The Pennsylvania State University

The Graduate School

Department of Political Science

THE SEASONAL INFLUENCE OF METEOROLOGICAL & PHYSICAL FACTORS ON THE ONSET OF VIOLENT CONFLICT

A Dissertation in

Political Science

by

Steven Tyler Landis

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

August 2013

The dissertation of Steven Tyler Landis was reviewed and approved* by the following:

Douglas Lemke
Associate Professor of Political Science
Dissertation Advisor
Chair of Committee

Xun Cao
Assistant Professor of Political Science

Philip Schrodt
Professor of Political Science

Jerry Y. Harrington
Associate Professor of Meteorology

Lee Ann Banaszak
Professor of Political Science
Director of Graduate Studies in Political Science

*Signatures are on file in the Graduate School

ABSTRACT

Despite the renewed popular interest in the effects of environmental change on the risk of violent conflict, careful theoretical analysis and subsequent empirical testing of these relationships remain elusive. I argue that our understanding of the debate over issues of resource scarcity and violent conflict have reached a theoretical standstill, which is compounded by an over reliance on poorly measured indicators that have little temporal variation and inconsistent spatial domains. This makes the search for any statistical relationships ambiguous because it is subsequently confounded by incorrect theoretical expectations, which anticipate that these relationships remain consistent across different forms of violent conflict. I address this issue by building a series of new environmental scarcity datasets, which are measured in country-months, and then systematically test for evidence of the ecoviolence theory across various forms of violent conflict. My findings show that the risks of violent conflict, as they relate to these disaggregated measures environmental scarcity, differ substantially and are contingent on both the environmental indicator used and the relationship tested. These results suggest that some of the alarmist interpretations of environmental change are significantly overstated.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

Completion of this work would not have been possible without the large number of people throughout my life encouraging me and advising me along the way. I owe all of you huge debt of gratitude and I cannot express how thankful I am for everything that you have done for me.

I would like to especially thank Kevin Sampson for all of his help and patience in assisting me with constructing the meteorological datasets used for my research. I would like to thank Dr. Douglas Lemke, Dr. Xun Cao, Dr. Philip Schrodt, and Dr. Jerry Harrington for their guidance and patience in advising me throughout this long research endeavor. I would like to thank Dr. Edward Sidlow for his unwavering faith in my abilities to pursue a graduate school education.

Ultimately, none of this would have been possible without the unconditional love of my family and the support of my friends. I would like to thank my mother and father for all of their love and encouragement whenever I needed them. I would like to thank my brother, Michael, for serving as my inspiration in being able to face difficult challenges and overcome them with determination, grace, and an unwavering sense of optimism. I would like to acknowledge the effusive love of several dogs in my life that always have brought a smile of joy to my face: Bentley, Oscar, Ollie, Sadie, and Nova. Finally, I would like to thank my beautiful wife, Luna, for being my rock of support throughout this long and occasionally trying time—to a new and happy phase of our life together that is no longer spent alone.

Chapter 1

A Changing Argument

In 1798, Thomas Malthus contended that the relationship between human population growth and the supply of resources needed to sustain that growth are long-term incompatible. Malthus theorized that human population growth increases exponentially while food production increases arithmetically. He argued that this growth would thus eventually outstrip food supply, creating social breakdown and starvation, an upper limit on the world's population size, and then mass violence due to intense competition for resources whenever that food limit was exceeded.

If you are reading this today, then it is likely the world has not devolved into the worldwide state of social chaos predicted by Thomas Malthus centuries ago. Regardless, if you are reading this today it is also likely the idea of 'water wars', vicious resource competition, or global environmental collapse remains a lucrative newspaper headline or a provocative title of a *History Channel* miniseries. A major reason for the persistence of these ideas is that the debate over the consequences of environmental change is literally evolving as the future generations experience environmental conditions unknown to previous generations. These changing experiences create the perception that the future is increasingly uncertain compared to the past. No longer is the debate over whether population growth will be limited by a lack of food. Worldwide population growth has remained unimpeded. Instead, Malthus's argument has been revised to address not only shortages of food, but also shortages of the resources need to produce food and the environmental conditions needed to replenish those resources. In short, this Neo-Malthusian notion of scarcity has become so broadened that now it speaks to any environmental or natural resource issue that may produce social uncertainties that could lead to human suffering and political grievances. It is this type of uncertainty that fuels a sense of alarmism over a host of environmental conditions and motivates a belief that regardless of what we do, we are all eventually doomed. Again, if you are reading this, that future has not arrived yet.

A further reason for the perpetuation of this alarmism is that political scientists have been unable to adequately address the question of how resource scarcities and environmental issues are related to the onset of violent conflict. Until quite recently, empirical support for these relationships have produced mixed results, leaving the causal process largely undefined (Gleditsch 1998; 2012; Salehyan 2008). What types of resource shortages? What types of environmental changes? Why violence over cooperation? These ambiguities and unanswered questions within the research agenda, aptly titled ‘ecoviolence’, have left it vulnerable to political manipulation and confusion. Indeed, with a definitive scientific consensus on the consequences of environmental change lacking, and when well-regarded newspapers like *The New York Times* reporting that:

> “Droughts, floods, heat waves…the changes have already heightened competition over scarce resources, and could foreshadow life in a world where conflicts are increasingly driven by environmental catastrophes.” (Marcus Stephen quoted in The New York Times 2011)

It becomes evident why Malthus’s ideas grip headlines the way they do.

The notion of violent conflict over scarce resources and environmental catastrophes is a powerful argument because so long as it remains a ‘future’ event, which is inadequately addressed by the political science community, it retains a sense of unassailable validity of what *might* happen regardless of its actual veracity.

Fortunately, it is now possible for political scientists to address the validity of this popularized argument. In the remainder of this dissertation, I systematically evaluate the existing literature on the relationship between environmental changes, resource scarcities, and violent conflict. In doing so, I delineate specific sets of causal mechanisms that relate violent conflict to exogenous changes in meteorological and physical factors and subject them to rigorous empirical testing. My results show that these ecoviolence arguments suffer from being over-generalized, and that upon closer examination they require a careful consideration of the context in which they are advanced.

1.1 Theoretical Foundations of Environmental Change & Violent Conflict

If one were to distill the notion of Malthus's argument to its core, one would see that the brilliance, and subsequent popularity, of his argument is in its simplicity. The idea of scarcity, or need, speaks ultimately to a universal feeling that all humans experience and understand quite well. Amartya Sen (1983, 159) once wrote that, "Hunger is the absolutist core in the idea of poverty." This notion is powerful because it resonates with a universal feeling that everyone has experienced sometime in his or her life. Malthus's argument of scarcity taps into this basic feeling of physiological need because the consumption food, thirst for water, and the feeling of sleep deprivation are essential human needs that must be fulfilled daily if we are to pursue any other psychological need (Maslow 1943). Thus, if one accepts that we operate according to a hierarchy of need, and this hierarchy is largely constructed on the idea of reducing the scarcity of resources used to fulfill these needs, then it should not come as a surprise that whenever the supply of these resources is disrupted it has the potential for generating severe social grievances and frustrations.

The seriousness of these grievances and frustrations resulting from the scarcity of basic resources is a debate ages old, but it is important because it underpins the foundation of my research. Although this concept of 'need' is something humans have had to deal with since our beginning, it is widely recognized that philosophers began seriously debating its social implications in the Eighteenth Century; with one side characterized by, among others, Marquis de Condorcet who optimistically argued in the unlimited potential for human civilization by believing that our "…need for new resources simultaneously produces the means of obtaining them" (Condorcet and Baker 2004, 72). The result of human progress in Condorcet's view was unbounded, set upon a trajectory where social vices and wars would ultimately cease in the prevailing force of human reason. The other side of this argument was advanced by Thomas Malthus who believed that mankind is ultimately limited by the supply of food, arguing that, "…the power of population is indefinitely greater than the power in the Earth to produce subsistence for man" (Malthus 1798, 4). The implication of what Malthus believed to be 'incontrovertible' truths was a grim one, where the future of mankind is ultimately headed toward a state of social misery, vice, and limitations.

As with most debates, which have persisted for generations, often their truths lie somewhere in between the two opposing sides. Malthus could not have predicted the advances in science and engineering which would allow the world's population to continue to grow as it does today. On the other hand, Condorcet's belief that the supply of human ingenuity is adequate to produce new solutions has been demonstrated repeatedly to be undermined by unimaginable feats of human selfishness, human cruelty, and natural forces beyond the control of mankind.

The inability to resolve this debate has led to its perpetuation today. With Elrich (1971) recasting the argument of Malthus to include the scarcity of all sorts of natural resources and their limited supply in the face increasing demand; and Simon (1981) arguing that scarcity of resources is a relative concept and an inevitable part of life, contending that the concreteness of these facts are often hijacked by alarmists who are fundamentally incorrect. He argues, as Condorcet did long ago, that "there is no physical or economic reason why human resourcefulness and enterprise cannot forever continue to respond to impending shortages and existing problems with new expedients, that after an adjustment period, leave us better off than before the problem arose" (Simon 1981, 345).

With the increased concern over the implications of global climate change, and the debate over these familiar issues of natural resource scarcities and other environment changes remaining unresolved, we have seen a renewed interest in media, academic, and policy communities on how environmental issues may be linked with the onset of violent conflict—echoes of a debate centuries old. These concerns are reflective of a specific field of conflict research, referred to as 'ecoviolence' because of the ambiguous argument[1] that environmentally-related changes may increase the risk of violent conflict due to resource shortages. Existing research has focused on attempting to answer this question, but little consensus has been reached on how these changes can lead to conflict via resource shortages, and what is the best way to operationalize and test these theoretical concepts (Gleditsch 1998; 2012; Salehyan 2008).

I believe that the current characterization of this debate: environmental scarcities—produced by environmental changes—cause (or do not cause) conflict, demonstrates a slightly myopic view of the potential of this research agenda. Environmental scarcities are merely *one* facet of a larger research narrative that should be focused on explaining how the various environmental factors, including scarcities, are associated with the onset of violent conflict. By recasting this debate into this broader framework, I am able to address this historical debate in a new light by offering

[1] Ambiguous because it is not evident how this process works from the perspective of large-n quantitative research

explanations that relate to issues of scarcity *and* issues of strategy and war making, while systematically examining the majority of the conflict literature relating to environmental issues.

1.2 Improvements of Design, Theory & Data

The principal contribution of my research lies within my overarching research design. Until quite recently the majority of published work within the ecoviolence literature can be characterized by country-year research designs with little theoretical connection between the causal mechanisms required for explaining changes in environmental conditions with the onset of violent conflict. Coupling these problems with inadequate data and issues of endogenous environmental measures (see Salehyan 2008), and one quickly arrives at Nordas and Gleditschs' (2007, 630) conclusion that "while the hard science in the climate change debate is backed up by peer reviewed studies, this is not the case when it comes to the literature relating climate change to conflict." My dissertation research represents a sustained effort to redress some of these shortcomings.

Among the variety of issues that plague existing studies, none is perhaps more problematic than the noticeable lack of detailed causal connections that relate meteorological and physical factors to the onset of violent conflict. Essentially, the argument most often advanced is derived from the aforementioned Neo-Malthusian notion that shortages of natural resources, induced by environmental changes, lead people to fight over these shortages. This argument is then typically followed with a country-year unit of analysis research design, in a time-series cross-sectional format, e.g. Ghana-1990, where reported aggregate estimates of various natural resources for a given country are regressed on a single measure of violent conflict. The results are then tabulated with a brief conclusion on the extent to which this observed correlation supports the ecoviolence theory.

My work helps resolve this dilemma by presenting a variety of new causal mechanisms to explain these relationships. To do so, I temporally disaggregate my unit of analysis for the independent variables of interest in all of my estimations to the country-month level. The net effect of this change is that it provides greater variation within my empirical tests and shows that a large contributor to the mixed findings of this research is due to a poorly specified research design that contains little variation across measures of the independent variables.

A further contribution is that this temporal disaggregation also allows for the introduction of *novel* causal explanations that can distinguish between the effects of weather and climate—something currently of issue within the ecoviolence literature (for further discussion see Gleditsch 2012). My first causal mechanism is related to weather, and is what I call the 'Seasonality and Strategic Viability' argument. It is an established fact within the meteorological community that various meteorological measures, like temperature and precipitation, change according to a given season. Indeed this is also true within agricultural studies as well, as Ellis (2000, 58) cogently states:

> "The production cycles of crop and livestock enterprises are determined by the onset of rains, their duration, the length of the growing season, temperature variations across the calendar year, so on. These seasonal factors apply just as

> much to landless rural families that depend on agricultural labour markets, as they do the farm families, and they also have strong effects on activities in agricultural supply and output services…"

Given importance of such changes, I argue, and subsequently show, that instances of violent conflict also correlate with seasonal conditions both empirically and anecdotally. This is novel because this mechanism sheds light on explaining why conflict is more or less likely in certain times of the year, a finding I argue is tied to favorable weather conditions that are supportive of the strategies of warring parties. My other major causal mechanism, 'Eco Shock and Equilibrium Disruption', relates closer to the issue of climate change. Here I argue that this mechanism acts as an important motivator of conflict because of the severe, unexpected disturbances climate disruptions create in the lives of people who are not accustomed to deviations from long-term climate patterns. Under certain circumstances, I show that these deviations are enough to be associated with the onset of violent conflict.

A further contribution of my research is my improvement in the application and use of meteorological data for ecoviolence studies. Salehyan (2008, 321) has criticized existing research by noting that "many of the indicators of environmental degradation—such as soil erosion, clean water availability, and land degradation—are probably endogenous to human activity and failures of governance." This issue has created a credibility problem within existing research because the majority of environmental data that have been used are often interpolated estimates based on expert surveys, self-reporting of individual governments, or inconsistent data collected by international organizations (for further discussion see Salehyan 2008;

Theisen 2008). In all of these instances, these trends are problematic because the data lack objectivity, lack consistent spatial and temporal domains, and are largely indistinguishable from human influences. The result of these flaws is that these measures are often infrequent and endogenous to the dependent variable of interest, violent conflict—an implication which suggests that violent conflict may actually be driving the decline in these reported measures that are then serving as independent variables.

I resolve these issues by building a series of meteorological and physical measures with global coverage that are largely exogenous to the dependent variable. This is important because it not only resolves the issue of data coverage, but it also gives credibility to my results by assuaging many of the concerns regarding endogeneity that have existed in previous studies. The majority of the data used in my research are obtained from the National Oceanic and Atmospheric Administration's Office (NOAA) of Outstanding Accomplishments in Research (OAR), Earth Systems Research Laboratory's (ESRL) Physical Science Division (PSD). These data are appropriate for my theory testing and research design because they are obtained from established datasets that are well known and widely respected within the meteorological and atmospheric science communities.

Another contribution of my research is that I offer a clarification on the expectations of the types of violence that environmental changes are expected to produce, which addresses a concern discussed at length by Nordas and Gleditsch (2007). It is often taken for granted the degree of organization and resources required to initiate and sustain certain forms of violent conflict, such as a civil war. As Raleigh and Kniveton (2012, 52) note, "different types of conflicts have alternate sets of instability determinants and, hence, will have distinct relationships (if any) with climate variability and change." I address this issue by systematically searching across various forms of violent intrastate conflict, detailing why and how violent conflict is more likely to occur at lower levels of organizational capacity. Doing so allows me to address Gleditsch's (2012, 6) concern by showing 'where it matters' by looking for evidence of these relationships where theory suggests they may occur. In pursuing this goal, I employ datasets that measure civil war and non-state conflict throughout the world, and violent social protest and spontaneous violent conflict in the developing countries of Africa and Asia.

I also examine the role of interactive relationships, particularly with respect to natural disasters. These have often been regarded as events that elicit violence *contingent on* state infrastructure. I not only test this claim, but I also offer novel explanations on how different types of state capacity may act to mitigate or enhance the effects of these destructive events.

Finally, I divide and empirically test various aspects of the ecoviolence literature in a manner that is both logical and consistent. Existing research suffers from a conflation of ideas and concepts. Disentangling the literature into identifiable and testable research designs makes for a more meaningful discussion of the various environmental factors that do or do not influence the onset of violent conflict. Together, the sum of these contributions make for a broad, detailed, and systematic testing of the claim that environmental change is a harbinger of violent conflict.

1.3 Chapter Overview

The chapters are organized thematically according to the major divisions within the ecoviolence literature. Chapter 2 serves two purposes. First, it establishes an empirical case for my argument that temporal disaggregation provides greater theoretical leverage for testing ecoviolence theories by showing the difference in results between using country-year and country-month units of analysis. In doing so, I evaluate the general claim, often made within the media, that changes in temperature and precipitation patterns influence the onset of violent conflict. My results show that these claims, while not unfounded, are perhaps overstated. This is because the results indicate that the risk of violent conflict varies according its form and the type of causal mechanism that is tested.

