthier countries to be more sensitive to the occurrence of social unrest. This supports the idea that it is not the poorest of the poor who take to the streets first, but rather those who have benefited from recent economic prosperity and fear impoverishment. However, further research must explore this causal mechanism.

## **Conclusion**

While there remains room for debate about the causal mechanisms that are conducive towards a variety of conflict processes via climate variability, recently shattered century-long global temperature records should urge policy makers and academics to further examine the climate-crops-conflict nexus. Climate change is a potential security risk for sub-Saharan Africa because of its strong dependence on rain-fed agriculture. Indeed, in this chapter, I have shown that from 1990

to 2012, warmer-than-average years have increased the frequency of social unrest via drops in cereal yields. While the statistical effects may not be very robust, the exploratory goal of this chapter was achieved. As global temperatures continue to increase and with the potential for low-intensity conflicts to escalate into a full-blown civil wars, further research should be focused on the effects that climate-induced scarcity will have on distinct conflict processes. Rather than simply dismissing such trends in the literature as “alarmist,” the climate-conflict academic literature should place more importance on the interactive effects linking climate change proxies and food production failures. It is important to note that an increase in social unrest does not occur simply because any given year is too warm or there is too little or too much rain, but rather through the interaction between climate anomalies and food production.

While the primary hope is that the results presented here will advance the academic literature in this area, further disaggregated analysis is needed to better understand this relationship. For instance, this research suggests that social unrest occurs in the same year that warmer-than-average temperatures are experienced. This raises the following questions: 1) Are farmers the main force behind episodes of social unrest during the same year that warmer-than-average temperatures decrease crop production? or, 2) Are urban dwellers taking to the streets in anticipation of future spikes in food prices during warmer-than-average years?

To conclude, the findings from this chapter suggest that on top of the all-too-common structurally induced food scarcities facing the region, temperature anomalies have begun—and will continue to—place further pressure on food security in sub-Saharan Africa. Given the evidence presented it seems important that policy makers take the necessary steps to lower the region’s agricultural sector’s sensitivity to climate shocks. This could entail better irrigation



systems and a mixture of rotating crops and genetically modified seeds in some areas. Further disaggregated research is needed to answer these important questions.

As will be seen in the next chapter, land degradation can be an important resource not only affecting food production, but also pastoralist communities who heavily depend on fertile lands to feed their livestock. Pastoralists require pastures to feed their livestock and earn income. These communities are often neglected by state authorities. This leaves them with little room to vent their grievances, which makes violence a potential tool to maximize gains (e.g., grassland) when climatic shocks befall them. In summation, the next chapter examines whether land degradation is exacerbated by continuous climatic anomalies, that in turn, increase the frequency of communal violence.

## FIVE

### CLIMATE VARIABILITY, LAND DEGRADATION AND COMMUNAL VIOLENCE

Little academic attention has been devoted to study the relationship between peripheral communities and climate change.<sup>49</sup> Dubbed the “climate change canaries,” these communities are often thought destined to be the first casualties of a warmer planet, given their strong dependence on changing ecosystems for their livelihoods (Meier et al. 2007: 721). Specifically, modest consideration has been given to disentangle the climate-conflict causal mechanisms. To fill this void in the literature, this chapter examines the effects of climate change on land degradation, and the impact of that degradation, in turn, in communal violence in sub-Saharan Africa.

In the previous chapter, I examined the theoretical and empirical nexus between supply-induced scarcity of cereal yields and social unrest via climate shocks. The empirical results led me to claim that declines in cereal yields in sub-Saharan Africa can be a path towards social unrest during warmer-than-average years. While the previous two chapters of this manuscript have focused on social unrest that is directed towards the state, I now turn to inter-group violence where state authority is not involved in any direct capacity (Hagmann & Mulugeta 2008).

Communal violence is not new. These types of conflicts generally have four main stimuli: rebellion and irredentism—mostly based on ethnicity, criminal activities, religious extremism and localized violence between rural communities who brawl over access to resources such as water and grazing lands (Hann et al. 2014). Communal violence receives little attention from policy makers and scholars of conflict processes. Nonetheless, communal violence poses a threat to the security of more than fifty million people in sub-Saharan Africa.<sup>50</sup> Given the strong dependence

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<sup>49</sup> These include pastoralists, agro-pastoralists and farmer communities that are organized along a shared identity.

<sup>50</sup> Working paper available at: [http://www.fao.org/ag/AGAInfo/programmes/en/pplpi/docarc/execsumm\\_wp3.pdf](http://www.fao.org/ag/AGAInfo/programmes/en/pplpi/docarc/execsumm_wp3.pdf)

of rural communities on ecological systems, communal conflicts tend to cluster in environments associated with a lack of water, under-population, state absence, a lack of infrastructure and basic social services, and largely uncontrolled spaces and borders (Blench 2001).

Academic focus on communal conflict has slowly began to increase as scholars slowly shift away from state-centric approaches towards lower levels of spatial desegregation and dedicate more attention to analyzing the effects of climate change and variability on various conflict processes. This growing literature has identified that wetter years are associated with organized armed violence (Buhaug 2010; Hendrix & Salehyan 2012; Salehyan & Hendrix 2014; Delvin & Hendrix 2014), while low-intensity conflicts, such as riots, protests, and communal conflict, are more likely to occur during drier years (Kahl 2006; Homer-Dixon 2007; Hsiang et al. 2013). However, these studies postulate that climatic conditions directly and dominantly influence the likelihood of violence among people, communities and states (Raleigh et al. 2014). However, consensus on these links remain elusive.

Therefore, in this chapter I examine how the frequency of communal violence increases in the presence of climate shocks via land degradation. In order to avoid repetition, the next section briefly summarizes the current literature on climate change and conflict along with my theoretical argument and hypotheses. The section after that presents data and operationalization measures. Finally, the results are presented and findings are discussed.

### **Previous research**

The majority of climate researchers conclude with high confidence that temperatures will continue to increase during the following decades, largely due to anthropogenic activities (IPCC 2014; Cook 2013). The IPCC envisages that climate change will affect different social and environmental

systems as temperature and sea levels continue to rise and erratic rainfall reduces water availability in some parts of the world (IPCC 2007, 2014).

In some areas of sub-Saharan Africa, rainfall patterns are twofold: March, April and May are the long rain season, while September, October and November are the short rain period. For instance, while the most recent IPCC report suggests an overall increase in rainfall for eastern Africa, recent academic research finds mixed results. Tierney et al. (2015) find an “overall drying of the region,” particularly during the long rain season. However, when looking exclusively at the short rainfall season, Schreck and Semmazzi (2004) find an increase in rainfall unfolding in the north while decreasing amounts are recorded in the southern region.