In Chapter 3, I reexamine the argument that environmental degradation increases the risk of violent conflict. I discuss at length the various datasets and measures used in previous research, and explain why they have been inadequate for testing this argument. Next, I explain why environmental degradation is better understood in the context of seasons and then detail the appropriate data required for measuring degradation. Finally, I empirically test this claim and show that the alarmist concerns regarding this trend are not well supported. In addition, I analyze Diamond's (2006) 'ecocide' hypothesis and show that there may be some truth to this claim, despite the mixed findings.

I examine the last major division of the ecoviolence literature in Chapter 4, which is concerned with the role natural disasters play in undermining state capacity and ultimately altering the risks for violent conflict. I explain why the logic of natural disasters is best understood through my theoretical mechanisms. Next, I offer a detailed explanation for why existing research has inadequately operationalized past measures of state capacity by explaining how different aspects of state capacity act to increase (or decrease) the risk of violent conflict in the event of a natural disaster. My results are largely consistent with these expectations, but vary substantially in terms of risk.

Finally, I conclude in Chapter 5 with a short summary of my findings and their implications for both academic and policy research. In doing so, I reiterate the importance of extensive empirical testing and the need for appropriate data to reflect well-developed theoretical expectations. This discussion is then followed with a consideration of improvements and next steps for future research. In this final section, I discuss the utility and limitations of spatial disaggregation for ecoviolence research and explain its potential for testing my theories (and other possible mechanisms) linking environmental changes with the onset of violent conflict.

1.4 References[2]

Condorcet and Keith Michael Baker. 2004. “Sketch for a Historical Picture of the Progress of the Human Mind: Tenth Epoch.” *Daedalus* 133 (3): 65–82.

Diamond, Jared. 2006. *Collapse: How Societies Choose to Fail or Succeed.* New York: Penguin Books.

Ellis, Frank. 2000. *Rural Livelihoods and Diversity in Developing Countries.* New York: Oxford University Press.

Elrich, Paul R. 1971. *The Population Bomb.* New York: Ballentine Books:

Gleditsch, Nils Petter. 2012. “Wither the Weather? Climate Change and Conflict.” *Journal of Peace Research* 49 (3): 3–9.

——— .1998. “Armed Conflict and the Environment: A Critique of the Literature.” *Journal of Peace Research* 35 (3): 381–400.

Malthus, Thomas. 1798. *An Essay on the Prince of Population*. J. Johnson in St. Pauls Shipyard: London.

[2] All references for my dissertation use the Chicago Manual of Style author-date citation format and Times New Roman font.

Maslo, Abraham. 1943. "A Theory of Human Motivation." *Psychological Review* 50 (4): 370–396.

Nordas, Ragnhild and Nils Petter Gleditsch. 2007. "Climate Change and Conflict." *Political Geography* 26 (6): 627–638.

Raleigh, Clionadh and Dominic Kniveton. 2012. "Come Rain or Shine: An Analysis of Conflict and Climate Variability in East Africa" *Journal of Peace Research* 49 (1): 51–64.

Salehyan, Idean. 2008. "From Climate to Conflict? No Consensus Yet." *Journal of Peace Research* 45 (3): 315–326.

Sen, Amartya. 1981. *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford: Clarendon Press.

Simon, Julian L. 1981. *The Ultimate Resource*. Princeton: Princeton University Press.

Stephen, Marcus. 2011. "On Nauru, A Sinking Feeling." *The New York Times*, July 18.

Theisen, Ole Magnus. 2008. "Blood and Soil? Resource Scarcity and Internal Armed Conflict Revisited." *Journal of Peace Research* 45 (6): 801–818.

Chapter 2

Temperature Seasonality & Violent Conflict: The Inconsistencies of a Warming Planet

Obtaining a clear understanding of the social consequences of rising global temperatures is difficult because it is uncertain whether these changes should systematically increase the risk of political instability and violent conflict throughout the world. Existing studies on the relationship between temperature and violent conflict are inconclusive, complicated by poor data and inappropriate research designs that understate the effects of seasonality in the temperature-to-conflict narrative. This study contributes to this burgeoning literature by evaluating the effects of temperature change across multiple forms of violent conflict, drawing the distinction that the propensity for, and form of, violent conflict varies given global temperature increase. Using a country-month research design, analyses show that the monthly measures of temperature seasonality and temperature shock more accurately reflect the theoretical expectations of the temperature-to-conflict hypothesis than when one uses a country-year research design. The results indicate that the risk of violent conflict due to global warming varies across different forms of violence and their locations. In comparatively warm months of the year, the results show that the risk of civil war and non-state conflict increases. However, these results are contradicted when using a monthly measure of temperature shock, with the risk declining for civil war and non-state conflict while increasing for violent social protest in Africa, but not in Asia. Overall, the inconsistency in these findings run somewhat contrary to the alarmist interpretations of global warming and suggest that further consideration must be given to the measurement and testing of ecoviolence concepts.

2.1 Introduction

Recent decades have heralded a new wave of research on the social and political consequences of global climate change. The notion that our planet is warming, and that this trend is 'unequivocal', has sparked considerable debate on what humanity should do about it (IPCC 2007, 30). Indeed, despite the objections of some skeptics, a substantial amount of statistical evidence now exists for supporting the argument that our planet is indeed warming. As quoted in *The Economist* (2010; 2011), whether it be the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration (NOAA), Berkeley Global Earth, the UK's Met Office, or the University of East Anglia's Climate Research Unit, the consensus is that in the past 50 years we have experienced a global increase in Earth's surface mean temperature by approximately .9 degrees Celsius—with the past 10 years being among the warmest on record (see IPCC 2007). Ironically then, it should come as a surprise that there is a remarkable lack of consensus on what the influences of increasing global temperatures will have for the risk of violent conflict (Gleditsch 2012).

Although this question of whether the Earth is warming no longer seems subject to serious debate, the social consequences of this phenomenon are poorly understood and have been the focus of recent intellectual exchanges among academics. It is generally accepted that the effects of climate change will usher in a new set of political and environmental challenges that will place significant stress on vulnerable communities and developing nations. Increasing weather variability can put communities that are dependent on weather-related agricultural practices in precarious situations. Extreme temperature changes can threaten crop yields by contributing to droughts, increasing the strain on resources needed to grow food, and altering seasonal weather patterns within growth and harvest seasons (IPCC 2007). The net effects of these changes are a subsequent increase in food insecurity and the undermining of the livelihoods of those dependent on predictable weather patterns for employment and agricultural production. Other consequences of global warming include warmer ocean surface temperatures, which are suggested to increase the frequency of some natural disasters and threaten the capacity of weak states and marine industries (IPCC 2007; National Research Council 2013).[3] Finally, warmer temperatures are shown to be accelerating the melting of Earth's polar ice caps and increasing the thermal expansion of the world's oceans. These effects are believed to raise sea levels and generate population displacements away from coastal zones (Rebetez 2011).

Small island nations, which have few choices in the face of rising sea levels, are extremely concerned by increasing global temperatures. Indeed, President Anote Tong has recently entered into negotiations with the government of Fiji over the lease of land for the relocation of the entire country of Kiribati in the face of rising seas (BBC News 2012). Similar concerns about environment-induced refugee relocation are also being

[3] Recent research shows a correlation between climatic-related monsoon intensifications and a historical increase in India/Eurasia plate convergence (for further discussion, see Iaffaldano, Husson, and Bunge 2011). Others argue that isostatic adjustment, the influence of glacial melting on slip behavior of tectonic fault lines, is a consequence of warmer temperatures (Hampel, Hetzel, and Maniatis 2010).

echoed by the governments of Nauru, the Maldives, Papua New Guinea, and the United States (Gillis 2012; Gupta 2007; Keating 2012; Stephen 2011). In addition to population displacement for small island nations, the risks posed by global warming, have been at the forefront of national security concerns among Western intelligence agencies, because of this warming's perceived potential for mass social disruption and the unexpected altering of security risks that climate change may produce—particularity the increase in the variability extreme weather events at increasing rates (National Research Council 2013). Even the Pentagon now includes climate change on its list of threats to US national security in its Quadrennial Defense Review for members of Congress (Department of Defense 2010; Gjelten 2009).

Understanding the social consequences of rising global temperatures is difficult because it is unclear whether these changes should systematically increase the risk of state collapse and violent conflict throughout the world. Studies of temperature and interstate conflict show a reduction in this risk (Gartzke 2012; Tol and Wagner 2010; Zhang et al. 2007), while studies on the risk of civil war and African communal violence are inconclusive (Buhaug 2010; Burke 2009; 2010; Hsiang, Meng, and Cane 2011; O'Loughlin et al. 2012; Sutton et al. 2010). The majority of these studies have relied on either a systemic research design that uses global temperature data in studying the international system as a single annually-observed unit or country-year designs, which use yearly mean temperature data that necessarily mask seasonal variability. Both of these research designs are problematic because they ignore the inherent temperature variability as seasons change, and they discount the influence these seasonal changes have for social stability in developing nations. And while more recent studies of temperature and conflict rely on geo-coded conflict events overlaid with temperature and precipitation data (O'Loughlin et al. 2012; Theisen, Holtermann, and Buhaug 2011)[4], an approach that certainly improves upon the disaggregation of environmental measures and conflict, these studies do not systematically address the issue of seasonality, measurement, and variation in the risk of violent conflict across different datasets, which is the major focus of this study.

My study contributes to this growing body of literature in two ways. Unlike past studies, I systematically evaluate the effects of temperature change across multiple conflict types. Second, I use a country-month research design, which allows for a more direct test of temperature variability from season to season, while also allowing for tests against long-term temperature means—shoring up some of the more serious threats to ecological inference while more accurately addressing the distinction between weather and climate. The results indicate that the onset of violent conflict due to increasing global temperatures varies across its different measures and various measures of temperature change. Although in some cases the findings run contrary to alarmist interpretations of global warming, further work should seek to uncover the specific causal mechanisms needed to explain the differences that are observed in these statistical relationships.

[4] O'Loughlin et al. (2012) is the closest match to my study. These authors use grid-months while I use country-months.

2.2.1 Theoretical Origins

The traditional argument for a relationship between environment changes and the onset of violent conflict is that the scarcities of environmental resources serve as a competitive source of friction, which in turn can cause or accelerate violent conflict (Homer-Dixon 1999). The scarcity of resources brought about through supply, demand, and distributional shortages incite people to violence by creating security dilemmas and making social adjustments difficult (Homer-Dixon 1999). Anecdotal case studies provide some evidence that environmental scarcities are associated with an increased risk of violent conflict in South Africa, the Philippines, China, and Kenya (Homer-Dixon 1994; 1999; Homer-Dixon and Percival 1998; Kahl 2006). However, most empirical studies have found little support for the scarcity-violence hypothesis (Benjaminsen et al. 2012; de Soysa 2002; Nordas and Gledistch 2007; Raliegh and Urdal 2007; Theisen 2008). Subsequently, more recent studies have focused more on the indirect mechanisms that create both episodes of scarcity *and* are correlates of conflict onset—such as the reduction in GDP per capita, the weakening of state institutional capacity, and refugee displacement (Bergholt and Lujala 2012; Reuveny 2007). These latter studies take a broader look at what the effects of climate change are expected to create, and then use these as proxies for testing the scarcity-violence hypothesis. My study follows this newer tendency by building a set of theoretical expectations given what we know from the literature on the expected consequences of a warming planet, and then tests for these indirect connections across different forms of violent conflict.

2.2.2 Recent Research on Temperature and Violent Conflict

Increases in global temperature are theorized to produce a host of different effects across the world: reducing water availability and crop yields in warmer regions of the world while increasing them in colder regions, reducing the mortality of cold-related disease and increasing the communicability of warm-related ones, and increasing the risk of drought in some regions and of flood in others (IPCC 2007, 53). Because of these inconsistent effects, there is no reason to expect that increases in global temperature will produce the same consequences everywhere. Just as these effects vary from place to place, so might the frequency and forms of violent conflict that they produce.

Consequently, the relationship between warmer temperatures and the onset of civil war is subject to much dispute. Burke et al. (2009) were the first to provide quantitative evidence in support of the expectation that warmer temperatures are associated with an increase in the risk of civil war, with evidence restricted to cases on the African continent. They find evidence that conflict in Africa is associated with temperature increases, but do not investigate how conflict may relate to seasonal temperature variability. These results were subsequently challenged by Sutton et al. (2010) who found Burke et al.'s (2009) statistical models sensitive to changes in sample size and outlying observations. Buhaug (2010) has also challenged these initial findings. He argues that the research suffers from several methodological flaws including an overly stringent definition of conflict, a misspecification of the dependent variable, a limited temporal domain, and the absence of fixed effects covariates required to mitigate omitted variable bias. When he addresses these issues, Buhaug (2010) re-estimates the relationship and finds little evidence of a connection between temperature and the onset of civil war. In response to Buhaug's methodological concerns, Burke et al. (2010) conducted a final follow up study, which in using Buhaug's (2010) different coding mechanisms of civil war and climate data specifications confirmed their initial results as robust, and in some cases demonstrating even stronger support for their temperature-conflict hypothesis.

A more recent study on the effects of temperature on the risk of civil war onset uses the El Niño /Southern Oscillation, which is responsible for the intermittent increases in global surface temperatures, as a quasi-experimental research design to evaluate whether civil war is more likely in warmer years than colder years (Hsiang, Meng, and Cane 2011). Hsiang, Meng, and Cane (2011) find an increase in the risk of civil war in years with warmer temperatures and their results lend support to the initial research of Burke et al. (2009; 2010). Finally, the most recent work on these relationships find conflicting results, with measures of drought, rainfall deviation, and temperature change linked to violent conflict in times of warmer, wetter weather *and* colder, drier weather throughout different regions of the world (Bai and Kai-sing Kung 2011; O'Loughlin et al. 2012; Theisen, Holtermann, and Buhaug 2011).

These studies paint a mixed picture about how much support there is for the temperature-to-conflict hypothesis. Researchers seem to believe that temperature and civil war are related via agricultural decline, and look for indirect evidence of this relationship primarily against African data with only mixed statistical support. To my knowledge, no studies thus far have attempted to systematically evaluate the role temperature seasonality plays in the onset of violent social protest and other forms of non-state violence, which are more theoretically plausible for a connection to conflict (Homer-Dixon 1999; Raleigh and Kniveton 2012).

2.3 Theory Refinement & Delineation of Causal Mechanisms

2.3.1 Mechanism 1: Seasonality & Strategic Viability

Although there is no theoretical reason for us to believe that the effects of global warming will be the same everywhere in the world, I identify two mechanisms in the literature on temperature and conflict that may broadly justify a link to the onset of various forms of violent conflict. The first of which is the ‘Seasonality and Strategic Viability’ mechanism. The IPCC (2007), and others (Mendelsohn, Dinar, and Williams 2006), contend that the effects of climate change will vary across the world. In some countries, warmer temperatures will increase agricultural productivity by extending growing seasons and making them more bountiful due to increases in precipitation and favorable growth temperatures. In other countries, issues of resource scarcity and soil aridity will be prolonged, exacerbating episodes of scarcity and drought.

Existing research on global warming not only implies an increase in the global mean temperatures, but also that within year seasonal swings will be increasingly variable (National Research Council 2013). If these month-to-month variations in temperature lead to warmer summers and milder winters, then the prolonging of dry seasons, harvest seasons, or monsoon seasons may have important implications for the onset of violent conflict. An extended summer climate may provide greater strategic opportunities for social organization, criminal opportunities, and full-scale rebellion as transportation is easier, food more available, and targets more plentiful. In other cases, periods of inclement weather may dissuade organizers to take to the streets or make force projection into and out of remote regions controlled by insurgent groups more difficult.

Interestingly, there is a small, but growing body of evidence to support the argument that seasonality affects the strategic interaction of conflict participants. At the intrastate level, global warming may increase the risk of war between rebel groups and government forces if warmer, wetter climates extend the time and environmental conditions in which armed conflict is strategically viable. In some areas of the world, increased foliage growth in previously colder, sparser climates allows for better coverage for guerrilla operations by favoring rebel troop movements; while in regions with semi-arid and arid climates, higher temperatures reduce foliage growth and reduce the options for strategic movements and the remote hideouts of rebel groups (Meier, Bond, and Bond 2007).

Warmer temperatures in colder regions of the world may grant governments and rebels an easier time transporting resources and troops to each other in remote regions of countries that usually are inaccessible when conditions are harsh. Unseasonably warm, winter weather has been cited as a reason for an increase in the observed violence in Afghanistan by affording the Taliban extended supply routes across the Afghanistan-Pakistan border and easier mobility throughout the Afghan countryside (King and Yaqubi 2012; Partlow 2011). Warmer temperatures may also increase the availability of resources for a longer harvest period, which creates opportunities for rebel looting in order to sustain their movements. Evidence for this latter mechanism finds support in the strategic movements of the Free Syrian Army that has benefited in its fight against the Assad regime by a bountiful harvest of crops, due directly to an increase in unusual weather patterns (Chivers 2012).

On the other hand, some evidence indicates that warmer temperatures may act to *reduce* conflict between rebel groups and government forces. Indeed, the extreme heat of the Saharan Desert in Northern Mali, heat so hot that it makes ‘it difficult to draw breath’, has been cited as a contributing factor that prevents Malian government troops from sustaining combat operations for more than six hours per day against Al-Qaeda in the Islamic Maghreb and the Movement for Unity and Jihad in West Africa insurgencies (quoted in The Economist 2012). In other instances, monsoon seasons which seasonally transform jungle paths and mountain roads into impassable terrain as they are washed away in strong monsoon downpours are argued as limiting factor for the feasibility of insurgencies in South East Asia (Lujala 2010). In the Middle East, overcast skies and unfavorable visibility are mentioned by the Free Syrian Army as a major determinant in preventing President Assad’s air force from effectively bombing rebel positions in Northern Syria (NBC News 2012a)

Evidence also exists to support the argument that seasonality influences the frequency of non-state conflict as well. Higher temperatures are associated with an increase in the frequency of US gang violence and crime as people spend more time interacting outdoors (NBC News 2012b; Schaper 2012). High temperatures brought larger numbers of protestors into the streets of Tel Aviv this past summer (AFP 2012), while low winter temperatures were responsible for the dispersing the large and notable ‘Occupy’ protests in Washington D.C. this past January (Samuels and Gowen 2012).

In summary, if we accept that global warming influences the inter-year variability of temperature and associated weather patterns, then actors looking to participate in violent conflict should be more likely to do so when seasonal conditions support their strategies for violent conflict—with the expectation being that this is more likely in periods of time with higher temperatures. This logic motivates the following two hypotheses:

> Hypothesis 1(a): The probability of civil war onset conflict increases as monthly temperatures increase.

> Hypothesis 1(b): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as monthly temperatures increase.

2.3.2 Mechanism 2: Temperature Shocks & Equilibrium Disruption

The second argument for how violent conflict may become more likely due to rising temperatures is through the 'Temperature Shock and Equilibrium Disruption' mechanism, which is an extreme deviation from the normal climate patterns that create abrupt economic and agricultural disturbances across countries and within communities (for further discussion see Hendrix and Salehyan 2012). Research suggests that increasing global temperatures will also bring increasing weather variability at an increasing rate (IPCC 2007; National Research Council 2013). This increased variability can generate abrupt disturbances in social and economic systems if temperature shocks become the main determinant for raising the price of food by reducing its supply. If so, then these abrupt temperature shocks may spark the onset of organized violence and social chaos because of the rapid, negative changes they create in the equilibriums of people's personal income, health, safety, and the overall capacity of the state to adapt to these changes. Evidence for this effect has found support in country-level studies of China and Brazil, and in several large-n, cross-national analyses on the African continent (Bai and Kai-sing Kung 2011; Hidalgo et al. 2010; Miguel et al. 2004; Hendrix and Salehyan 2012). The expectation is that unexpected temperature shocks may rapidly intensify normal climate patterns, such as a heat wave or exacerbate drought-like conditions by weeks and months. These changes may spike food prices as crops fail in intensely arid soil, and government infrastructure may collapse under the extreme stress that results from temperature spikes and flash flood—as was recently observed in Brazil this past summer (Latin American Herald Tribune 2013). These temperature shocks have the potential for generating a host of negative consequences for societies and governments by increasing grievances and straining resources. Thus, it is not necessarily the slow and sustained increase in temperatures that are most important, or predicable inter-year temperature patterns, because these may be easy to adapt to, rather it is the extreme variability of those temperature changes that deviate so dramatically from long-term climate patterns that actors cannot anticipate or adapt to, which motivates violent conflict and political grievances. Therefore, this mechanism is different from the former in that it refers to deviations from long-term climate patterns, which speaks more to the issue of climate change rather than the predictability of monthly temperatures. This different causal logic motivates a final set of hypotheses:

Hypothesis 2(a): The probability of civil war onset increases as monthly temperatures deviate from their long-term monthly means.

Hypothesis 2(b): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as monthly temperatures deviate from their long-term monthly means.

Since these two theoretical arguments anticipate different effects across the world for different actors, the hypotheses represent an attempt to discover general statistical support for the temperature-to-conflict hypothesis. Akin to Hendrix and Salehyan (2012, 38–39), and as evident in this theoretical discussion, I argue that “there are varieties of specific causal mechanisms that may be responsible for the onset of violence and there is no reason to believe that any of these are mutually exclusive.” However, to the extent that the literature on temperature and conflict is reaching a consensus on the set of general mechanisms that relate temperature to conflict, these two arguments seem the most plausible and identifiable. Consequently, the goal of my study is to determine if a robust connection between temperature and conflict exists along these two different dimensions while leaving the deconstruction of their specific nuances for future research.

2.4 Research Design & Data

The majority of past studies of the temperature-conflict nexus for intrastate conflict have used yearly mean temperature data for each country. This approach masks monthly temperature variation within each country by assigning the same temperature for every month of its year. A consequence of this approach is the loss of meaningful inter-annual temperature variation by using a yearly average. **Figure 2-1** illustrates this point by showing the observed change in Syria's temperature according to the choice of temporal aggregation.

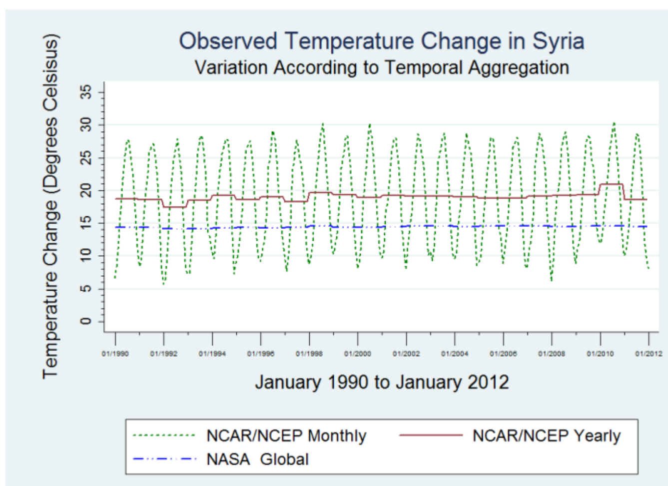


Figure 2-1: Observed Temperature Change in Syria: Variation According to Choice of Temporal Aggregation.

As evidenced by Figure 2-1 the effects of seasonality are muted when relying on a systemic or yearly aggregated measure of temperature. Since agriculture harvests, droughts, monsoons, summers, and winters occur within different months of the year—and do so directly related to temperature changes—tests of relationships between temperature change and conflict make more theoretical sense when undertaken using country-month observations.

2.4.1 Dependent Variables

My tests of temperature and intrastate conflict use the Armed Conflict Database (ACD) (Gleditsch et al. 2002; Harbom and Wallensteen 2010). This provides a binary variable indicating the monthly onset of an internal or internationalized intrastate conflict, which results in 25 or more annual battle deaths. Because I am interested in the onset of civil war, I use the standard convention in the literature of assigning a value of one to indicate when a new onset emerges, when a conflict reemerges after two years of peace, or when a new rebel party becomes a new combatant in an ongoing war to which it was not a party in the previous year. For a more stringent test of this relationship, I also include separate models that estimate the effect of temperature on high intensity civil war onset using the 1,000 or more battle death threshold.

Existing research suggests that small-scale violence may be more likely a product of the enhanced effects of resource competition and individual frustration brought about by climate change (Raleigh and Kniveton 2012). In order to address instances of less-organized, non-state conflict with the greatest degree of focus, I use the Uppsala Conflict Data Programs (UDCP)'s Non-State Conflict Dataset Version 2.4 (Sundberg, Eck, and Kreutz 2012). Non-state conflicts are defined as "the use of armed formed between two organized armed groups, neither of which is a government of a state, which results in at least 25 battle related deaths in a year" (Sundberg, Eck, and Kreutz 2012, 352–353).

Finally, for my analysis of more spontaneous forms of violent conflict, I use two regional databases. The first of these datasets is the Social Conflict in Africa Database (SCAD), which provides information on protests, riots, and other social disturbances in Africa (Salehyan et al. 2012). From SCAD, I use the count of violent social protest events—specifically organized violent riots, spontaneous violent riots, pro-government violence, anti-government violence, extra-government violence, and intra-government violence in a given month (year) (see Salehyan et al. 2012). Second, is the Integrated Conflict Early Warning System (ICEWS) Asia dataset, which collects data on a variety of political instability indicators including violent conflict events (O'Brien 2010). From ICEWS, I use the count of assaults, fights, and unconventional mass violence in a given month.

These latter two datasets are preferable for this study because the negative effects of climate change are argued to be felt disproportionately in less-developed countries with a comparatively lower than average GDP per capita and those that have agricultural-dependent economies (Mendelsohn, Dinar, and Williams 2006). Countries with these characteristics are located primarily within the African and Asians continents. Thus, if we are to expect the onset of violent conflict from changes in temperature, particularly at lower levels of organization that ecoviolence theory implies, it is reasonable to assume that this area of the world be where we should observe it.

Unlike my intrastate conflict analyses that are more infrequent, the UCDP non-state, SCAD, and ICEWS violent events are more frequent and are often correlated across time as one event makes another more likely to occur. This tendency makes it is more difficult to discern their independence from one another for the purposes of coding unique and independent onsets. Therefore, the dependent variables for these models use the ‘counts’ of each.

2.4.2 Independent Variables

Temperature data are collected NOAA’s NCEP/NCAR Reanalysis Monthly Means Dataset covering the years 1948–2011 (Kalnay et al. 1996)[5]. These data provide surface or near surface air temperatures (.995 sigma level) with spatial coverage of a 2.5 by 2.5 degree longitude native resolution (144 x 72). Once collected, these data were then aggregated into country-month units of analysis. *Temp Mean* is measured as the monthly mean temperature for country (i) in month (t) in year (z). *Temp Shock* is measured as monthly deviation from a country’s long-term monthly mean, indicated by $(X_{itz}-X_{it\text{-}bar})/\sigma_{it}$ where X_{itz} is the mean temperature of country (i) in month (t) in year (z) and $X_{it\text{-}bar}$ is the panel mean of country’s (i) long-term monthly (t-bar) mean temperature from the period 1948–2011, and σ_{it} is the standard deviation of that panel. This approach is akin to Hendrix and Salehyans’ (2012) measure of rainfall deviation who argue that deviations from the mean are an optimal operationalization of the ‘eco shock’ mechanism. A deviation measure like this is preferable compared to other measures of variability because its construction acknowledges that climate is different than weather, speaking to extended periods of time rather than changes from month-to-month. Moreover, this measure is standardized, allowing for meaningful comparisons of deviational differences

[5] NCEP Reanalysis Derived data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their website at http://www.esrl.noaa.gov/psd/

between countries. Because of the inconsistency in existing studies of whether temperature shocks are more likely associated with conflict in periods that are unseasonably warm or unseasonably cold, I include *Temp Shock*^{2} to capture the magnitude of this change relative to zero (see Tol and Wagner 2010; Zhang et al. 2007). Therefore, in line with Hendrix and Salehyan (2012, 38) “[the] expectation is that extreme events in either direction make a society more prone to conflict”—a practice that exists in studies that use annual mean temperatures as well (see Buhaug 2010; Hsiang, Meng, and Cane 2011).

2.4.3 Control Variables & Estimators

The onset of civil wars are not known with precision in Uppsala datasets and because the focus of this analysis seeks to explain the importance of seasonality and temperature, I include a binary variable indicating the first month of the year in all intrastate and non-state conflict models to address the uncertainty in this coding practice.[6] Because temperature changes often bring about changes in precipitation patterns, and the interest of this study is in establishing whether the effects of temperature are independent from precipitation, I include controls for monthly levels of precipitation and precipitation shocks[7] using monthly precipitation data from the Global Precipitation Climatology

---

[6] When the exact month is unknown, Uppsala uses the 1st of January as its default date.
[7] These measures are based on the same logic as the construction of my independent variables. Using these data and measures allows for comparison with other studies that find evidence of a relationship between rainfall shocks and the onset of violent conflict (see Hendrix and Salehyan 2012).

Project Version 2.2[8]. These data have a spatial coverage of 2.5 x 2.5 degree with a longitude resolution (144 x 72) from 1979–2011 (Adler et al. 2003). Using these data accomplishes two goals. First, it helps distinguish the difference between theoretical dimensions related to temperature change and those related to precipitation. Second, it allows for as a more direct comparison between recent studies that use these precipitation data.

Lastly, I also control for El Niño/Southern Oscillation (ENSO) years, which have been demonstrated to be associated with an increased risk of civil war (Hsiang, Meng, and Cane 2011). ENSO is a cyclical phenomenon of natural climate variability that is responsible for contributing to warmer climates during years when it is active. However, the focus of this study is intended to address the influence of the sustained increase in global temperatures and the associated inter-annual seasonality—not necessarily the natural variability of preexisting climate conditions. Time may reveal that the effects ENSO are exacerbated due to the effects of climate change, but the validity of this relationship is largely speculative and actively debated (see Collins et al. 2010; Philip and Van Oldenborgh 2006). In order to separate out this effect from my temperature measures, I include a binary variable indicating years influenced by the El Niño /Southern Oscillation in accordance with the Center for Ocean-Atmospheric Prediction Studies ENSO index (2012).

Finally, I include a number of common controls identified in the conflict literature as increasing the likelihood of conflict onset. First is regime type, taken from the Polity

---

[8] GPCP Precipitation data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their website at http://www.esrl.noaa.gov/psd/

IV dataset and covering the period 1946–2011 (Marshall and Jaggers 2010). Scholars have found that democratic institutions mitigate the effects of political disagreements and make violent conflict less likely to occur (Hegre and Sambanis 2006). Some scholars have found evidence of an inverted quadratic relationship between regime type and conflict onset (Fearon and Laitin 2003; Hegre et al. 2001). These authors contend that these regimes, named ‘anocracies’ and find themselves in the middle of Polity IV’s 21-point measure of regime type that ranges from -10 to 10, are characterized by a mix of democratic and authoritarian institutions that make them most at risk for conflict, relative to their democratic and authoritarian cousins. Although theoretically plausible, Vreeland (2008) has demonstrated this coding measure is tautological due to the inclusion of political violence in the construction of Polity IV’s regime coding. Therefore, instead of using this contaminated measure, I follow Vreeland’s (2008) recommendation of deconstructing the Polity IV index into its component parts, when estimating the impact of regime type on civil war onset. The resulting measure of regime type is *Xpolity*, which is a summation of three ordinal measures: constraints on the chief executive (*Xconst*), competitiveness of executive recruitment (*Xrcomp*), and the openness of that recruitment (*Xropen*). This variable ranges from values of 1 to 14, with 14 being most democratic.

Larger, poorer countries are more likely to experience violent conflict (Collier Hoeffler 2004; Fearon and Laitin 2003; Hegre and Sambanis 2006). Hence, I control for *Population* size and *GDP per Capita* using data from Gleditsch’s (2002) version 5.0 expanded GDP data, supplemented with data from Penn World Tables 7.0 and the World Bank (2012) to extend the time-series through 2010. These measures are also logged to reduce skewness as some countries are much wealthier and larger than others.

In order to address issues of simultaneity within these controls and the onset of conflict, *Xpolity*, *GDP per Capita,* and *Population* variables are lagged by one year (12 months). Lastly, I also control for temporal dependence for all conflict measures using Carter and Signorinos' (2010) recommendation of the linear, quadratic, and cubic counts of time. One last item of note is that the measurement of the majority of these control variables are aggregated at the country-year level unit of analysis, and are therefore most appropriate for a country-year research design. Ideally, I would use monthly measures for these all controls, but unfortunately, some monthly measures do not exist. As a result, I use the same yearly value for each month of a given year when necessary but recognize that the inclusion of these controls, though not ideal, is neither taboo, nor theoretically inappropriate since we can believe that their effects are important.[9]

All estimations are estimated in STATA 12. Models of the onset of intrastate conflict use logistic regression, which include robust standard errors clustered on country. Additionally, I also estimate models with conditional fixed effects to correct for the exclusion of potentially influential country-level attributes that may be correlated with both temperature changes and the onset of civil war. Estimations of non-state conflict and social protest use negative binomial regression to account for over-dispersion in the count structure of the dependent variable. These models also use robust standard errors clustered on country as well as with conditional fixed effects. Substantive effects of the results are generated using the CLARIFY software from the estimations (King, Tomz,

[9]For further discussion, see Raleigh and Kniveton (2012)

and Wittenburg 2000; Tomz, Wittenberg, and King 2003). Fixed effects models are denoted with an even number (i.e. 2, 4, 6…).