While rainfall can bring much needed relief to pastoralists and farmers alike, too much rain and longer dry spells can also cause or exacerbate land degradation. Land degradation is the temporary or permanent decrease of the productive capacity of soil.<sup>51</sup> The Global Assessment of Soil Degradation (GLASOD) provides two major natural hazards for land degradation: water and wind. Water contributes to land degradation when rainfall intensity is too high or too low. On one hand, too little rain combined with higher temperatures speeds the loss of organic matter in the soil. On the other, excessive rain can cause floods that displace topsoil, remove a large amount of nutrients and reduce water-holding capacity, all of which can create a long-term problems for land productivity.<sup>52</sup> Similarly, wind speeds can displace topsoil and selectively remove fine particles, particularly in arid and semi-arid climates (FAO 1993). High levels of land degradation decrease

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<sup>51</sup> “Soil is a living material with microbes that recycle organic material, which underpins the cycle of life on earth, and also engineer the soil on a tiny level to make it more resilient and better at holding onto water. Microbes need carbon for food, but carbon is being lost from the soil in a number of ways. Simply put, we take too much from the soil and don’t put enough back.”

Interview from the World Economic Forum available at: <http://world.time.com/2012/12/14/what-if-the-worlds-soil-runs-out/>

<sup>52</sup> Topsoil is the first eight inches of soil, with the highest concentration of nutrients and microorganisms that allows plants to grow.

the productive amount of soil available for grazing land to feed livestock. Thus, land degradation Africa will worsen as global temperatures increase and rainfall becomes more erratic.<sup>53</sup>

### *Climate shocks and communal conflict*

Pastoral groups face various challenges to their livelihoods: impoverishment, political marginalization, shrinkage of grazing land due to the expansion of agriculture, land grabs and zoned wildlife parks, as well as armed conflict. To make matters worse, temperature and rainfall anomalies are expected to further “shorten the resource pie” among pastoral groups, which often contributes to frictions between groups and their neighboring communities (Fratkin 1997; Sharamo 2014). Anecdotal events from South Omo, Ethiopia, provide *prima facie* evidence for the claims of communal violence occurring as a result of supply-induced scarcity of a basic resource: land. While the livelihoods of farming communities in South Omo revolve around the Omro River, pastoralist groups are always in pursuit of new grazing lands. In recent years, however, driven by a reduction in grazing land during prolonged dry years, pastoralist communities have begun to emerge near the Omo River, increasing episodes of violence between pastoralist and farmer communities. For instance, pastoralists often shoot farmers who are caught spraying pesticides on crops—considered livestock food by pastoralists. Similarly, farmers frequently retaliate against pastoralists whose livestock damage their crops (Onyima and Iwuoha 2015).

At the heart of the debate over the role of climate change is whether rainfall and temperature variability will lead to scarcity or abundance of basic resources such as food and water. However, recent evidence of the direct climate-communal conflict nexus is mixed at best. A recently conducted ethnographic assessment in Eastern Africa illustrates how competition over

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<sup>53</sup> United Nations Convention to Combat Desertification: <http://www.unccd.int/en/regional-access/Africa/Pages/alltext.aspx>

water and land are the most frequent causes of communal conflicts during wetter-*and* drier-than-average seasons (Michael et al. 2005). A proposed causal chain posits that during above-average rainfall years (Raleigh and Kniveton 2012) or years following wetter years (Theisen 2012), pastoralists communities increase the mobility of their livestock to take advantage of robust grazing lands and water deposits, which often lead to conflicts over the *abundance* of grassland and water (Meier et al. 2007). As Turner (2004: 877) explains, these “conflicts are less likely to be ‘in-the-moment’ struggles over a particular resource patch and more likely to resemble strategic contests to maintain resource access over the longer term.” Similarly, Adano and Witsenburg (2009: 520) find that “twice as many people are killed in wet years than in drought years given high grass and dense bush cover which makes it easier to track and ambush” other communities.

This direct relationship suggests that when wetter seasons bring a limited amount of pasture, combined with the uncertainty of rainfall from one year to the next, pastoralist communities seek to strategically maximize a way to get fatter livestock that will increase their economic impute—a process that requires time and discourages sharing access to renewables with others.

On the scarcity side of the argument, Fjelde & Uexkull (2012) and Mkutu (2008) find negative rainfall deviations to be associated with a stronger likelihood of communal conflict in sub-Saharan Africa. That is not to say that pastoralists fight over dry patches of land. In fact, because they often inhabit drylands where resources are normally dispersed and dependent on erratic climatic conditions, pastoralists have learned to recognize regions where rainfall is more frequent (Nori et al. 2005). However, during extended dry seasons, *scarcity* of resources forces pastoralists to migrate closer to waterlogged areas in order to access feed and water, making farmlands and water deposits common settings for violent clashes (Onyima and Iwuoha 2015).

Nonetheless, empirical results from large-N studies examining a relationship between precipitation variability and communal conflict are sparse and inconclusive. As with the conflict literature exploring climate shocks and episodes of violence towards the state, the research on non-state actor violence assumes that climate shocks alone can result in violent episodes. However, climate shocks may be a necessary but insufficient condition for conflict to occur. Stating that conflict occurs solely due to climate anomalies only implies that scarcity or abundance are the consequences of climatic shocks. However, there is little research that directly tests this causal chain.

### **Climate variability, land degradation and communal violence**

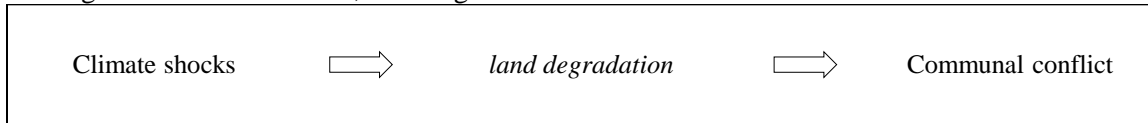
Figure L shows the theoretical argument proposed in this chapter. Temperature and precipitation anomalies are arguably the most important natural hazards for worsening land degradation and desertification. The World Meteorological Organization of the United Nations claims that sub-Saharan Africa is particularly sensitive to land degradation as a result of climate shocks, the region's poor vegetation and high amounts of suspended sediments.<sup>54</sup> In fact, the Global Footprint Network estimates that in 2011, Ethiopia, Eritrea, Kenya, Somalia and Uganda had only 0.1, 0.2, 0.2, 0.6 and 0.1 global hectares per capita of grazing land left, respectively.<sup>55</sup> The already low availability of grazing land in some areas and further deterioration brought on by erratic precipitation and longer dry spells suggests a very small "resource pie" to be distributed among rural communities.

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<sup>54</sup> World Meteorological Organization report is available at: <https://www.wmo.int>

<sup>55</sup> "Because each unit of space harbors a different portion of the global regenerative capacity, each unit is counted proportionally to its global bio-capacity share. For this reason, hectares are adjusted proportionally to their productivity and are expressed in global hectares. A global hectare is a biologically productive hectare with world average productivity (The Global Footprint Network 2011). For more information visit: [www.footprintnetwork.org](http://www.footprintnetwork.org).

Figure L. Climate shocks, land degradation and communal violence



As land degradation further decreases the amount of pasture land available, tensions between rural communities are likely to increase. A study of 200 pastoralists in Mandera, Kenya, found that after the 2006 drought, pastoralists lost 87 percent of all cattle, camel and sheep (Christian Aid, 2006). These communities mostly derive their income from the sale of animal products (e.g., milk, meat and hides), followed by wage labor, remittances and humanitarian aid (Halderman 2004; Ammann 2005). Consequently, the income of pastoralist communities is strongly and directly tied to livestock—whose productivity depends on grazing lands and water. Figure M shows the livestock agglomeration for sub-Saharan Africa.

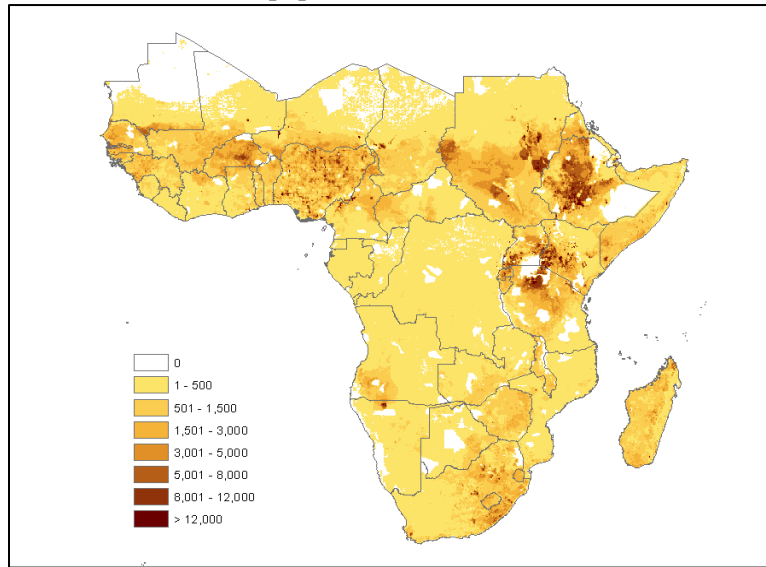
Over the last 25 years, Africa has seen a decline in poverty rates.<sup>56</sup> This increase in socio-economic status has simultaneously increased the demand for meat consumption in the region. Overall, per capita consumption of meat in sub-Saharan Africa has steadily increased since the 1990s. In 1994, per capita consumption stood at 9.3 kg compared to 11 kg in 2015.<sup>57</sup> During the same time period, meat consumption in the Middle East and North Africa—two major (formal and informal) livestock importers or meat from pastoralist communities rose from 19.5 kg to 28.6 kg.

<sup>56</sup> Income groups by income: the poor live on \$2.00 or less per day, low-income on \$2.01–\$10.01, middle-income on \$10.01–20.00, upper-middle income on \$20.01–\$50.00, and high income on more than \$50. Figures based on 2011 purchasing power parity in 2011 prices.

<sup>57</sup> Kg per capita in carcass weight equivalent. More information at: <http://www.fao.org/docrep/005/y4252e/y4252e05b.htm>



Figure M. Total livestock population (TLU 2005)<sup>58</sup>



Source: International Food Policy Research Institute<sup>59</sup>

Regional meat consumption growth, in theory, should increase the income of pastoralist communities through a rise in livestock trade. For instance, in a livestock market in Nairobi, a goat or sheep can be sold for about \$31–\$37, a cow for \$250–\$312 and a camel for \$625–\$750.<sup>60</sup> Pastoralists' expectations of higher incomes, signaled by an increase in livestock exports, should simultaneously increase with meat consumption. However, despite such gains, pastoralist communities remain one of the poorest sub-groups in sub-Saharan Africa. The World Bank (2014) estimates that among pastoralist communities in Africa, “the incidence of extreme poverty ranges from 25 to 55 percent”.<sup>61</sup> Based on this, I argue that if the capabilities to increase their income decline as a result of climate shocks, economic grievances can trigger violence towards those perceived to be preventing a maximization of capabilities.

<sup>58</sup> Tropical Livestock Units are livestock numbers converted to a common unit (in 2005). Conversion factors: cattle = 0.7, sheep = 0.1, goats = 0.1, pigs = 0.2, chickens = 0.01. For more information, visit: <http://harvestchoice.org/node/4788>.

<sup>59</sup> Harvest Choice, 2011. "Total livestock population (TLU) (2005)." International Food Policy Research Institute, Washington, DC., and University of Minnesota, St. Paul, MN. Available online at <http://harvestchoice.org/node/4788>

<sup>60</sup> IRIN News: <http://www.irinnews.org/report/90678/horn-africa-livestock-trade-booms-borderlands>

<sup>61</sup> World Bank Boosts Support for Pastoralists in Horn of Africa. Press release available at: <http://www.worldbank.org/en/news/press-release/2014/03/18/world-bank-pastoralists-horn-africa>

In summation, an increase or decrease in the economic capabilities of pastoralists is contingent upon healthy and fat livestock, which depend in turn on grassland and water from rainfall. However, grasslands depend on fertile soil provided by rainfall. Thus, I examine whether temperature and rainfall anomalies exacerbate land degradation and reduce grazing land available for pastoralists, thereby increasing the likelihood of communal violence due to fears of economic loss.

Six hypotheses are drawn to test the offered theoretical approach:

*Land degradation*

H1 Land degradation should be positively associated to the frequency of communal violence.

*Precipitation*

H2 Precipitation deviations from average rainfall patterns should increase the frequency of communal violence.

H3 The interaction of extreme deviations from average rainfall patterns and land degradation should be associated with an increase in the frequency of communal violence.

*Temperature*

H4 Above-average temperature years should increase the frequency of communal violence.

H5 The interaction between above-average temperature years and land degradation should be associated with an increase in the frequency of communal violence.

## **Research design**

Due to the highly skewed distribution of events on the dependent variable, I employ a negative binomial model with robust standard errors clustered in countries. The robustness of the results is explored using an alternate measurement of rainfall anomalies. The precipitation data is from Hendrix and Salehyan (2012), who use the Global Precipitation Climatology Project (GPCP), a data set that also uses monthly rainfall estimates that are aggregated at the country level. Their

data measure the annual standardized rainfall deviation for the 1979–2008 period. The robustness check did not alter my main findings. Table 5.1 provides summary statistics.