2.5 Results & Discussion

2.5.1 Results: Yearly Tests

In order to demonstrate the important the differences that emerge from using a country-month research design, I first briefly report the results of my estimations at the yearly level to illustrate the drawbacks of over aggregation in existing studies of temperature and conflict. These results are shown in **Table 2-1** below:

Table 2-1: Country-Year Estimation Results

Country-Month Table 2-1	**(1) ACD (25+ Dead) 1979–2010**	**(2) ACD (25+ Dead) 1979–2010**	**(3) ACD (1000+Dead) 1979–2010**	**(4) ACD (1000+Dead) 1979–2010**	**(5) UCDP 1989–2010**	**(6) UCDP 1989–2010**	**(7) SCAD 1990–2010**	**(8) SCAD 1990–2010**	**(9) ICEWS 2000–2009**	**(10) ICEWS 2000–2009**
Negative Binomial DV Lag	---	---	---	---	.0107759	-.0526638	.0524691**	.0170997**	.0045232**	.001213**
					(.0263929)	(.0380813)	(.0047809)	(.002014)	(.0009516)	(.0001611)
Temp Mean	.0270409+	-.1046804	.0409442*	.1195601**	.0344519*	.0860032	-.006438	.0759277**	.0127871	-.0150301
	(.0147619)	(.2309313)	(.0177067)	(.3014599)	(.0116401)	(.0904767)	(.0169516)	(.0170272)	(.0241012)	(.0150404)
Temp Shock	-.5598873+	-.2587153	-.7301856+	-.5497019	.3826916	.1330521	.190661	-.0170493	1.086081	.2094751
	(.2965711)	(.4400738)	(.3991333)	(.5595034)	(.3376578)	(.3984469)	(.3260281)	(.2175044)	(1.12746)	(.4658474)
Temp Shock^2	-.0315489	-.1433218	.2740554	.2115118	-.1845765	-.1287659	-.1071663	.0011671	-1.250897	-.8102607
	(.3228273)	(.4347356)	(.3740466)	(.5081667)	(.4723432)	(.3608604)	(.2422391)	(.1834599)	(1.306459)	(.6572761)
Precip Mean	-.0615744	-.1650776	-.0755871	.2671197	-.0727314**	.0620058	-.052682+	.0969095	-.0111051	-.0102096
	(.0443986)	(.3611924)	(.0614101)	(.4721937)	(.0333808)	(.3339989)	(.0329086)	(.0638412)	(.1020583)	(.0732973)
Precip Shock	.4191568	.5471184	.421256	.011574	.1570325	-.1038385	.2413213	-.3495209*/+	.5438243	-.2326988
	(.2797135)	(.6484228)	(.3325226)	(.8437098)	(.2614084)	(.5590005)	(.214526)	(.1825163)	(.4308329)	(.2568224)
Precip Shock^2	.018427	.3809625	-.0901212	.7816491	.0020379	-.0377171	-.1120396	.5013432+	1.044718	.0708625
	(.775881)	(.6537993)	(1.058683)	(1.054447)	(.4038684)	(.5945458)	(.548197)	(.3116856)	(1.730251)	(.68021)
Xpolity (lag)	-.001501	-.0006955	-.0021772+	-.0014601	-.0013458+	-.0015786+	-.0016021**	-.000758*	.0009478	.0010394
	(.0009653)	(.0010355)	(.0012853)	(.0012827)	(.0007654)	(.0009511)	(.0003651)	(.0003779)	(.001736)	(.0016559)
GDP Per Capita (lag)	-.1988524*	.0819195	-.0682741	-.006842	-.0375668	.1868074	.0065272	-.1575639**	-.009167	.0639324+
	(.0827332)	(.1846716)	(.1141618)	(.2511341)	(.0528018)	(.1656288)	(.0398939)	(.0406341)	(.1147249)	(.0388128)
Population (lag)	.2047918 **	.2827069	.2171952**	-.0071088	.0930376**	.0776662+	.1095751	.0327503+	.2442752**	.0647576**
	(.067927)	(.4007776)	(.0643946)	(.5155508)	(.0275777)	(.0459052)	(.0228856)	(.0181841)	(.0766223)	(.0283824)
El Niño	-.0864431	-.0466099	-.3374396	-.279139	-.0634924	.031063	.0407701	.027203	-.108082	.0085674
	(.1717875)	(.1713299)	(.2631961)	(.2335185)	(.1552251)	(.160734)	(.1021785)	(.068759)	(.1300653)	(.0811981)
Peace Years	-.2645469**	-.1015833*	-.289864**	-.1354118	-1.320455**	-1.111145	-2.621891**	-2.025604**	-15.37203**	-10.91528
	(.0353055)	(.0480857)	(.0476084)	(.0598205)	(.1164209)	(.0995199)	(.174916)	(.1371444)	(2.093777)	(180.3379)
Peace Years^2	.008718**	.0023975	.0090453**	.0037296	.1322801**	.1146204	.6049047**	.461654**	13.51362**	10.48133
	(.0018758)	(.0029577)	(.0024686)	(.0035508)	(.019134)	(.0134069)	(.0810595)	(.052695)	(1.89743)	(270.4927)
Peace Years^3	-.0000804**	.0000293	-.0000948**	.0000162	-.0036471**	-.0028154	-.0381296**	-.0281163	-3.513052	-2.838307
	(.0000269)	(.0000487)	(.0000335)	(.0000576)	(.0007638)	(.0004923)	(.0079076)	(.0047592)	(.4066454)	(90.16247)
Constant	-1.628855	---	-2.947076**	---	-.7807604	---	.4929424	---	.8813065	---
			(1.219646)		(.7454238)		(.6730323)		(1.635484)	
Observations	2818	2275	2818	1226	1128	1086	924	924	304	304
Log Pesudolikelihood	-835.17354	-624.34598	-519.57843	-359.82485	-556.60678	-434.79119	-1648.8058	-1456.6872	-1439.561	-1142.0539
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses $^{**}p < 0.01$; $^{*}p < 0.05$; $^{+}p < 0.1$ (reported, but not discussed);

Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects model

A close reading of the estimation results in Table 2-1 reveals that the relationships between temperature measures and the risk of violent conflict are inconsistent and infrequent. The results are strongest when using the ACD civil war onset '1,000 dead threshold' as the dependent variable. In these cases, the risk of civil increases with an increase in a country's yearly mean temperature value. **Figure 2-2** shows that when simulating the effects of a change in the yearly temperature measure, a one standard deviation increase from the mean (.023) increases the risk of high intensity civil war increases by 34.7% (.031) and a two standard deviation increases this risk by 82.6% (.042).

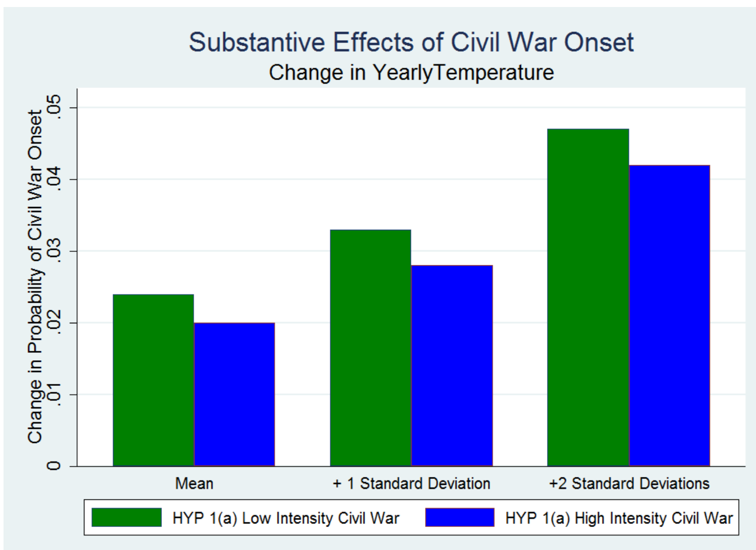


Figure 2-2: Substantive Effects of Civil War Onset: Change in Yearly Temperature

When examining measures non-state violent conflict, **Figure 2-3** shows that the risk of non-state conflict also shows a positive relationship, with a one standard deviation and two standard deviation increase from a country's mean yearly temperature raising the risk of non-state conflict by 28.4% (.102 to .131) and 65.6% (.169), respectively. These patterns do not hold however, when looking at spontaneous episodes of violence in Asia or the frequency of violent social protests in Africa. Furthermore, the results of the estimations in Table 2-1 show scant evidence of a relationship with *Temp Shock*, the effects of El Niño, or various the measures of precipitation. Overall, if scholars were to rely on the results of only this country-year research design, they might conclude that the temperature-to-conflict relationship is too sensitive to nuances of the chosen dependent variable or otherwise nonexistent.

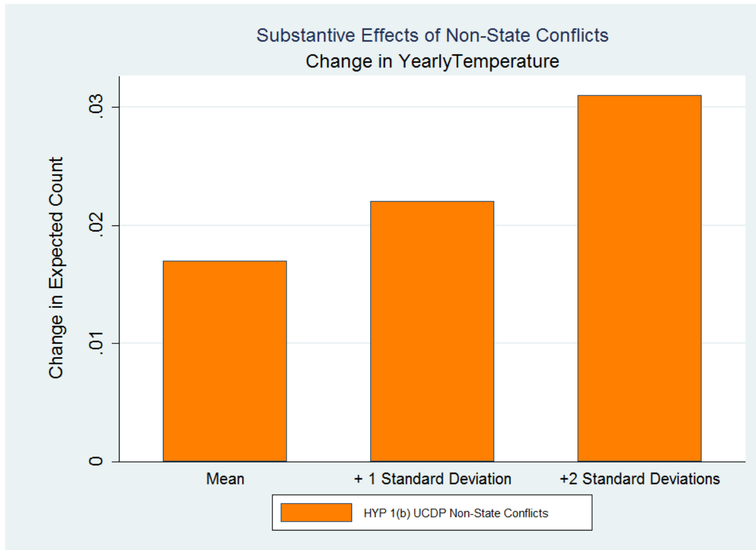


Figure 2-3: Substantive Effects of Non-State Conflict: Changes in Yearly Temperature

2.5.2 Results: Monthly Tests

The major issue with a country-year research design when using meteorological data, like measures of temperature and precipitation, is that the approach ignores the inter-year differences in temperature, effectively equating the temperature for July as being the same as it would be in January (see Figure 2-1). In equatorial countries, this difference may be negligible; however, in non-equatorial countries this is quite problematic. Given the theoretical expectations regarding the effects of seasonality on the risk of conflict onset, this assumption seems wildly inappropriate. The results of **Table 2-2** better illustrates this point, demonstrating that when one disaggregates these measures into a country-month unit of analysis, the results can be dramatic.

Table 2-2: Country-Month Estimation Results

Country-Month Table 2-2	**(1) ACD (25+ Dead) 1979–2010**	**(2) ACD (25+ Dead) 1979–2010**	**(3) ACD (1000+Dead) 1979–2010**	**(4) ACD (1000+Dead) 1979–2010**	**(5) UCDP 1989–2010**	**(6) UCDP 1989–2010**	**(7) SCAD 1990–2010**	**(8) SCAD 1990–2010**	**(9) ICEWS 2000–2009**	**(10) ICEWS 2000–2009**
Negative Binomial DV Lag	---	---	---	---	.0654373	-.0439199	.1422427**	.0713892**	.0358675**	.0124695**
					(.1927895)	(.1486893)	(.0229245)	(.0084173)	(.003703)	(.0003902)
Temp Mean	.0106437	.0041689	.0230342*	.0069663	.0227666*	.0235058	-.008454	.0127753+	-.000438	.0066212**
	(.0086357)	(.0134761)	(.0114161)	(.0171411)	(.0115282)	(.016591)	(.0118329)	(.007108)	(.0063994)	(.0021437)
Temp Shock	-.1931003**	-.1745457**	-.23991**	-.1869143*	.1868253**	.0948185	.1129918**	.0744185**	.0109806	.0015942
	(.0610057)	(.0678851)	(.0792625)	(.0860642)	(.0658764)	(.0824532)	(.0317692)	(.0289217)	(.0326736)	(.0195407)
Temp Shock^2	-.0005359	.0221532	.0324007	.0527819	-.0743151	-.0747066	-.0285034	-.0263636	-.0011229	-.0086266
	(.0414413)	(.0427551)	(.0495482)	(.0532186)	(.054729)	(.0512696)	(.0197375)	(.0169372)	(.0236626)	(.0120255)
Precip Mean	-.0509443+	-.0412224	-.1264082**	-.1731297**	-.0927642**	-.039573	-.0245568	-.0320592**	.0033891	-.0081239+
	(.0301452)	(.0306337)	(.0379239)	(.0509607)	(.028806)	(.0318285)	(.012533)	(.0099131)	(.0132065)	(.0049742)
Precip Shock	-.023911	-.0352289	.0136206	.0578375	.0131204	-.0533142	.0345887	.0304742	-.0289912	-.0291564*/+
	(.063355)	(.0693649)	(.0719419)	(.0914386)	(.0480623)	(.0612828)	(.0217683)	(0214676)	(.0236626)	(.0149964)
Precip Shock^2	-.0205835	-.0128677	-.0049306	0003175	.0055775	.0145475	-.0066364	-.0041402	.0302896**	.0229913*
	(.0439615)	(.0416423)	(.0370631)	(.0527512)	(.042437)	(.0318338)	(.0146692)	(.0112939)	(.0135455)	(.0097361)
Xpolity (lag)	-.0013421+	-.0005616	-.0018351+	-.0010515	-.0032829**	-.0035206**	-.0016459**	-.0013926**	.0012409	.0009883
	(.0007385)	(.0008934)	(.0009699)	(.0010879)	(.0009699)	**(.0008295)**	(.0004803)	(.0002594)	(.0010398)	(.00065)
GDP Per Capita (lag)	-.1921327**	.0664996	-.0660939	-.0384655	-.1876374**	.026642	.0453352	-.1083819**	-.0676179	.0407803**
	(.0670294)	(.1612621)	(.0981455)	(.222228)	(.0672067)	(.1009481)	(.0607023)	(.0383439)	(.0454537)	(.0149836)
Population (lag)	.1828298**	.1866753	.2055148**	.0600461	.1590631**	.0629772	.1551472**	.0730067**	.0779903**	.011223
	(.0547083)	(.3370365)	(.0607863)	(.4285781)	(.0292299)	(.0399462)	(.0214606)	(.0131579)	(.0384924)	(.0112537)
El Niño	-.0711424	-.0338784	-.2489327	-.2171894	-.0905441	-.057796	.1254892**	.081168+	-.0358182	-.0072822
	(.1400241)	(.1500011)	(.2197319)	(.2063863)	(.1668224)	(.1518365)	(.0552068)	(.0503548)	(.0530702)	(.0325106)
January	1.164368**	1.155303**	1.394613**	1.288577**	.065452**	.0815453	---	---	---	---
	(.2876097)	(.1586757)	(.3502404)	(.1996837)	(.1692844)	(.1987759)				
Peace Months	-.0122061**	.0030019	-.0133975**	.0010036	-.0753528**	-.0427741	-.3673983**	-.2949444	-1.473907	-.9269473**
	(.0023581)	(.0035261)	(.0031111)	(.0044172)	(.0125385)	(.0083073)	(.0529068)	(.0124583)	(.1580149)	(.0380391)
Peace Months^2	.000025*	-.000037	.0000247+	-.0000294	.0006636**	.000404	.0089313**	.0071725	.0718573	.043492**
	(.0000109)	(.0000197)	(.0000138)	(.0000243)	(.0001612)	(.000104)	(.0019591)	(.0004377)	(.0172273)	(.0029939)
Peace Months^3	-1.21e-08	8.47e-08**	-1.87e-08	7.75e-08*	-1.70e-06**	-8.57e-07	-.0000581**	-.0000457	-.0009317	-.0005412**
	(1.27e-08)	(2.89e-08)	(1.50e-08)	(3.57e-08)	(5.45e-07)	(3.42e-07)	(.0000176)	(3.93e-06)	(.0003842)	(.0000586)
Constant	-4.4039**	---	-5.754868**	---	-3.018125**	---	-1.789808**	---	1.45529*	---
	(.7662293)		(1.08731)		(.8323038)		(.6007897)		(.7427874)	
Observations	33816	27300	33816	14712	13815	13043	11355	11355	3945	3945
Log Pesudolikelihood	-1591.6036	-1371.6126	-949.45911	-783.03271	-1458.2278	-1285.8163	-6378.0896	-6068.1812	-8925.2862	-8445.2885
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses **p < 0.01; *p < 0.05; $^{+}$p < 0.1 (reported, but not discussed);

Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects models

The results in Table 2-2 reveal a much stronger relationship between the measures of temperature change and conflict. These findings are more consistent across different datasets and their implications are important. According to Table 2-2**,** the effects of an increase in the mean monthly temperature largely reflect the findings of Table 2-1. Holding all variables at meaningful values, an increase from the mean to one standard deviation above it increases the risk of high intensity civil war onset by 16.7% (.006 to.007), while a two standard deviation increase raises the risk by 50% (.009). Concomitantly, increasing a country's monthly temperature raises the risk of conflict by 16.7% (.012 to .014) and 50% (.018), respectively, in the expected count of non-state conflict events. Taken together with the findings of the country-month research design, along with the country-year findings, the results confirm Hypothesis 1(a), and provide weaker support for Hypothesis 1(b) due to the loss of significance in the fixed effects models. When examining the effect of temperature shocks on the risk of conflict, the importance of using a country-month research design becomes evident. Unlike Table 2-1, the results show a significant and consistently *negative* effect on the risk of civil war onset; while in models of non-state conflict and violent social protest, temperature shocks are positively associated the expected count of these events. These results run somewhat contrary my expectations in Hypothesis 2(a) and 2(b), which argue that temperature shocks, should uniformly increase the risk of violent conflict onset. Surprisingly, the results show quite the opposite. Controlling for a variety of founding factors, the probability of civil war onset actually declines as values of the temperature shock measure increase, while simultaneously raising the expected count of non-state conflict and social protest events.

The modest substantive effects of these changes are illustrated in **Figure 2-4**. They indicate that a one standard deviation increase in the value of the temperature shock measure from its mean value (.016) reduces the probability of civil onset by 12.5% (.014), for low intensity civil wars by 16.7% (.007 to .006), and for high intensity civil wars; with a two standard deviation increase reducing the risk by 31.3% (.011) and 33.3% (.004) respectively.

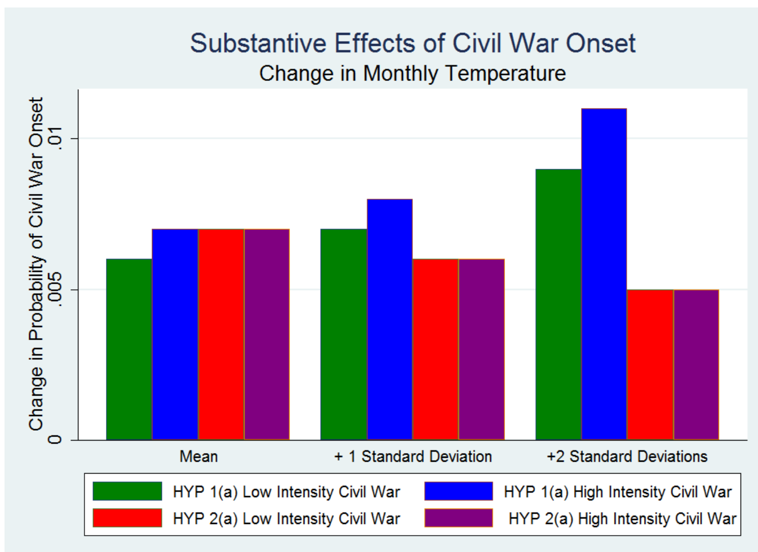


Figure 2-4: Substantive Effects of Civil War Onset: Change in Monthly Temperature

Further results are shown in **Figure 2-5**. For non-state conflict, an increase from the mean (.012) value of temperature shock by one standard deviation increases the expected count by 16.7% (.014) and by 41.7% (.017) for a two standard deviation increase. For violent social protests, an increase from the mean (.069) to one standard deviation above it is associated with an increase in the expected violent social protests by 14.5% (.070), while a two standard deviation increase is associated with a 24.6% (.086) increase. Taken together, the findings of the country-month estimations reject Hypothesis 2(a), running directly counter to my expectations, while being more sensitive but tending to support Hypothesis 2(b).

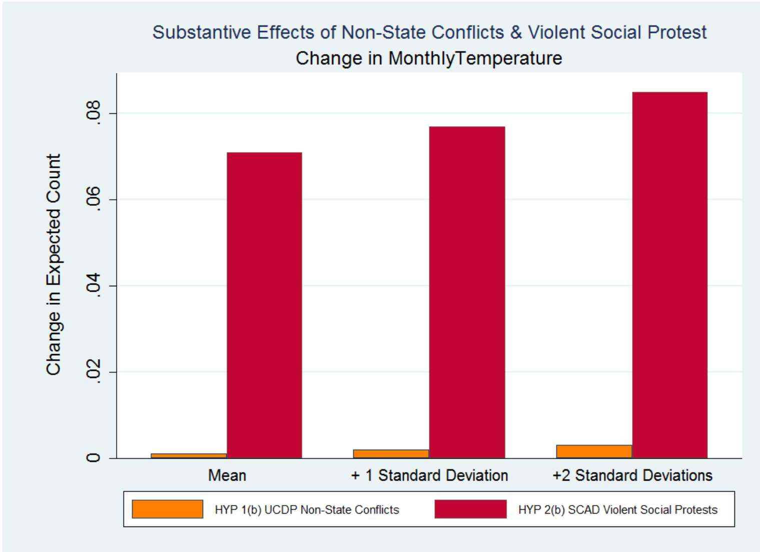


Figure 2-5: Substantive Effects of Non-State Conflict & Violent Social Protest: Change in Monthly Temperature

Finally, the statistical pattern observed within the control variables are largely as expected. *Xpolity*, *Population*, and *GDP per Capita* all tend to have strong effects on the likelihood of conflict onset in accordance with established research, but this tendency is weaker for fixed effects models and less organized forms of violent conflict. Unlike Hisang, Meng, and Cane (2011), I find little evidence of El Niño influencing the risk of conflict onset. Surprisingly, I also find no support of a positive rainfall shock influencing the risk of conflict onset, but do find that risks of civil war, non-state conflict, and African social protest are less likely in months with comparatively more precipitation—a finding that is somewhat consistent with existing research (Hendrix and Salehyan 2012; Lujala 2010).

2.5.3 Discussion

Overall, the findings of my analyses make several important contributions. First, it is evident that choices of measurement and research design have important implications for the study of temperature and conflict. Depending on the unit of analysis and the dependent variable that are chosen, the statistical significance of the hypothesized relationship changes or disappears altogether. All things equal, the results are supportive of a disaggregated approach for this vein of research. A country-month unit of analysis better matches the theoretical connections between theory and the realities of measurement with regard to changes in temperature. Moreover, this approach shows more interesting differentiation and important effects, with no loss of information or findings, which would have been missed by using a country-year research design.

Furthermore, this study also emphasizes the importance of concept measurement. In estimations using monthly temperate change, the relationship with the onset of civil war was positive and supportive of the alarmist arguments regarding global warming. In estimations using the temperature shock measure, the findings were in the opposite direction for civil war onset, while in a positive direction for less organized forms of violent conflict. Future research should seek to uncover and corroborate the underlying mechanisms that drive the difference in these relationships.

Comparability between different measures and datasets is also a useful externality of this study. With the inclusion of the GPCC data, I was able to distinguish whether temperature or precipitation was more closely linked with the onset of violent conflict. Somewhat surprisingly, my study diverges from other studies by showing temperature as the more important factor for influencing the risk of conflict rather than rainfall (see Hendrix and Salehyan 2012; O'Loughlin et al. 2012). The results also show that the risk of violent conflict as it is linked with temperature change is most salient for the onset of civil war and social protests within Africa, while measures of violent conflict in Asia and non-state conflict being more sensitive to the inclusion of fixed effects, changes in measurement, and sample size between various datasets.

2.6 Conclusion

Overall, the findings of this study further our understanding, but do not provide a definitive answer on the direction of this relationship. The results show that the likelihood of the onset of violent conflict varies according to seasonal temperature changes across different units of analysis, forms of measurement, and specific datasets. Specifically, I tested two different arguments born out of the climate-change and conflict literature: the 'Seasonality and Strategic Viability' mechanism and the 'Temperature Shock and Equilibrium Disruption' mechanism. The first mechanism suggests that violent conflict will be more likely when the temperature conditions are amendable for actors' strategies, typically so in months of warm weather. In instances of civil war onset and non-state conflict, my results are supportive of this idea. The second mechanism tests the effects of a temperature shock in which the expected monthly temperature deviates substantially from its long-term monthly mean and if this deviation increases the risk of violent conflict. Surprisingly, the results show that the risk of civil war and non-state conflict is actually reduced in months that experience a dramatic deviation from expected temperature patterns. Ironically, these results are contradictive of the alarmist interpretations of global warming; however, these findings are not consistent when examining less organized forms of violent conflict such as non-state conflict and African social protests, with notable absence in Asia.

My study deviates from past studies on the relationship between temperature and conflict by showing the importance of seasonal variability through disaggregation. The predictability in weather patterns or lack thereof appears to be an important, but modest, factor in determining the onset of violent conflict. Future research should seek to explain whether this finding is better explained through strategic decision-making related to changing temperature patterns or some other mechanism. While this work represents a more detailed contribution to our understanding of the relationship between temperature and the onset of violent conflict, further work is necessary to better delineate the causal mechanisms and explain why the findings change depending on the measurement of the independent variable. A further benefit of this study is that it allows for a more direct comparison with existing research by using similar data and measurement techniques. Future work should seek to build off this approach of using similar dataset to arrive at a stronger consensus on the temperature-to-conflict debate.

2.7 References

Adler, R.F., G.J. Huffman, A. Chang, R. Ferraro, P. Xie, J. Janowiak, B. Rudolf, U. Schneider, S. Curtis, D. Bolvin, A. Gruber, J. Susskind, and P. Arkin. 2003. "The Version 2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation Analysis (1979–Present)." *Journal of Hydrometeor* 4: 1147–1167

AFP. 2012. "Israelis Battle Police in Tel Aviv Social Protest." *AFP*, June 23. Accessed May 6, 2013. http://www.google.com/hostednews/afp/article/ALeqM5hcrm_ZxbKKvRqYIiQ_cWHPWkTkOg?docId=CNG.991c650c9d6e161243d52aa26c191527.121.

Bai, Ying and James Kai-sing Kung. 2011. "Climate Shocks and Sino-Nomadic Conflict." *The Review of Economics and Statistics* 93 (3): 970–981.

BBC News. 2012. "Kiribati Mulls Fiji Land Purchase in Battle Against Sea." *British Broadcast Corporation (BBC),* March 8. Accessed May 6, 2013. http://www.bbc.co.uk/news/world-asia-17295862.

Benjaminsen, Tor A., Koffi Alinon, Halvard Buhaug, and Jill Tove Buseth. 2012. "Does Climate Change Drive Land-Use Conflicts in the Sahel?" *Journal of Peace Research* 49 (1): 97–111.

Bergholt, Drago and Paivi Lujala. 2012. “Climate-Related Natural Disasters, Economic Growth, and Armed Conflict.” *Journal of Peace Research* 491 (1): 147–162.

Buhaug, Halvard. 2010. “Climate Not to Blame for African Civil Wars.” *Proceedings of the National Academy of Sciences* 107 (38): 16477–16482.

Burke, Marshall B, John A. Dykema, David B. Lobell, Edward Miguel, and Shanker Satyanath. 2010. “Climate and Civil War: Is the Relationship Robust?” *National Bureau of Economic Research*: NBER Working Paper Series No. 16440. October.

Burke, Marshall B, Edward Miguel, Shanker Satyanath, John A. Dykema, and David B. Lobell. 2010. “Reply to Sutton et al.: Relationship Between Temperature and Conflict is Robust.” *Proceedings of the National Academy of Sciences* 107 (25): E103.

———.2009. “Warming Increases the Risk of Civil War in Africa.” *Proceedings of the National Academy of Sciences* 106 (49): 20670–20674.

Carter, David B. and Curtis S. Signorino. 2010. “Back to the Future: Modeling Time Dependence in Binary Data.” *Political Analysis* 18: 271–292.

Center for Ocean-Atmospheric Prediction Studies. 2012. "ESNO Index According to JMA SSTA (1868–Present)." Florida State University: Center for Ocean-Atmospheric Prediction Studies. Accessed May 6, 2013. http://coaps.fsu.edu/jma.shtml.

Chivers, C.J. 2012. "In the Syrian Fight, Rebels' Prospects can Change with the Weather." *The New York Times,* August 29. Accessed May 6, 2013. http://atwar.blogs.nytimes.com/2012/08/29/in-the-syrian-fight-rebels-prospects-can-change-with-the-weather/.

Collier, Paul and Anke Hoeffler. 2004. "Greed and Grievance in Civil War." *Oxford Economic Papers* 56 (4): 563–595.

Collins, Mat, Soon-Il An, Wenju Cai, Alexandre Ganachaud, Eric Guilyardi, Fei-Fei Jin, Markus Jochum, Matthieu Lengaigne, Scott Power, Axel Timmermann, Gabe Vecchi, and Andrew Wittenberg. 2010. "The Impact of Global Warming on the Tropical Pacific Ocean and El Niño." *Nature Geoscience* 3: 391–397.

Department of Defense. 2010. "Quadrennial Defense Review Report." *Department of Defense*, February. Accessed May 6. 2013. http://www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf.

De Soysa, Indra. 2002. “Ecoviolence: Shrinking Pie, or Honey Pot?” *Global Environmental Politics* 2 (4): 1–34.

The Economist. 2012. “Jihad in Africa: Danger in the Desert.” *The Economist.* January 26.

———.2011. “The Heat is On: A New Analysis of the Temperature Record Leaves Little Room for the Doubters. The World is Warming.” *The Economist*. October 22.

———.2010. “The Hottest Years on Record: This Year is Likely to be the Warmest Ever Recorded.” *The Economist*, December 3. Accessed May 2013. http://www.economist.com/blogs/dailychart/2010/12/climate_change.

Fearon, James D. and David Laitin. 2003. “Ethnicity, Insurgency, and Civil War.” *American Political Science Review* 97 (1): 75–90.

Gartzke, Erik. 2012. “Could Climate Change Precipitate Peace?” *Journal of Peace Research* 29 (1): 177–192.

Gillis, Justin. 2012. “Rising Sea Levels a Growing Risk to Costal U.S., Study Says.” *The New York Times*, March 13. Accessed May 6, 2013. http://www.nytimes.com/2012/03/14/science/earth/study-rising-sea-levels-a-risk-to-coastal-states.html.

Gjelten, Tom. 2009. “Pentagon, CIA Eye New Threat: Climate Change.” *National Public Radio*, December 14. Accessed May 6, 2013. http://www.npr.org/templates/story/story.php?storyId=121352495.

Gleditsch, Nils Petter. 2012. “Wither the Weather? Climate Change and Conflict.” *Journal of Peace Research* 49 (3): 3–9.

Gleditsch, Nils Petter, Peter Wallensteen, Mikael Erikson, Margareta Sollenberg, and Havard Strand. 2002. “Armed Conflict 1946–2001: A New Dataset.” *Journal of Peace Research* 39 (5): 615–637.

Gleditsch, Kristian Skrede. 2002. “Expanded Trade and GDP Data.” *The Journal of Conflict Resolution* 46 (5): 712–724.

Gupta, Sanjay. 2007. “Pacific Swallowing Remote Island Chain.” *CNN*, July 31. Accessed May 6, 2013. http://www.cnn.com/CNN/Programs/anderson.cooper.360/blog/2007/07/pacific-swallowing-remote-island-chain.html.

Hampel, Andrea, Ralf Hetzel, and Georgios Maniatis. 2010. “Responses of Faults to Climate-Driven Changes in Ice and Water Volumes on Earth’s Surface.” *Philosophical Transactions of The Royal Society* 368: 2501–2517.

Harbom, Lotta and Peter Wallensteen. 2010. "Armed Conflicts, 1946–2009*" Journal of Peace Research* 47 (4): 501–509.

Hegre, Havard, Tanja Ellingsen, Scott Gates, and Nils Petter Gleditsch. 2001. "Toward a Democratic Civil Peace? Democracy, Political Change, and Civil War, 1816–1992." *American Political Science Review* 95 (1): 33–48.

Hegre, Havard, Gundrun Ostby, and Clionadh Raleigh. 2009. "Poverty and Civil War Events: A Disaggregated Study of Liberia." *Journal of Conflict Resolution* 53 (4): 598–623.