Table 5.1. Summary of main sample statistics

	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
<b><i>Dependent variables</i></b>				
Communal violence	0.29	1.00	0	9
<b><i>Environmental factors</i></b>				
Land degradation	0.29	0.26	0	1
RAIN <sub>(t-5)</sub>	0.07	0.98	-2.87	4.67
RAIN <sup>2</sup> <sub>(t-5)</sub>	0.98	1.58	5.07	21.86
Land deg* RAIN <sub>(t-5)</sub>	0.02	0.38	-2.29	2.27
Land deg* RAIN <sup>2</sup> <sub>(t-5)</sub>	0.28	0.59	0	5.90
TEMP <sub>(t-5)</sub>	0.93	0.85	-1.86	3.84
TEMP <sup>2</sup> <sub>(t-5)</sub>	1.60	2.13	8.97	14.80
Land deg* TEMP <sub>(t-5)</sub>	0.29	0.44	-0.57	3.64
Land deg* TEMP <sup>2</sup> <sub>(t-5)</sub>	0.50	1.08	0	13.29
<b><i>Controls</i></b>				
log GDP per capita <sub>(t-1)</sub>	22.28	1.30	18.77	26.48
Ethnic exclusion	0.56	0.49	0	1
log total population <sub>(t-1)</sub>	15.34	2.77	3.01	18.94
Civil war occurrence	0.21	0.41	0	1
Time trend	11.95	6.62	1	23

### ***Dependent variable***

To operationalize communal violence, I draw from the non-state conflict dataset from Uppsala Conflict Data Program (UCDP). A non-state conflict is defined “as the use of armed force between two armed groups, neither of which is the government of a state, which results in at least 25 battle-related deaths in a year” (Sundberg et al. 2012). The dependent variable only includes groups that share a common identification along ethnic lines, clan, religious, national or tribal lines.

### ***Independent variables: land degradation and climate shocks***

#### ***Land degradation***

To examine the influence of land degradation, I use Hendrix and Glaser's (2007) per-country percentage of total degraded land. Unfortunately, these values are static within countries and are an admitted limitation of this study. It should be noted that this does in no way implies that the data are necessarily outdated, as most soil properties are in fact quite stable over time, and significantly measureable over a time span of 20–30 years. For a more detailed discussion of variable construction, see the FAOs World Soil Resources Report (2000).<sup>62</sup>

### *Climate shocks*

The operationalization of both covariates is performed under the same conditions stipulated in the previous chapter—using 0.5° latitude/longitude gridded data from the University of East Anglia Climate Research Unit.<sup>63</sup> The yearly data for sub-Saharan countries is transformed into a moving standardized cumulative rainfall, RAIN and the moving standardized temperature yearly average, TEMP. The squared terms of both variables are included to account for a curvilinear relationship. To examine the theoretical argument that an interactive effect between climate anomalies and land degradation increases communal conflicts, interaction terms between the climate proxies and land degradation are introduced into the analysis. Finally, to account for the slow-moving process of land degradation via climate shocks, all climate variables are lagged by five years.

### *Control variables*

Pastoralist communities are among the poorest in Africa, as well as the least resilient to climatic anomalies. Sabates-Wheeler et al. (2008) suggest that during periods of environmental hardship, economic adversity among vulnerable groups is often exacerbated. Given the primary emphasis placed on the temporal changes in the welfare of pastoralist communities, I use GDP per capita (in

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<sup>62</sup> World Soil Resources Report available at: <ftp://ftp.fao.org/agl/agll/docs/wsr.pdf>

<sup>63</sup> The monthly data is added to obtain the total yearly precipitation per country.

2005 US\$) to test the proposition that economic grievances are a function of the level of income levels (Blattman & Miguel 2010).

Kahl (2006) and Homer-Dixon (1999) suggest that weak institutions limit the ability of societies to adapt to environmental scarcity and to properly deal with violent conflict. However, pastoralist communities are often excluded from the political arena. Three consequences arise from this exclusion. First, political exclusion of ethno-political groups has been found to be strongly associated with participation in organized violence (Cederman et al. 2010, Theisen et al. 2010). Second, political exclusion results in a strong reliance on ethno-linguistic alliances when organizing for collective action around socio-political and economic grievances (Scarritt & Mozaffar 1999). Finally, ethno-political groups that are not represented in the political arena share grievances that motivate participation in violence. Inter-group violence is a way to mediate access to resources critical to sustain livelihood in a space of minimal governments (see also Hagmann & Mulugeta, 2008; Cederman et al. 2010). Thus, to control for ethnic exclusion of certain groups from the political process, I turn to the Ethnic Power Relations (EPR) data set. The data set identifies all politically relevant ethnic groups worldwide since 1945 and provides annual data on the group's access to executive power (Cederman et al. 2010). Ethnic exclusion is coded 0 for non-excluded groups and 1 if otherwise.

Collier et al. (2003) claim that the spatial and temporal occurrence of conflict can lead to repeating cycles of political violence. In order to avoid the inter-dependencies that arise from the so-called “conflict trap,” I control for the occurrence of civil war. Finally, I control for the neo-Malthusian premise that populous countries will experience stronger degradation and scarcity of natural resources (Renner 1996; Gleditsch 2001).

## Results and Discussion

The results in table 5.2 report the coefficient estimates for a negative binomial regression model, and report robust standard errors clustered in countries. A glance at all three models suggests that, *ceteris paribus*, higher levels of land degradation are positively and statistically significant (at  $p < 0.01$ ) with a higher frequency of communal violence. Therefore, I find support for hypothesis 1. That is to say, countries with a higher percentage of total degraded land are more likely to experience a higher incidence of communal violence.

Model 1 presents the coefficient estimates solely using precipitation proxies. The results from the first model do not lend support to hypothesis 2, which proposes that precipitation anomalies (on either direction) during the previous 5 years increase the frequency of communal violence. These findings are contrary to recent research that finds a direct and statistically significant relationship between precipitation anomalies and communal violence (Mkutu 2008; Fjelde & Uexkull 2012). However, I find support for hypothesis 3. That is, the interaction between RAIN at year  $t-5$  and land degradation to be associated and statistically significant (at  $p < 0.05$ ) with the frequency of communal violence. In line with my theoretical argument, a strain of five consecutive drier-than-average years significantly increase the frequency of communal violence via land degradation. This suggests that consecutively drier years have a deteriorating effect on soil, reducing available pastures for pastoral communities, leading to conflict over scarce resources.