Hegre, Havard and Nicholas Sambanis. 2006. "Sensitivity Analysis of Empirical Results on Civil War Onset." *Journal of Conflict Resolution* 50 (4): 508–535.

Hendrix, Cullen S. and Idean Salehyan. 2012. "Climate Change, Rainfall, and Social Conflict in Africa." *Journal of Peace Research* 49 (1): 35–50.

Heston, Alan, Robert Summers, and Bettina Aten. 2011. "Penn World Table Version 7.0." University of Pennsylvania: Center for International Comparisons of Production, Income and Prices. Accessed May 6, 2013. https://pwt.sas.upenn.edu/php_site/pwt_index.php.

Hidalgo, F. Daniel, Suresh Naidu, Simeon Nichter, and Neal Richardson. 2011. “Economic Determinants of Land Invasions.” *The Review of Economics and Statistics* 92 (3): 505–523.

Homer-Dixon, Thomas. 1999. *Environment, Scarcity, and Violence.* Princeton: Princeton University Press.

———.1994. “Environmental Scarcities and Violent Conflict: Evidence from Cases.” *International Security* 19 (1): 5–40.

Hsiang, Solomon M., Kyle C. Meng, and Mark A. Cane. 2011. “Civil Conflicts are Associated with Global Temperature.” *Nature* 476: 438–441.

Iaffaldano, Giampiero, Laurent Husson, and Hans-Peter Bunge. 2011. “Monsoon Speeds up Indian Plate Motion.” *Earth and Planetary Science Letters* 304: 503–510.

IPCC. 2007. “IPCC Fourth Assessment Report. Climate Change 2007: Synthesis Report.” edited by R.K Pachauri and A. Reisinger. Geneva: Intergovernmental Panel on Climate Change. Accessed May 6, 2013. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

Kahl, Colin H. 2006. *States, Scarcity, and Civil Strife in the Developing World.* Princeton: Princeton University Press.

Kalnay, Eugenia, Masao Kanamitsu, Robert Kistler, William Collins, Dennis Deaven, Lev Gandin, Mark Iredell, Suranjana Saha, Glenn White, John Woollen, Yuejian. Zhu, Muthuvel Chelliah, Wesley Ebisuzaki, Wayne Higgins, John. Janowiak, Kingste C. Mo, Chester Ropelewski, J. Wang, Ants Leetmaa, Richard Reynolds, Roy Jenne, and Dennis Joseph. 1996. "The NCEP/NCAR 40-Year Reanalysis Project." *Bulletin of the American Meteorological Society* 77 (3): 437–471.

Keating, Joushua. 2012. "Nation of Kiribati considers relocation." *Foreign Policy,* March 8. Accessed May 6, 2013. http://blog.foreignpolicy.com/posts/2012/03/08/nation_of_kiribati_considers_relocation.

King, Gary, Michael Tomz, and Jason Wittenberg. 2000. "Making the Most of Statistical Analyses: Improving Interpretation and Presentation." *American Journal of Political Science* 44 (2): 347–361.

King, Laura and Amial Yaqubi. 2012. 18 Killed Across Afghanistan; Violence Tends to Increase Seasonally." *Los Angeles Times.* April 26. Accessed May 6, 2013. http://latimesblogs.latimes.com/world_now/2012/04/afghanistan-violence-kills-18-seasonal-increase.html.

Latin American Herald Tribune. 2013. “Buenos Aires Swelters Amid Heat Wave, Power Outages.” *Latin American Herald Tribune*, January 29. Accessed May 6, 2013. http://www.laht.com/article.asp?ArticleId=382538&CategoryId=14093.

Lujala, Paivi. 2010. “The Spoils of Nature: Armed Civil Conflict and Rebel Access to Natural Resources.” *Journal of Peace Research* 47 (1): 15–28.

Marshall, Monty J. and Keith Jaggers. 2010. “Polity IV Project: Political Regime Characteristics and Transitions, 1800–2010. Version p4v2010.” College Park, MD: University of Maryland. Accessed May 6, 2013. http://www.systemicpeace.org/inscr/inscr.htm.

Meier, Patrick, Doug Bond, and Joe Bond. 2007. “Environmental Influences on Pastoral Conflict in the Horn of Africa.” *Political Geography* 26: 716–735.

Mendelsohn, Robert, Ariel Dinar, and Larry Williams. 2006. “The Distributional Impact of Climate Change on Rich and Poor Countries.” *Environment and Development Economics* 11: 159–178.

Miguel, Edward, Shanker Satyanath, and Ernest Sergenti. 2004. “Economic Shocks and Civil Conflict: An Instrumental Variables Approach.” *Journal of Political Economy* 112 (4): 725–753.

National Research Council. 2013. "Climate and Social Stress: Implications for Security Analysis." *Committee on Assessing the Impacts of Climate Change on Social and Political Stresses*, edited by John D. Steinbruner, Paul C. Stern, and Jo L. Husbands. Board on Environmental Change and Society, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academic Press.

NBC News. 2012a. "View from Northern Syria: Rebels Control Countryside, Open Roads." *NBC News*, December 9. Accessed May 6, 2013. http://worldnews.nbcnews.com/_news/2012/12/09/15790886-view-from-northern-syria-rebels-control-countryside-open-roads?lite.

———.2012b. "Violent Holiday Weekend Claim at Least 10 Lives in Chicago." *NBC News*, May 9. Accessed May 6, 2013. http://usnews.nbcnews.com/_nv/more/section/archive?year=2012&month=5&ct=a&pc=25&sp=50.

Nordas, Ragnhild and Nils Petter Gleditsch. 2007. "Climate Change and Conflict." *Political Geography* 26 (6): 627–638.

O'Brien, Sean P. 2010. Crisis Early Warning Decision Support: Contemporary Approaches and Thoughts on Future Research." *International Studies Review* 12 (1): 87–104.

O'Loughlin, John, Frank D. W. Witmer, Andrew M. Linke, Arlene Laing, Andrew Getteleman, and Jimy Dudhia. 2012. "Climate Variability and Conflict Risk in East Africa, 1990–2009." *Proceedings of the National Academy of Sciences* 109: 18344–18349.

Partlow, Joshua. 2011. In Afghanistan, Uptick in Violence this Winter Coincides with Less Snow. *The Washington Post*, January 15. Accessed May 6, 2013. http://www.washingtonpost.com/wp-dyn/content/article/2011/01/14/AR2011011404695.html.

Percival, Val and Thomas Homer-Dixon. 1998. "Environmental Scarcity and Violent Conflict: The Case of South Africa." *Journal of Peace Research* 35 (3): 279–298.

Philip, Sjoukje and Geert Jan van Oldenborgh. 2006. "Shifts in ESNO Coupling Process Under Global Warming." *Geophysical Research Letters* 33 (L11704): 1–5.

Raleigh, Clionadh and Dominic Kniveton. 2012. "Come Rain or Shine: An Analysis of Conflict and Climate Variability in East Africa." *Journal of Peace Research* 49 (1): 51–64.

Raleigh, Clionadh and Henrik Urdal. 2007. "Climate Change, Environmental Degradation, and Armed Conflict." *Political Geography* 26: 674–694.

Rebetez, Miguel. 2011. "The Main Climate Change Forecasts that May Cause Human Displacement." In *Migration and Climate Change*, edited by Etienne Piguet, Antoine Pecoud and Paul De Guchteneire, pp. 37–48. Cambridge: Cambridge University Press.

Reuveny, Rafael. 2007. "Climate Change-Induced Migration and Violent Conflict." *Political Geography* 29: 565–673.

Salehyan, Idean. 2008. "From Climate to Conflict? No Consensus Yet." *Journal of Peace Research* 45 (3): 315–326.

Salehyan, Idean, Cullen S. Hendrix, Jesse Hamner, Christina Case, Christopher Linebarger, Emily Stull, and Jennifer Williams. 2012. "Social Conflict in Africa: A New Database" *International Interactions* 38 (4): 503–511.

Samuels, Robert and Annie Gowen. 2012. "Occupy D.C.'s New Battle? Cold." *The Washington Post*, January 4. Accessed May 6, 2013. http://www.washingtonpost.com/local/occupy-dcs-new-battle-cold/2012/01/04/gIQAGISRbP_story.html.

Schaper, David. 2012. "Experts Stumped by Chicago's Soaring Homicide Rate." *National Public Radio*, May 16. Accessed May 6, 2013.

http://www.npr.org/2012/05/16/152852264/experts-stumped-by-chicagos-soaring-homicide-rate.

Stephen, Marcus. 2011. “On Nauru, a Sinking Feeling.” *The New York Times*, July 18. Accessed May 6, 2013. http://www.nytimes.com/2011/07/19/opinion/19stephen.html.

Sundberg, Ralph, Kristine Eck, and Joakim Kreutz. 2012. “Introducing the UCDP Non-State Conflict Dataset.” *Journal of Peace Research* 49 (2): 351–362.

Sutton, Alexandra E., Justin Dohn, Kara Loyd, Andrew Tredennick, Gabriela Bucini, Alexandro Solorzano, Lara Prihodko, and Niall P. Hanan. 2010. Does Warming Increase the Risk of Civil War in Africa?” *Proceedings of the National Academy of Sciences* 107(25): E102.

Theisen, Ole Magnus, Helge Holtermann, and Halvard Buhaug. 2011. “Climate Wars? Assessing the Claim that Drought Breeds Conflict.” *International Security* 36 (3): 79–106.

Theisen, Ole Magnus. 2008. “Blood and Soil? Resource Scarcity and Internal Armed Conflict Revisited.” *Journal of Peace Research* 45 (6): 801–818.

Tol, Richard S. J. and Sebastian Wagner. 2010. "Climate Change and Violent Conflict in Europe Over the Last Millennium." *Climate Change* 99: 65–79.

Tomz, Michael, Wittenberg, Jason, and King, Gary. 2003. "CLARIFY: Software for Interpreting and Presenting Statistical Results." *Journal of Statistical Software* 8 (1).

Vreeland, James Raymond. 2008. "The Effect of Political Regime on Civil War: Unpacking Anocracy." *Journal of Conflict Resolution* 53 (2): 401–425.

World Bank. 2012. "World Development Indicators." *World Bank.* Accessed July 31, 2012. http://data.worldbank.org.

Zhang, David D., Peter Brecke, Harry F. Lee,Yuan-Qing He, and Jane Zhang. 2007. "Global Climate Change, War, and Population Decline in Recent Human History.*" Proceedings of the National Academy of Sciences* 104 (49): 19214–1921

Chapter 3

Environmental Degradation & Violent Conflict: Different Measures, Diffferent Findings

This past decade has spurred a new wave of research on the social and political consequences of climate change. Although alarmists have cited a variety of possible mechanisms for linking climate change to the onset of violent conflict, and recent studies have begun to better investigate some of these pathways, there lacks a consensus on what effects climate change will have for the onset violent conflict in the future.

One argument propounded by alarmists is that environmental degradation will motivate the onset of violent conflict as the availability of resources deteriorate, which will lead to shortages, grievances, and competition. A second is the 'Diamond Hypothesis', taken from Jared Diamond's (2006) work, *Collapse.* In his book, Diamond uses a series of case studies for arguing that irreversible, environmental degradation destabilizes and contributes to the onset of violent conflict and societal collapse. Despite the popularity of this claim, few have subjected it to rigorous empirical testing. I argue that this has occurred for two reasons, both of which are largely indicative of the major difficulties inherent in this field of research.

The first issue is that there is an underdevelopment of the theoretical mechanisms for tying environmental degradation to the onset of violent conflict. Many of the anecdotal accounts advanced in the media often imply that these effects are systematic. However, the extreme heterogeneity present in the environmental risk profiles of various countries suggests that the conflictual effects of environmental stress will not manifest themselves along the same causal chains as one moves from studying the onset of more organized to less organized forms of violent conflict.

Confounding this theoretical mismatch is the lack of reliable data. Until recently, most empirical testing relied on slow moving and poorly measured environmental indicators, which have had little temporal variation and inconsistent spatial domains. These issues often generated inaccurate conclusions on the veracity of any observed, statistical relationship. I argue that these issues have tended to leave this portion of the research agenda at an impasse.

This dilemma motivates my integrated research design that searches for evidence of the alarmist claims regarding environmental degradation and the famous 'Diamond Hypothesis' by using comprehensive, cross-national time-series datasets on environmental degradation, which can better account for the known changes in both time and space. Using these new indicators of environmental degradation and environmental stress, I examine their effects on the onset of violent conflict and find limited evidence to support such alarmist claims about environmental degradation and mixed evidence to support Diamond's (2006) warning of 'ecocide'.

3.1 Introduction

Among the plethora of concerns inherent in the debate over the social effects of climate change none is perhaps more serious than the need to halt the rate of global environmental degradation. Deforestation, vegetation loss, and soil erosion not only threaten food security by reducing crop yields and soil fertility, they also increase the rate of global warming by amplifying the ‘greenhouse effect’ of global emissions (IPCC 2007; The Economist 2011). It has been estimated that nearly one-third of cropland has been lost due to soil erosions over the past 40 years alone (quoted in Ye and Ranst 2009, 464). In addition to food production, soil erosion is intimately tied to vegetation growth and tree canopy coverage, which have also seen marked declines. Often referred to as ‘the world’s lungs’, the Earth’s forests have been reduced at an alarming rate of 13 million hectares a year, roughly the size of England, in the past decade alone (quoted in The Economist 2010, 1). These changes not only exacerbate the effects of global warming, they are often costly—and may even be irreversible. In the words of Hameed UIllah Jan Afridi, Pakistan’s Minister of the Environment, “our [environmental] degradation costs are increasing year by year, and eventually, time will come when it will be nearly impossible to manage them.” (quoted in Gronewold 2010, 1). Indeed, the extent of deforestation and soil erosion in Haiti, for example, is so extreme that it is, and remains, the poorest country in the Western Hemisphere (Diamond 2006; Ewers 2006; Pearce 1985; World Bank 2012). Far from anecdotal, the economic and social consequences environmental degradation are felt globally from Latin America to South East Asia, from Central Asia to Africa, and even in China (Ewers 2006; Zhang, Yang, and Zepp 2004). As noted in *The Economist* (2012, 2), the total annual cost of environmental degradation equals nearly 9% of China’s GDP.

Although the impacts of the environmental degradation are far reaching, they are perhaps most salient for the poor who are often dependent on agricultural farming for their livelihoods. Thus, when environmental conditions worsen, so do the lives of those who are dependent on them for survival. In the context of rising temperatures and an increasing variability in extreme weather events, this degradation is argued by some scholars to be a significant motivator of political grievances and violent conflict (Hauge and Ellingsen 1998; Homer-Dixon 1999; Stalley 2003). Shortages of food, agricultural failure, loss of property are all consequences of pervasive environmental degradation. In the face of these negative changes, scarcities are expected to become common events where political grievances rise as people are forced into difficult and desperate situations for survival. Under these circumstances, ecoviolence theory argues that the hardships of environmental stress motivate the onset of violent conflict and social chaos with neighbors stealing from neighbors, competing for shared resources, protesting against their governments, and even organizing to overthrow them (Homer-Dixon 1999). Typically, environmental issues are often considered as minor in comparison to the host of other issues a society encounters. Ironically perhaps, that it comes from Tariq Yousafizai, a Pakistani citizen, who states, “I think that, after terrorism, the biggest threat we have is the environmental decay” (quoted in Gronewold 2010, 1).

Despite the attention given by the alarmists, the environmentalists, and the previously noted anecdotal accounts, the relationship between environmental degradation and the onset of violent conflict has garnered little empirical support. These null findings may largely be due to the lack of consistency across research designs and the use of poor data. Until recently, most empirical testing has relied on slow moving and poorly measured environmental indicators, such as extrapolated measures and subjective survey methods, which have had little temporal variation and inconsistent spatial domains. These issues often generated inaccurate conclusions on the veracity of any observed statistical relationship between environmental degradation and the onset of violent conflict.

This study addresses these issues in several ways. First, I resolve the issue of poor data by using a series of time-series cross-sectional environmental datasets that better capture the variation and different dimensions of environmental degradation. Specifically, I apply meteorological data on vegetation loss and soil quality to construct measures that more accurately reflect the dynamics of normal environmental processes and the theoretical expectations of the ecoviolence literature. Second, I employ a temporally disaggregated research design that uses the country-month as the unit of analysis rather than the country-year designs of past studies. This difference makes for more meaningful analyses of the inter-annual variation inherent in these environmental measures, which better reflect the changes in seasons of those associated with abundance and those associated with scarcity. I argue that these seasonal changes are theoretically meaningful and can help explain the lack of statistical evidence shown in past studies. Finally, my research design systematically searches for evidence of a connection to the onset of various forms of violent conflict because the expectations of ecoviolence theory suggest that onsets should vary according to degree of organizational capacity needed to participate—with small-scale violent conflict being the most likely result of the resource competition brought about by environmental degradation (Homer-Dixon 1999; Raleigh and Kniveton 2012).

3.2 Review of the Literature

3.2.1 Theoretical Origins

The theoretical relationship between environmental degradation and the onset of violent conflict has long roots in the social sciences[10], but it is perhaps most often attributed to the work of Homer-Dixon (1999), who argues that environmental changes create scarcities in the supply, demand, and distribution of renewable resources; and that these scarcities subsequently generate significant political and economic grievances that lead to the onset of violent conflict between individuals, communities, and (in rare cases) governments. Case studies and anecdotes show evidence for these claims. From the rural grievances of Filipinos farmers who were displaced by the deforestation policies of the Marcos Regime (Homer-Dixon 1994; 1999), to the scarcity of, and subsequent lack of access to, fresh water by Blacks in Apartheid South Africa (Percival and Homer-Dixon 1999), or the historic environmental collapse of the Anasazi, Mayan, and Easter Island civilizations (Diamond 2006), environmental degradation features as an important variable for explaining the resulting violent conflict observed in these vastly different societies. Systematic empirical evidence for these claims however is largely absent. Support from large–n studies of these relationships is divided, with some studies showing that the overall scarcity of natural resources provides little-to-no explanatory power (Nordas and Gleditsch 2007; Gleditsch 1998; Theisen 2008; de Soysa 2002), and other studies claiming the opposite (Hauge and Ellingsen 1998; Stalley 2003). The major drawback with the existing research on environmental degradation and the onset of

[10] See Chapter 1

violent conflict relates to the choice of and measurement of concepts, types of data used, and flaws in their research designs.

3.2.2 Limitations of Existing Research

Environmental degradation may carry a variety of meanings depending on the context. Although Homer-Dixon (1999) refers specifically to the scarcity of naturally renewable resources (i.e. forests, water, plants, soil, etc.) brought by changes in their availability (demand, supply, and distribution), this concept has been muddled by previous research to include either inaccurate or indirect measures of the same concept. The bulk of these studies can be divided into those that use ‘natural measures’ such as the availability and integrity of aggregate natural resources, and those that use ‘demographic measures’, which speak more to the Malthusian notion of population demand on available resources.

3.2.3 Natural Degradation Measures: Concepts & Data Limitations

Indra de Soysa (2002, 14) uses the absolute value of the estimated economic value of aggregate per capita availability of ‘natural resources’, which include cropland, timber resources, other forests resources, pasture, and subsoil assets from the World Bank (see Kunte et al. 1998, 4). These data are problematic for several reasons. First, they are *estimates* based on the perceived, present, and projected, annualized market values of a specific set of natural resources, which is subjective and inherently variable because markets change over time in unpredictable ways that are often unrelated to environmental conditions. Second, de Soysa's measure excludes any direct estimates of water availability, which strongly influences vegetation growth and its overall scarcity levels. Finally, these data have been criticized in other studies for being notoriously inconsistent and imprecise due to their uneven spatial and temporal domains, changing coding definitions, and interpolation practices for their missingness (see FAO 2001; Rudel and Roper 1997; Rudel et al. 2005; Ewers 2006). Ultimately, changes in estimated per capita market value of natural resources only provide an indirect and inaccurate measure of environmental scarcity. Moreover, changes in market price do not capture 'degradation' as it is understood by Homer-Dixon (1999) because of unaccounted for factors that influence the price of these commodities, but are not related to their supply (tariffs, quotas, inflation, etc.).

Alternatives to using this estimated market value of natural resources strikes slightly closer to the theoretical concept of environmental degradation. The first alternative is the use of FAO estimates of fresh water availability, and the percentage of land forested, which are inconsistent and interpolated across several years of missingness (Matthews 2001). A second alternative is using measures of shared river and water basins, which is problematic because these resources are not country-specific, they tend to be a reductive proxy for environmental degradation (indirectly capturing availability of water only), and they involve other interstate dynamics that are beyond the scope of this study (Brochmann and Gledistch 2012; Gleditch et al. 2006; Nordas and Gleditsch 2007; Hensel, Mitchell, and Sowers II 2006). A third alternative measure is the 'ecological footprint', which is a component index based on a consumption formula that differences the biocapacity of a country's cropland, grazing land, forest areas, fishing ground, built-up land and energy land summed with its overall imports and then differenced from its overall exports (Wackernagel et al. 2005; see also Monfreda, Wackernagel, and Deumling 2004). This measure allows one to calculate the use and overuse of natural resources needed to sustain human activities based on aggregate national data. Although these data are "useful for policymakers who wish to set targets for sustainability policies or test the ecological implications of policy choices" (Wackernagel et al. 2005, 3), these data have noted weaknesses discussed by Fergueson (2002) with regards to their accuracy and their substitutability of inputs, and their use of fossil fuel consumption in the formula's construction (Binngsbo, de Soysa, and Gledistch 2007, 343). Moreover, the use of these problematic data show an inverse relationship with the onset of civil war, which contradicts ecoviolence theory and is suspect given the noted limitations in the measurement of their concept (Binngsbo, de Soysa, and Gledistch 2007).

The more widely cited paper that finds support for a connection between natural measures of environmental degradation and intrastate conflict is by Hauge and Ellingsen (1998). In addition to FAO deforestation data, these scholars use a measure of environmental degradation built from unsystematic and interpolated fresh water per capita data from the World Resources and the World Map of the State of Human Induced Soil Degradation (GLASOD) dataset, which classifies degradation based on water, wind, chemical, and physical degradation in which 'degradation severity' is measured by 'relative extent' (Hauge and Ellingsen 1998, 307). Although widely cited, Theisen (2008) was unable to effectively replicate their results and have criticized Hauge and Ellingsen (1998) for significant issues of listwise deletion in their analyses and the lack of data reliability inherent in the GLASOD database because it overestimates the state of soil degradation throughout Africa (Theisen 2008, 807–809).

A further alternative is employed by Raleigh and Urdal (2007) who use geo-coded grid-years (1990–2004) of soil moisture data from TERRASTAT and expert surveys from the International Soil Reference and Information Center (ISRIC). These ISRIC data are derived from questionnaire responses from a panel of soil experts to globally code human induced soil degradation on 1 (low) to 4 (high) scale. These authors show support for the argument that the onset of violent conflict increases as environmental degradation increases, however the substantive effects are small. Although a step forward, these authors leave out of their analyses measures of vegetation loss and do not adequately control for intervening variables likely to influence environmental degradation.

Meier, Bond, and Bond (2007) measure environmental stress along two additional dimensions. The first is the change in vegetation coverage to capture desertification from the Normalized Difference Vegetation Index (NDVI) from the National Ocean Aeronautic Administration's (NOAA) Advanced Very High Resolution Radiometer (AVHRR) sensor, and a measure of forage availability from the Live Stock Early Warning System (LEWS), which tracks the availability of plants uses for pastoral grazing across the Horn of Africa. Somewhat counter intuitively, these authors find that increases in vegetation coverage are positively associated with an increased risk of organized cattle raids, a finding which they claim shows, "that raiding behavior is strategically planned and tied to opportunities presented by the environment" (Meier, Bond, and Bond 2007). Although this finding is not exactly consistent with the expectations of resource scarcity propounded by Homer-Dixon (1999), the study does suggest that environmental change is a significant factor in determining the onset of violent conflict.

Finally, the most recent study that employs the ‘natural measures’ of environmental degradation is by O’Loughlin et al. (2012a). Similar to Raleigh and Urdal (2007), these scholars also use a geographically disaggregated research design with a grid-month unit of analysis and a variety of different measures of environmental degradation to estimate the risk of conflict in East Africa. Their measures include: ‘percentage grassland’ which inaccurately captures the availability for pastoral grazing and cattle raiding because it is based on linearly interpolated estimates from three years (1990, 2000, 2005); a binary indicator of ‘growing season’ used to capture the effects of drought; a ‘crop production index’, which measures yearly percentage change from year-to-year of the extent of agricultural production and food availability based on FAO production indexes from the World Development Indicators; and a ‘vegetation condition index’ used to measure variations in vegetation coverage using (NDVI) data from NOAA’s AVHRR sensor to capture the monthly change in vegetation coverage as a proxy for food stress and social stress (O’Loughlin et al. 2012b, 3–4).

3.2.4 Demographic Degradation Measures: Concepts & Data Limitations

A second set of measures that are intended to capture the change in resource scarcity brought about by environmental degradation are based on a variety of proxies for demographic pressures. According to this view, increases in population pressure place significant strain on environment factors that are expected to support that population.

This idea is rooted in Malthusian concerns regarding the decline of food availability as populations grow (Malthus 1798). Studies suggest that population growth and urbanization have a negative impact on a country's soil integrity and agricultural yields due to overplanting, salinization, deforestation, and overgrazing (Diamond 2006; Hardin 1968; Wang, Chen, and Dong 2006; Ye and Ranst 2009; Zhang, Yang, and Zepp 2004). The resulting logic implies that demographic factors should indirectly influence the onset of violent conflict *through* their negative impact on the availability of food and stress on renewable resources.

This logic has been operationalized by a variety of measures. The first is 'aggregate population size', which a is intended to capture the idea that larger populations demand more resources to sustain them. Although reasonable, this measure is routinely demonstrated to be associated with an increase in the risk of violent conflict in a variety of different, unrelated studies (Hegre and Sambanis 2006). The use of this aggregated measure is a poor proxy because it may capture a variety of mechanisms that motivate the onset of conflict, but are unrelated to environmental stress including: state capacity, political grievances, inequality, terrorism, etc.

A second demographic measure is 'population growth' measured as the annual percentage change in population size taken from the Penn World Tables or the World Bank's World Development Indicators. A growth-based measure is consistent with the logic that faster rates of growth are associated with a greater demand in resources in accordance with traditional Malthusian theory (Malthus 1798; see Urdal 2005). The major limitation of population growth measures is that they change slowly and remain quite consistent from year-to-year, which necessarily masks variation and leads to null findings. Moreover, studies that use these measures tend not to distinguish between urban and rural growth rates[11] which are important for the construction of various causal mechanisms related to environmental factors; moreover, these studies only show mixed support for a relationship with the onset of violent conflict when they are used (Tir and Diehl 1998; Urdal 2005; 2008).

The annual change in the 'percentage of urbanization' taken from the World Development Indicators is a third measure, which is intended to capture an increasing demand on renewable resources (Klare 2001); however, this measure also changes slowly overtime and it is theoretically unclear exactly this measure captures. 'Population density' and 'population pressure' measures are perhaps the closest proxies for capturing increasing resource scarcity and environmental stress. These measures are also derived from the World Bank and are usually constructed according the number of people per square kilometer of usable land, arable land, or cropland. Although much closer to the notion of environmental stress, Urdal (2005, 421) criticizes them by stating that these measures reveal little information about the relationship between environmental stress and overall availability of natural resources. Moreover, studies have shown mixed support for these population density measures being associated with the onset of violent conflict (Buhaug and Rod 2006; de Sosya 2002; Raleigh and Urdal 2007; Theisen 2008; Urdal 2008), and ultimately these measures are limited by the 'Netherlands fallacy'[12] (see Elrich and Elrich 1990; Urdal 2005). Therefore, with respect to the use of population

[11] Urdal (2008) being the notable exception.

[12] These measures ultimately do not reflect the fact that some countries are both better stewards of their resources *and* have higher population densities. The Netherlands is often the example invoked as the critique.

measures as proxies for environmental degradation, their utility is inaccurate and ultimately limited.

3.2.5 Research Designs: Limitations

Until recently, the majority of studies of on the relationship between environmental degradation and the onset of violent conflict used a country-year or country-decade unit of analysis due to issues of data availability and limitations in statistical computing. The drawback with using these research designs is that they understate the degree of temporal and spatial variability (like growth seasons or desertification) that are inherent in meteorological measures like vegetation coverage, soil change, or precipitation patterns. A consequence of this understatement is that it masks important variation in these measures, forcing them to be extremely slow moving through both space and time. This tendency contributes to the lack of observed support that has been criticized by conflict scholars reviewing the ecoviolence literature (Gleditsch 1998; 2012; Salahyan 2008). In addition to biasing the results toward null findings, this aggregation does not theoretically reflect the variety of expectations in the ecoviolence literature, particularly with regard to conflict strategies, fleeting periods of environmental stress, and sustained ecological collapse.

Recent research has made a strong effort to remedy these drawbacks. The most notable change is the spatial disaggregation to geocoded grids or ‘grid cells’. One criticism of using a country-year unit of analysis for conflict studies is that it does not accurately reflect conflict zones and affected communities (Buhaug and Lujala 2005;

Meier, Bond, and Bond 2007), which may contribute to null findings (Cederman and Gleditsch 2009) and lead to ecological fallacies (Tollefsen, Strand, and Buhaug 2012). Spatial disaggregation through geocoded grids helps address this problem by providing a closer match to the location of a conflict onset and the corresponding local environmental conditions. A drawback of this approach is they can often be a-theoretical because grids are fixed in time and space and they are often insensitive to political boundaries (Tollefsen et al. 2012, 365). More problematic is how one can resolve the absence of locally disaggregated control variables and the transitory nature of seasonal weather and climate patterns, which is the a goal of my research (that is to say that meteorological factors often encompass larger units than grids specifically temperature, precipitation, and forestation patterns, and therefore makes the use of grids imprecise regardless of the locality of the conflict event in study). A further complication is that although some conflict events are more localized than others (civil war vs. social protest), their influence on other events throughout a country may not be, particularly when considering 'onsets' of violent conflict. For these reasons, the spatial unit of this study remains the country; however, I recognize that these alternative approaches are more appropriate under certain circumstances.

A more tractable issue is the problem of temporal aggregation. Meteorological conditions change according to seasons more so than they do on an annual basis. As climate change accelerates, inter-annual changes are expected to become more disrupted (IPCC 2007). These disruptions have important social and political consequences. Indeed, as *The Economist* aptly states "climate change also affects the rhythm of the seasons...all living things depend on the heartbeat of seasonal change" (The Economist

2011, 5). Past studies have almost uniformly relied on annually aggregated or per decade measures, interpolating data when they are missing[13]. These approaches are severely problematic because they do not capture seasonal variation and essentially force the meteorological conditions for January and July (or perhaps more alarming the period 1979 –1989) to be equivalent figures. When considering food availability and the seasonal cycles of planting and harvest this level of aggregation failures to capture these dynamics. Given the economic and social importance that is often attached to seasonal cycles for the rural poor, disaggregation from decades and years, to months is a worthwhile and theoretically attractive endeavor, particularly when anecdotal accounts support the argument that seasonality is so important. This study makes use of existing meteorological data to do just that.

Among the existing studies that use temporally disaggregated environmental degradation, O'Loughlin et al. (2012a) and Meier, Bond, and Bond (2007) are the closet matches to my study, however there are notable differences. The first difference is the spatial domain and unit of analysis. O'Loughlin et al. (2012a) use a grid-month unit of analysis, which allows them to capture monthly meteorological changes across 100 km grids from 1990–2010 in East Africa; and Meier, Bond, and Bond (2007) use administrative district-months as their unit of analysis from the period 2003–2006 in the Karamoja Cluster[14]. Finally, my study uses a country-month unit of analysis, which allows me identify and explain important differences in the findings in that emerge from over-aggregating meteorological changes throughout various countries across the world

[13] See a more detailed discussion Section 3.2
[14] Ethiopia, Kenya, and Uganda

from 1980–2006. The second major difference is that my study searches for variation across a variety of conflict datasets because existing research suggests that the onset of conflict resulting from environmental changes is more likely at less organized forms of violent conflict. Thus, I test for these effects using global intrastate and non-state conflict datasets in addition to regional datasets of violent social protests and spontaneous violent events.

3.3 Theory Refinement & Delineation of Causal Mechanisms

The limitations of existing research between environmental degradation and the onset of violent conflict are perhaps only overmatched by the variation in the theoretical expectations of these relationships. A shortcoming of existing research is the lack of consistency in the statistical findings (Gleditsch 1998; 2012; Salehyan 2008), which is largely due to ambiguously defined theoretical expectations. Simply by the nature of the problem, environmental degradation, this literature speaks to a variety of academic disciplines. As a result, different theoretical expectations exist depending on how one analyzes this issue. Given the focus of this study on the role environmental changes for the onset of violent conflict, the literature is suggestive of three different mechanisms focusing on: the strategic conditions for conflict, the unpredictability of environmental scarcities for social stability, and the cumulative net burden of environmental degradation countries may experience.