Table 5.2 Coefficient effects for climate change &amp; land degradation on communal violence

	(1)	(2)	(3)
Lagged DV	0.483*** (0.141)	0.457*** (0.136)	0.476*** (0.127)
Land degradation	2.483*** (0.775)	2.345*** (0.829)	2.480*** (0.752)
RAIN <sub>(t-5)</sub>	0.0751 (0.201)		0.128 (0.196)
RAIN <sup>2</sup> <sub>(t-5)</sub>	-0.0841 (0.105)		-0.092 (0.088)
Land deg*RAIN <sub>(t-5)</sub>	-0.707** (0.347)		-0.732** (0.315)
Land deg*RAIN <sup>2</sup> <sub>(t-5)</sub>	-0.153 (0.196)		-0.154 (0.178)
TEMP <sub>(t-5)</sub>		0.622 (0.417)	0.661 (0.422)
TEMP <sup>2</sup> <sub>(t-5)</sub>		-0.136 (0.185)	-0.144 (0.182)
Land deg*TEMP <sub>(t-5)</sub>		-0.334 (0.824)	-0.430 (0.770)
Land deg*TEMP <sup>2</sup> <sub>(t-5)</sub>		0.160	0.178
<b>Controls</b>			
log GDP per capita <sub>(t-1)</sub>	0.767*** (0.159)	0.750*** (0.162)	0.772*** (0.159)
log total population <sub>(t-1)</sub>	-0.062 (0.069)	-0.055 (0.063)	-0.063 (0.062)
Civil war occurrence	1.567*** (0.358)	1.467*** (0.370)	1.495*** (0.368)
Ethnic exclusion	-0.145 (0.463)	-0.090 (0.459)	-0.082 (0.458)
Time trend	-0.037** (0.016)	-0.044*** (0.016)	-0.045*** (0.016)
Observations	850	850	850
Countries	38	38	38

Negative binomial with robust standard errors clustered in countries \*\*\* p<0.01,

\*\* p<0.05, \* p<0.1

Model 2 presents the coefficient estimates using only temperature measurements to account for potential loss of organic matter in soil from temperature increases.<sup>64</sup> The results indicate no support for hypotheses 3 and 4. These results indicate that consecutive years with above-average

<sup>64</sup> WMO: [http://www.wmo.int/pages/prog/wcp/agm/publications/documents/wmo\\_cc\\_desertif\\_foldout\\_en.pdf](http://www.wmo.int/pages/prog/wcp/agm/publications/documents/wmo_cc_desertif_foldout_en.pdf)

temperatures have not (yet) increased the incidence of communal violence. The interaction between TEMP<sup>2</sup> at  $t-5$  years and land degradation is also not associated with communal violence.

As a robustness check, model 3 includes the five-year lag of temperature and precipitation anomalies, plus their interaction terms. The results in model 3 do not alter the results found in the previous two models. For substantive results tracing the interaction of land degradation and the five-year lag of RAIN, I turn to CLARIFY software (King et al. 2003) using the results from model 3 while holding all other variables to their mean value. The results are displayed in table 5.3.

Table 5.3 Interaction effects between RAIN<sub>( $t-5$ )</sub> and land degradation on communal violence<sup>65</sup>

	-3 SD	-2 SD	-1 SD	+1 SD	+2 SD	+3 SD
<b>Pr(1)</b>	10.8%	7.2%	6.0%	5.6%	3.5%	2.6%
<b>Pr(2)</b>	1.8%	0.7%	0.4%	0.4%	0.1%	0.09%

A one standard deviation decrease from the mean interaction between RAIN and land degradation increases the probability of experiencing one communal violence event by 6.0%, while a two standard deviation decrease from the mean increases the probability of one communal violence event by 7.2%. A three standard deviation decrease from the mean interaction between RAIN and land degradation increases the probability of one communal violence event by 10.8%. This supports the argument that drier consecutive years of negative precipitation anomalies intensifies land degradation, placing additional strains on the availability of pasture lands and

<sup>65</sup>Note: -3 SD held at 1th percentile, -2 SD at 10<sup>th</sup> percentile; -1 SD at 30<sup>th</sup> percentile; +1 SD at 70<sup>th</sup> percentile and +2SD at 95<sup>th</sup> percentile, and +3 SD at 99 percentiles.



leading groups to compete for scarce resources (Homer-Dixon 1999; Kahl 2006; Fjelde & Uexkull 2012).

Turning to the control variables, the directionality of per capita GDP is positive and statistically significant (at  $p < 0.01$ ) across all models. I find support for hypothesis 5. This finding is in opposition to Raleigh and Kniveton (2012), who find that lower levels of per capita GDP are associated with the onset of communal violence. This finding is in line with the previous chapter, reinforcing the idea that as the region's economic growth continues to lift people out of poverty, climatic shocks increase economic grievances, in this case, among pastoralist communities who fear falling (or falling back) into poverty. Neither ethnic exclusion nor are more populous countries associated with the frequency of communal violence across models. The occurrence of an armed conflict is positively associated and statistically significant with a higher incidence of communal violence in the region. This is in line with previous research suggesting that during armed conflicts, pastoralist communities become militarized, increasing the severity of resource conflicts among pastoralist communities (Gebre 2001; Kassa 2001; Abdulahi 2005).

## **Conclusion**

In contrast to recent research on communal violence and climate shocks (Meier et al. 2007; Raleigh and Kniveton 2012) I find that drier, not wetter years, increase the likelihood of communal violence via land degradation. This research exposes two central findings. First, rather than assume that people react violently to changes in weather patterns, this research provides a conducive causal mechanism towards communal violence that advances the climate-conflict nexus. Second, it provides robust evidence that the interaction between consecutive drier than average years and higher levels of land degradation increases the frequency of communal violence in sub-Saharan Africa.

It is important to note that even when these conditions are met, individuals must *choose* to act violently. In most cases individuals and entire communities chose to adapt or seek relief from national and international agencies. For instance, between 2015 and 2016 Ethiopia faced its worst drought in 50 years that left millions in need of aid. Ethiopia has the largest livestock population in Africa and one of the highest percentages of pastoralist communities in the region (FAO 2015a). In a FAO meeting in the country, one pastoralists recounts that before the drought he owned “500 sheep and goats and 60 cattle, but now has just 13 sheep and goats and 4 cattle ...”<sup>66</sup> While many pastoralist communities in the country suffered a similar fate, the Armed Conflict Location and Event Data Project (ACLED) has not recorded a single incidence of communal violence in the country since the beginning of the drought.<sup>67</sup> While this is simply anecdotal evidence from a single country, researchers of conflict processes ought to consider that climate shocks and their impacts on various resources can also incite people and communities to cooperate rather than fight with one another. To further examine this, more attention should be devoted to resource-conflicts during El Niño years that increases the forecast probability of above-average drought by 20 percent in some parts of the region, particularly in eastern Africa (WMO 2005).

Policy makers ought to expand the reach of legal and political government administrative instruments, empower local institutions, and increase transparency between communal groups in order to better mitigate potential disputes and resolve conflicts. Failure to do so can have two principal consequences. First, as land degradation increases as a result of climatic shocks, individuals will seek alternative ways to improve their livelihoods. This can result in an increase participation by peripheral communities in criminal networks, including drug smuggling, kidnapping and armed groups in North Africa and the Middle East. Second, forced displacements

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<sup>66</sup> Ibid.

<sup>67</sup> ACLED: <http://www.acleddata.com/data/realtime-data-2016/>

of large segments of people will grow as climate- and human-induced pressures increase demands on ecological systems. The International Displacement Monitoring Center (IDMC) estimates that in 2014, 17.5 million people around the world were internally displaced by weather-related disasters. In 2013 alone, “floods in sub-Saharan Africa triggered five of the 10 largest displacements” in recent history (IDMC 2014:8). And, as previously theorized (Reuveny 2007) prolonged displacement adds to grievances and trauma, and can spark conflicts. Therefore, while for now consensus alludes the climate-conflict research, the quest for a better understanding of this complex relationship should not be abandoned.

## SIX

### A GREAT BALANCING ACT

In 100 CE, Roman poet Juvenal recognized that by providing *panem et circenses*, Roman politicians were able to garner public support and prevent the populace from expressing discontent. Juvenal was among the first to recognize the important link between food security and a peaceful citizenry. Is this assertion still true today? This dissertation sought to answer two important questions: does poor access to water and food motivate people to protest? Have climate shocks already begun to negatively impact crop yields and exacerbated land degradation, that in turn, have increased the likelihood of socio-political unrest and communal violence? By exploring these questions, this research has sought to contribute to the growing literature on climate change and conflict processes. The findings presented in chapters three through five have policy and theoretical implications which I discuss below.

Under the assumption that climate shocks can result in a scarcity *or* abundance of basic resources, the climate-conflict literature has been dominated by the notion that violence is more likely when climate shocks occur. Yet, there are two important gaps in this literature. First, the current literature has been devoted of quantitative analysis that examines the interactive effect between climate shocks and basic resources have on various conflict processes (with the exception of Hendrix & Glaser 2007). Second, there is a tendency among researchers to presume that people will always choose to react violently instead of choosing to positively cope. In fact, some argue that cooperation and aid is often the prevailing response during climate shocks (Raleigh et al. 2014). This research seeks to clarify this current debate.

*The micro-causalities between poor access to renewables and protests*

To understand how climate change and variability can open a further exacerbate the challenge of feeding a growing population, one must first examine the micro-causalities between protest participation and access to basic resources such as water and food. Chapter 3 captures a ‘snapshot’ in time of these micro-causalities by using Afrobarometer data from three different survey rounds collected between 2005–2013. Through the chapter, I argue that people who reported going without enough water or food would be more likely to protest, when compared to those who reported otherwise. The results show that, in fact, people who go without enough water or food have a higher probability to protest. The results also indicate that the more often people go without access to either basic resource, the higher their likelihood of protesting. The results also suggest that contrary to the literature on collective mobilization, employed individuals are more likely to protest when compared to unemployed individuals. This suggest that those employed have more to lose by not protesting as they risk impoverishment when access to basic resources is limited.

As I noted in the literature, the scholarship on food security has been static since the 1980s. The idea of resource scarcity is not new. In his 1968 book, *The Population Bomb*, biologist Paul Ehrlich renovated the Thomas Malthus projections, which argue that overpopulation would outpace the production of food. An economist, Julian Simon, was convinced that Mr. Ehrlich’s thesis was flawed. He argued that humans are like no other species in the world given that we have an economy and markets. According to his counterargument, if overpopulation led to the demand for more resources by increasing their prices, then this price increase would serve as a motivator to find more or alternative ways to produce more of that resource. So, in 1980, both men placed a bet. Ten years later Mr. Ehrlich lost the bet after his projections failed to materialize.

While Mr. Ehrlich's thesis earned him epithets such as "doomster" and "alarmist" from his critiques, his work gained many supporters and inspired others to follow this line of research (Meadowns et al. 1972; Jackson & Webster 2016). Among those to carry out this line of research was economist Amartya Sen. In his seminal work on famines, Sen (1981) points out that production shortfalls do not automatically lead to consumption deficits, rather, he argued, consumption deficits occur when political institutions fail to accurately distribute resources. While the contribution by Sen is not directly disputed in this pages, we now know that production shortfalls need to be reincorporated into the research agenda as a result of climate change. This is not to say that distribution problems should be ignored, but it is essential to contemplate that climate change will very likely provide the *coup de grâce* to an already fragile distribution system while at the same time reduce food production. To makes matters worse, given the expected population growth, world food production needs to increase by 69% to feed 9.6 billion people by 2050. Climate change is expected to complicate this production challenge.

Understandably, data on climate change was scarce and our understanding of the potential effects of climate shocks on basic resources remained poor at the time of the bet between Simon and Ehrlich, and we were just understanding the phenomena by the time Sen's research was published. Since then, much has changed. Good quality data is widely available and the understanding of some of the overall impacts of climate change are well documented, including the its potential impacts on social cohesion (IPCC 2001, 2007, 2014). However, the causal links between climate change and conflict processes remains unclear.

#### *Climate variability, food production and social unrest*

In chapter 4, I examine the interaction effects between climate change and cereal yields, and the impact of that interaction, in turn, has on the frequency of social unrest in sub-Saharan Africa.

Cereals are the main food source purchased and auto-consumed by most households in the region (Chauvin 2012). Although some cereals are more susceptible to higher temperatures and dry spells than others, extreme temperature and precipitation variations can damage plant growth, thus weakening plant development that results in yield losses (Bita & Gerats 2013). I find that the interaction between cereal yields and above average temperature years increase the frequency of social unrest, particularly peaceful protests. This indicates that warmer-than-average temperatures have already begun to negatively impact social cohesion when cereal yields decline.

Previous literature denotes a direct nexus between climate variability and conflict (Ragnhild & Gleditsch 2007; Raleigh & Kniveton 2012; Salehyan & Hendrix 2014). However, this literature is based on the assumption that climate variability (mostly rainfall) results in resource abundance or scarcity. Indirectly, this literature suggests that people will become violent when too many or too little resources exist. Yet, not all basic resources affect population sub-groups equally. For instance, too much rain in semi-arid areas where crop production is absent will have no direct impact on urban dwellers. However, in these regions too much rain can increase pastures, potentially sparking abundance conflicts among pastoralists who seek to maximize their income by fattening their livestock. Thus, different regions and populations have different causal mechanisms that can lead to periods of conflict. As the increasing threat of climate change continues to impact agricultural production in sub-Saharan Africa, yield losses will continue to threaten future regional food security and social cohesion.

The role of political institutions is consistent with previous literature on collective mobilization and food security. On one hand, countries with weaker political institutions are associated with a higher incidence of protest (Hendrix & Haggard 2012; Weezek 2013). Stronger political institutions are more accessible (open regimes) are more likely to mitigate and respond

to constituent grievances; however, when these mechanisms fail protests, riots, and demonstrations serve as counteractive responses. Autocratic regimes with weak political institutions (closed regimes) tend to be highly repressive and usually prevent their citizens from developing the organizational means to express their grievances are also less inclined to tolerate protest. Such repression deters popular mobilization and represses them if they occur (Goodwin 2001). However, Africa is the continent with more “anocracies” (hybrid regimes). These regimes are characterized by not being either democratic nor autocratic, but rather somewhere in the middle with political elements from both regime types (Weezel 2013). Thus, anocracies limit political competition and civil liberties but at the same time provide space for contestation and opportunity for individuals to make their claims publically, that is, protesting.

On the other hand, democratic regimes (e.g., strong democratic institutions) are more efficient when it comes to providing a broader access to basic resources such as water and food for their citizens. However, authoritarian regimes are often not as efficient as democratic regimes in broadening access to most citizens. This is often due to poor affordability (lower household incomes, little financing to farmers, etc.), availability (poor supply, poor infrastructure, corruption, etc.), and poor quality & safety (little diet diversification, bad protein quality, poor presence of grocery sector, etc.).

I further argued that given the economic growth in the region since the beginning of the twenty-first century, richer countries should be more susceptible to incidence of social unrest. Using GDP per capita as a proxy for standard of living, I find this to be the case. After undergoing regional economic growth since 2001, more than 15 percent of the population in sub-Saharan Africa transitioned from poverty (\$2 or less) to low-income (\$2.01-\$10), or from low-income to



middle-class (\$10.01-\$20) (Kochhar 2015).<sup>68</sup> However, this economic transition is a frail one. A recent household-panel survey indicates that individuals are *more likely* to fall back into poverty “if they are hit by unemployment, illness, a disability, *extreme climate events* or conflict.”<sup>69</sup> Therefore, when climate shocks occur, the capabilities of people to sustain their new acquired economic status can remain static or decline, deepening economic grievances that can trigger episodes of social unrest.

### *Climate variability, land degradation and communal violence*

In chapter 5, I examine the effects of climate change on land degradation and the impact of that degradation, in turn, on the frequency of social unrest in sub-Saharan Africa. I further argue that the interaction of climate change proxies and land degradation should increase the occurrence of communal violence given that climate shocks can reduce the pastures available for pastoralists to feed their livestock. Indeed, the results show that higher levels of land degradation are positively associated with a higher frequency of communal violence in sub-Saharan Africa. Therefore, I find that climatic shocks do increase the frequency of communal violence via higher levels of land degradation.

Specifically, it is the interaction between land degradation and drier than average years at  $t-5$ , that is associated with an increased incidence of communal violence. The substantive effects show that moving from a -1 standard deviation to a -3 standard deviation, the probability of communal violence almost doubles. Thus, longer dry-spells worsen land degradation, which in turn decreases pastures for the livestock of pastoralist communities. This results are in line with

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<sup>68</sup> In a more optimist view, the African Development Bank suggests that Africa now has the fastest-growing middle-class in the world, and by 2060 the Bank expects the 1 billion Africans to join the middle-class. The report is available at: <http://www.afdb.org/>

<sup>69</sup> The Chronic Poverty Report 2014-2015: The road to zero extreme poverty. Available at: <http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8835.pdf>

Fjelde & Uexkull (2012) who find that negative deviations in rainfall are associated with a higher risk of communal conflict.

### *Future research*

I have answered some relevant questions here about the effects that climate change has had on social cohesion in sub-Saharan Africa from 1990 to 2012. I have examined whether poor access to food and water can be a determinant of protest participation and whether climatic shocks have decreased cereal yields, that in turn, increase the frequency of social unrest. I have also tested whether climatic shocks exacerbate land degradation, that in turn, increases the frequency of communal violence. The answer to these questions is that, in fact, poor access to water and food was a contributing factor for protest participation from 2005 to 2013. I also find that climatic shocks have begun to decrease cereal yields and exacerbate land degradation in the region, resulting in episodes of conflict. Though these questions are now answered, several more remain unanswered.

Further research is needed in several fronts. First, more research should focus on identifying how climate change will affect specific regions and sub-regions of sub-Saharan Africa. Doing this will allow scholars and policy makers to determine the most adequate regions better suited to grow crops that resistant to the expected changes in climate. For instance, Nigeria and South Africa are the largest growers of maize in sub-Saharan Africa.<sup>70</sup> However, predictive climate models expect Nigeria to become wetter and South Africa to become dryer (IPCC 2014). Given the susceptibility of maize to water variations, maize yields are expected to decline in both countries as global temperatures continue to increase. Such declines would further increase the current 28 percent of maize imports required to meet demand in the region, leaving it dependent

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<sup>70</sup> International Institute of Tropical Agriculture (IITA): <http://www.iita.org/maize>

on major international exporters like the United States and China. However, shifting to more climate resistant crops such as cassava, while boosting maize production better suited areas can mitigate future food shortages for the region.

Second, further research should also focus on unpacking other intervening causal nexus between climate change and conflict processes. For instance, while research on the impact of climate change on water scarcity has made some progress recently (Savenije 2000; Rockström et al. 2009; Devlin & Hendrix 2014), more research is needed to better understand the role that climate change will have on freshwater and the potential consequences of water scarcity of various conflict processes.

Finally, while the results presented in this dissertation are pessimistic, future analysis should focus on the premise that climatic shocks can also lead to a more peaceful world, rather than one plagued by conflict. In fact, anecdotal evidence from periods of weather shocks show higher levels of cooperation, rather than conflict, among individuals. For instance, in the aftermath of hurricane Katrina that hit the city of New Orleans in 2005, people and communities came together to help their friends and neighbors by building temporary shelters, or to share water and food. Many of such episodes of cooperation after natural hazard are common. Failing to incorporate this into the discourse of climate security can “influence the perceptions of the actors in local and regional conflict and lead to militarized responses and thus perhaps contribute to a self-fulfilling prophecy” (Gleditsch 2012: 3).

### *Conclusion*

The findings in this dissertation have begun to close important gaps in the climate-conflict literature. However, as previously mentioned, further research is required to have a more comprehensive understanding of the socio-political impacts that climate change will have in sub-

Saharan Africa. In the meantime, this research suggests that poor access to basic needs such as food will be exacerbated by higher-than-average temperatures in years to come, further increasing the propensity and frequency of social unrest in sub-Saharan Africa. Moreover, the findings also indicate that peripheral communities are particularly vulnerable to violence as prolonged dry spells exacerbate land degradation in the region.

These findings provide evidence of the fragile situation facing sub-Saharan Africa in the emergence of a changing climate. Policy makers and academic research should find adequate ways to mitigate the negative impacts of climate change on basic resources in a way that fosters economic development and places no burden on ecological systems and the environment. Achieving this will require a “great balancing act” on several fronts. As it pertains to food security, four issues are crucial. First, overall access to basic needs such as water and food need to improve in areas where access is poor or non-existent. Second, governments need to be more efficient in *how* they grow, *what* they grow and *how* they grow different crops in the region. Doing this can allow for an increase in per acre crop yields as well as lessening the impact of climatic shocks. Third, governments must find different ways to grow meat and shift to less intensive meat diets. Currently only about half of the world’s crop calories are destined for human consumption, while the rest are used to feed livestock or turned into biofuels (Foley et al. 2011). Finally, governments ought to implement policies that reduce food waste. It is estimated that about one third of the food produced worldwide is lost or wasted. Food loss and waste in developing countries mostly takes place during post-harvest and processing stages.<sup>71</sup> The FAO estimates that the current loss or waste could feed an additional 300 million people.<sup>72</sup> Achieving this “great balancing act” is not an easy

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<sup>71</sup> FAO. Global Initiative on Food Loss and Waste Reduction. Statistics [accessed June 1, 2016] at: <http://www.fao.org/save-food/resources/keyfindings/en/>

<sup>72</sup> Ibid.

task. However, taken together, these steps can increase food supplies in order to mitigate the impact that climate change, and thus, reduce the likelihood and frequency of social unrest in the region.

The challenges for mitigating the effects of climate change among peripheral communities are equally complex. First, governments should increase market access to pastoralist communities. While European markets are often hard to penetrate due to strict meat quality and safety safeguards, as well as competition from large scale competitors, livestock imports to North Africa and the Middle East have increased. Thus, there are some available markets for pastoralist communities to export their meat and livestock. Second, government programs should be offered to peripheral communities that target specific development of skills that can be useful for people who wish to migrate towards urban areas. Finally, government investment in early weather monitoring systems can provide sufficient time for pastoralist communities to respond to long term dry spells. For instance, pastoralist communities can choose to protect core livestock during climate shocks and/or decide to sell more livestock before weather conditions worsen.

This dissertation began with two goals. On one hand, it wanted to incorporate food access into the collective action literature. I proposed that people with poor access to water and food would be more likely to participate in protests, compared to those who have uninterrupted access to these basic needs. On the other hand, this research wanted to untangle the climate-conflict nexus. That is to say, rather than assuming that people react violently to climate shocks, I argued that climate shocks decrease cereal yields and exacerbate land degradation, that in turn, increased the frequency of social unrest and communal conflict, respectively. Now, I conclude this research project by asserting that indeed, poor food access in sub-Saharan Africa motivates people to protest, particularly employed individuals who fear impoverishment. Moreover, the results lead me to claim that climate shocks have begun to negatively impact social cohesion in sub-Saharan

Africa through intensifying land degradation and declining cereal yields. While for now consensus eludes the climate-conflict research, the quest for a better understanding of this complex relationship should not be abandoned.

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## Appendix A: Afrobarometer questions used in the analysis

	Original answer options	Recoded answer (if applicable)	Afrobarometer question #
<b><i>Dependent variable</i></b>			
Here is a list of actions that people sometimes take as citizens. For each of these, please tell me whether you, personally, have done any of these things during the past year. If not, would you do this if you had the chance: Attend a demonstration or protest march?	0. No, would never 1. No, but would 2. Yes, once or twice 3. Yes, several times 4. Yes, often	0. No 1. Yes	Q23C
<b><i>Independent variables</i></b>			
Over the past year, how often, if ever, have you or anyone in your family gone without: Enough food to eat? <i>[same coding scheme used for having: Enough water to drink?]</i>	0. Never 1. Just once or twice 2. Several times 3. Many times 4. Always		Q8A Q8B
Do you have a job that pays cash? Is it full-time or part-time? And are you presently looking for a job (even if you are presently working)? ( <i>*Not Looking/ ** Looking</i> )	0. No, not looking 1. No, looking 2. Yes, part-time* 3. Yes, part-time** 4. Yes, full-time* 5. Yes, full-time**	0. Unemployed 1. Employed part-time 2. Employed full-time	Q98

### *Controls*

For each one, could you tell me whether you are an official leader, an active member, an inactive member, or not a member: some other voluntary association or community group?

- 0. Not a member
- 1. Inactive member
- 2. Active member
- 3. Official leader

Q22B

How interested would you say you are in public affairs?

- 0. Not at all interested
- 1. Not very interested
- 2. Somewhat interested
- 3. Very interested

Q13

In your opinion how much of a democracy is [Ghana/Kenya/etc.]?

- 1. Not a democracy
- 2. A democracy with major problems
- 3. A democracy with minor problems
- 4. A full democracy

Q42A

How old are you?

18-110

Q1

Respondent's gender

- 1. Male
- 2. Female
- 0. Female
- 1. Male

Q101

What is the highest level of education you have completed?

- 0. No formal schooling
- 1. Informal schooling only
- 2. Some primary schooling
- 3. Primary school completed
- 4. Some secondary school/high school
- 5. Secondary school completed
- 6. Post-secondary qualifications, other than university

Q90



- 7. Some university
  - 8. University completed
  - 9. Post-graduate
- 

Do you come from a rural or urban area?

- 1. Rural
- 2. Urban

- 0. Rural
- 1. Urban

Q113

## Vita

Alfonso Sánchez was born in Ciudad Juárez, Chihuahua, México. He obtained his bachelor's and first Master's degree in Political Science at the University of Texas at El Paso. Alfonso received a second master's degree in Political Science from the University of New Orleans in 2014. He finished writing his dissertation while he was an Academic Guest of the Political Science Department at the University of Zürich. Currently, Alfonso is an Assistant Professor of International Relations at the University of Loyola Andalucía in Seville, Spain.