3.3.1 Mechanisms 1: Seasonality & Strategic Viability

It is often remarked that the environmental degradation is the harbinger of conflict because it exacerbates resource competition. However, there are notable exceptions to this thinking, particularly with respect to military strategy. Indeed, increased vegetation coverage may actually promote conflict rather than reduce it because of its complementary ability to facilitate guerilla warfare and troop movements. As Peluso and Vandergeest (2011, 588–589) note, "forests provide excellent cover for guerrilla warfare; thus their continued existence or their cutting, burning, conversion, or appropriation and control by state authorities has security implications." Perhaps one of the most shocking anecdotes in support of this argument comes from the US counterinsurgency efforts in Vietnam, which during a ten-year period, were estimated to have used over 20 million gallons of Agent Orange defoliant on Vietnam's jungle-like vegetation in an effort to reduce vegetation coverage and expose the movements of North Vietnamese troops (quoted in Chicago Tribune Watchdog Report 2009). Meier, Bond, and Bond (2007), find support for this mechanism even in studying the onset of less organized forms of conflict, showing that episodes of increased African pastoral conflict are tied to increased vegetation coverage because it facilitates cattle theft and reduces the risk of being seen and (subsequently) caught. With respect to seasonality and growing seasons, this argument suggests that conflict may wax and wane in response to seasonal changes in growth patterns of vegetation and forests.

One of the most important determinants of vegetation growth is the quality of the soil where the vegetation has the opportunity to grow. Vegetation growth and soil quality form a symbiotic relationship in which each factor is dependent on the other. Studies show that deforestation has a negative impact on soil aridity and (subsequently) erosion (Stocking 2004; Tejedor et al. 2004; Zhang, Yang, and Zepp 2004). As one factor worsens, so do the others. This relationship is particularly acute in tropical regions, where Stocking (2004, 1357) notes that, "once vegetation is removed, they [soils] degrade quickly and irreversibly…" Cognizant of the importance of strategy and tactics in war (and theft), we should expect that seasonality, vegetation growth, and soil quality all to have a significant impact on the outbreak of violent conflict. Given that military success is often tied to strategies made viable by favorable environmental conditions, this suggests the following set of hypotheses:

> Hypothesis 1(a): The probability of civil war onset increases as monthly vegetation coverage and soil quality increase.

> Hypothesis 1(b): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as monthly vegetation coverage and soil quality increase.

3.3.2 Mechanism 2: Scarcity Shocks & Equilibrium Disruption

A more often discussed mechanism by which environmental degradation is argued to generate conflict is through a change in the availability of resources brought about by disruptions in the ability to produce food. Shortages of natural resources increase food scarcity and subsequently increase the competition between actors trying to survive. However, in order for these shortages to create the most likely conditions for the outbreak of violent conflict, one must distinguish between predictable, seasonal changes in the availability of resources needed to produce food and those unpredictable changes, which create severe disruptions in its availability. Predictable growing and harvest seasons are something that farmers and rural societies know well, and subtle changes are unlikely to create grievances to the degree that motivates people to take desperate, violent actions. However, dramatic and unpredictable disruptions brought about by unusual changes in established environmental conditions can generate feels of deprivation, frustration, and anger when the natural cycles of growth and decay are altered to such extremes that they destroy livelihoods (see Hendrix and Salehyan 2012). Indeed, *The Economist* (2011) reports that biggest concern born out of a recent Oxfam survey of farmers was the disruptions to this aforementioned natural cycle. As one Bangladeshi farmer stated, "I know what I am supposed to sow by a certain time or date… that is what my forefathers have been doing. But then for several years the temperature and weather just does not seem right for what we have been doing traditionally. I do not know how to cope with these problems" (quoted in The Economist 2011, 6). What makes this environmental degradation and disruption such salient a 'shock' is its substitution problem. Renewable resources like soil or water are not easily replaced. As Ellis (2000, 42) notes, "[the] low potential for substitution makes livelihoods more vulnerable, especially to shocks, since a sudden change in a single asset or activity cannot be compensated by redeployment or switches between them."

In the context of establishing a causal pathway to conflict, this is a major problem because the lack of substitution exacerbates losses and gains, while reducing the set of alternatives available for mitigating their negative consequences. Substantial decline in agricultural conditions have been shown to motivate temporary migration in Kenya and the exacerbation of a poverty trap in Uganda (Gray 2011). These effects can increase the onset of violent conflict in countries because of an increase in the competition for resources between migrants and host communities (see Martin 2005; Salehyan and Gleditsch 2006). Moreover, when environmental degradation contributes to a poverty trap, it facilitates the conditions for rebel recruitment because the poor have a lower opportunity cost to participate in rebellion and have an common organizing grievance (see Homer-Dixon 1999); while governments (subsequently) have less extractive capacity for addressing this grievance or engaging in repression (Collier and Hoeffler 1998; 2004; Fearon and Laitin 2003, Humphreys and Weinstein 2008). This logic motivates a second set of hypotheses:

> Hypothesis 2(a): The probability of civil war onset increases as monthly vegetation growth and soil quality negatively deviate from their long-term monthly means.

> Hypothesis 2(b): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as vegetation growth and soil quality negatively deviate from their long-term monthly means.

3.3.3 Mechanism 3: "Committing Ecocide"

A third possible mechanism by which environmental degradation may generate violent conflict is by committing 'ecocide'. Ecocide is the inadvertent destruction of the environmental resources on which a society depends (Diamond 2006, 6). Past ecoviolence studies have tended to consider either a single, or small subset of, demographic and environmental factors for their connection to the onset of violent conflict. A perhaps more plausible alternative is to consider the cumulative effect of all these relevant factors, where their sum total creates an unsustainable environmental burden that may lead to the collapse of a society. This sentiment is perhaps best captured in Jared Diamond's Book, *Collapse* (2006, 516):

> "Today, just as in the past, countries that are environmentally stressed, overpopulated, or both, become at risk of getting politically stressed and of their governments collapsing. When people are desperate, undernourished, and without hope, they blame their governments, which they see as responsible for or unable to solve their problems. They try to emigrate at any cost. They fight each other over land. They kill each other. They start civil wars. They figure that they have nothing to lose, so they become terrorists, or they support or tolerate terrorism."

Of all the countries that have suffered due to environmental degradation, none is perhaps a more serious or a more fitting example ecocide than Haiti. Haiti suffers a plethora of environmental conditions that are all intimately related. Haiti is a net importer of food largely because it is unable to grow crops due to severe soil erosion that results from its lack of forests. Less than 2% of Haiti is forested and this problem continues to worsen because Haiti is densely populated, with its main source for fuel being charcoal that is derived from the logging of its own forests (quoted in Gronewold 2009). These factors undermine Haiti's ability for long-term economic growth by perpetuating a poverty trap throughout Haiti, which serves to foster a vicious cycle of environmental destruction. Today Haiti stands as 7th on the Failed States Index (Fund for Peace 2012) with crime and instability a persistent issuing plaguing its government. Aside from widespread social misery, research shows that states with weak institutions and rampant poverty—conditions that can stem from ecocide—to be associated with an increase in transnational terrorism, civil war, and interstate disputes (Carter 2011; Piazza 2008; Rothberg 2004). Thus, when environmental conditions worsen to the point where they are persistently undermining the institutions of society then the onset of violent conflict and social instability may indeed be the result. This logic motivates a final set of hypotheses:

Hypothesis 3(a): The probability of civil war onset increases as monthly environmental stress worsens

Hypothesis 3(b): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as monthly environmental stress worsens.

3.4 Research Design & Data

3.4.1 Dependent Variables for all Models

All my estimations of intrastate conflict use the Armed Conflict Database (ACD) (Gleditsch et al. 2002; Harbom and Wallensteen 2010). This provides a binary variable indicating the monthly onset of an internal or internationalized intrastate conflict, which results in 25 or more annual battle deaths. Because I am interested in the onset of civil war, I use the standard convention in the literature of assigning a value of one to indicate when a new onset emerges, when a conflict reemerges after two years of peace, or when a new rebel party becomes a new combatant in an ongoing war to which it was not a party in the previous year. For a more stringent test of this relationship, I also include separate models that estimate the effects of environmental degradation and stress on the onset of civil war using the 1,000 or more battle death threshold.

Raleigh and Kniveton (2012) argue that small-scale violence may be more likely a product of the enhanced effects of resource competition and individual frustration brought about by climate change. In order to allay these concerns, I also use the count of less-organized, non-state conflict events with the greatest degree of focus, by using the Uppsala Conflict Data Programs (UDCP)'s Non-State Conflict Dataset Version 2.4 (Sundberg, Eck, and Kreutz 2012). Non-state conflicts are defined as 'the use of armed formed between two organized armed groups, neither of which is a government of a state, which results in at least 25 battle related deaths in a year' (Sundberg, Eck, and Kreutz 2012, 352–353). Finally, I also analyze more spontaneous forms of violent conflict by using two regional databases. The first measure comes from the Social Conflict in Africa Database (SCAD), which provides information on protests, riots, and other social disturbances in Africa (Salehyan et al. 2012). Here, I use the count of violent social protest events—specifically organized violent riots, spontaneous violent riots, pro-government violence, anti-government violence, extra-government violence, and intra-government violence in a given month (see Salehyan et al. 2012). The second regional database I use is the Integrated Conflict Early Warning System (ICEWS) Asia dataset, which collects data on a variety of political instability indicators including violent conflict events (O'Brien 2010). Here, I use the count of assaults, fights, and unconventional mass violence in a given month.

Regional datasets like these are preferable for this study because the negative effects of climate change are argued to be felt disproportionately in less-developed countries that are characterized with comparatively lower than average GDP per capita and those that have agricultural-dependent economies (Mendelsohn, Dinar, and Williams 2006). Countries with these characteristics are located primarily within the African and Asians continents. Therefore, if we are to expect the onset of violent conflict from deteriorating environmental conditions tied to agricultural production, subsidence living, and economic income—particularly at lower levels of organization that ecoviolence theory implies—it is reasonable to assume that this area of the world be where we should observe it.

In comparison to my estimations of intrastate conflict, the UCDP non-state conflict events, SCAD social protests, and ICEWS violent events are far more frequent, and they are often correlated across time as one event makes another more likely to occur. This tendency makes it is more difficult to discern their independence from one another for the purposes of coding unique and independent onsets. Therefore, the dependent variables for these models use the 'counts' of each in a given country-month.

3.4.2 Independent Variables for Hypotheses 1 & 2

Data for my measures of deforestation comes from the Global Inventory Modeling and Mapping Studies (GIMMS) Advanced Very High Resolution Radiometer (AVHRR) 8km Normalized Vegetation Index (NDVI) bimonthly dataset 1981–2006 (Pinzon, Brown, and Tucker 2005; Tucker, Pinzon, and Brown 2004; Tucker et al. 2005). NDVI is defined as the difference in reflectance between the AVHRR near-infrared and visible bands divided by the sum of the two bands (Tucker, Pinzon, and Brown 2004, 2). According to Tucker, Pinzon, and Brown (2004) it is calculated as follows:

$$NVDI= NIR-VIS/NIR+VIS$$

Essentially, NDVI is a measure of vegetation reflectivity, with more reflectivity indicating a higher degree of vegetation coverage. As Pinzon, Brown, and Tucker (2005, 168) note: “this ratio yields a measure of photosynthetic capacity such that the higher the value of the ratio, the more photosynthetically active the cover type. Thus, the NDVI product produces the longest existing record of spatial coverage needed for monitoring global vegetation dynamics.” NDVI data are sometimes criticized due to intervening metrological issues and instrument issues. These data mitigate this problem because they have been corrected for a variety of measurement issues including: missing data, cloud cover, signal to noise errors, and sensor degradation. These data have an 8 km Albers Equal Area Conic projection (for further discussion, see Tucker, Pinzon, and Brown 2004), which are aggregated into a country-month unit of analysis.

Intimately tied to vegetation change is soil quality, which is largely influenced by its state of erosion. One of the most important determinants of vegetation growth is quality of the soil where the vegetation has the opportunity to grow. Vegetation growth and soil quality form a symbiotic relationship in which is each factor is dependent on the other. Studies show that deforestation has a negative impact on soil aridity and (subsequently) erosion (Stocking 2004; Tejedor et al. 2004; Zhang, Yang, and Zepp 2004). Because this study is interested in environmental degradation, an accurate measure of soil erosion constitutes the missing piece of this puzzle. Weinan et al. (1996, 391) plainly state that, "soil moisture is one of the most important factors influencing the credibility of soil." To address these concerns, data for my measures of soil degradation are taken from the NOAA's Climate Prediction Center (GPC) Global Monthly Soil Moisture dataset 1948–2011[15] (Huang, van den Dool, and Georgakakos 1996; Fan and van den Dool 2004; van den Dool, Huang, and Fan 2003). These data have a .5 x.5 degree spatial resolution and are aggregated into country-month units of analysis.

Overall, the use of these data for measures of deforestation and soil degradation are preferable than most other measures (e.g. FAOSTAT and GLASOD) because they are inherently more objective, more reliable, and have a more consistent monthly time-series (global coverage). In addition, these data are preferable because they reflect the concepts discussed in this study.[16] NDVI captures seasonal changes in low-level vegetation *and* tree canopy coverage, thus providing a more robust measure of deforestation. Together, NDVI and soil moisture provide an accurate and robust reflection of the seasonal, natural degradation measures required for majority of hypothesis testing in this study.

---

[15] CPC Soil Moisture data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their website at http://www.esrl.noaa.gov/psd/

[16] See Section 3.23: Natural Degradation Measures: Concepts & Data Limitations

With regard to the construction of the independent variables, for Hypothesis 1(a) and 1(b) *Vegetation Change* is simply the monthly change in NDVI of a given country and *Soil Quality* is simply the monthly change in the GPC soil moisture value of a given country. *Vegetation Shock* and *Soil Quality Shock* are defined as the monthly mean NDVI and soil moisture value for country (i) in month (t) in year (z) in which a 'shock' is measured as the monthly deviation from a country's long-term monthly mean, indicated by $(X_{itz}-X_{it-bar})/\sigma_{it}$ where X_{itz} is the mean value of the given degradation indicator of country (i) in month (t) in year (z) and X_{it-bar} is the panel mean of country's (i) long-term monthly (t-bar) mean NDVI value 1980–2006, and soil moisture value 1948–2006, and σ_{it} is the standard deviation of that given panel. This approach is akin to Hendrix and Salehyans' (2012) measure of rainfall deviation who argue that the deviations from the mean are an optimal operationalization of the 'eco shock' mechanism. A deviation measure like this is preferable compared to other measures of variability because its construction acknowledges that climate is different than weather, speaking to extended periods of time rather than changes from month-to-month. Moreover, this measure is standardized, allowing for meaningful comparisons of deviational differences between countries. Because of the inconsistency in existing studies of whether scarcity shocks are more likely associated with the onset of conflict periods that are unseasonably fertile or unseasonably sparse, I include a squared measure of *Vegetation Shock* and *Soil Quality Shock* to test the magnitude of this change relative to zero (see Meier, Bond, and Bond 2007; Nordas and Gledistch 2007).

Finally, for testing Hypotheses 3(a) and 3(b), I construct measures of 'environmental collapse' akin to Diamond's (2006) theory via a series of proxies for different aspects of what Diamond argues contributes to ecocide. Ultimately, environmental collapse is a difficult concept to measure and there is strong reason to believe that a variety of factors influence this process. For these reasons, I rely on the use of principal component factoring of a series of environmental and a demographic measure, which Diamond (2006) argues as important for the ecological health of a country. These measures include: temperature, precipitation, soil aridity, vegetation coverage, caloric intake, population density, and population growth.

3.4.3 Standard Controls & Estimators for all Hypotheses

In order to differentiate the effect of the independent variables from other possible influential factors, I include a number of relevant control variables highlighted in the existing conflict literature that are influential when testing the onset of violent conflict. Unfortunately, the onset of civil wars are not known with precision in Uppsala datasets, and because the focus of this analysis seeks to explain the importance of seasonality and environmental degradation, I include a binary variable indicating the first month of the year in all intrastate and non-state conflict models to address the uncertainty in this coding practice.[17] Because changes in soil aridity and plant growth are related to temperature and precipitation changes, I include controls for monthly levels of *Precipitation* using monthly precipitation data from the Global Precipitation Climatology Project Version 2.2[18] and monthly *Temperature* from the NCEP/NCAR Reanalysis

[17] When the exact month is unknown, Uppsala uses the 1st of January as its default date.
[18] GPCP Precipitation data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their website at http://www.esrl.noaa.gov/psd/

Monthly Means Dataset covering the years 1948–2011 (Kalnay et al. 1996)[19]. Temperature data provide surface or near surface air temperatures (.995 sigma level) with spatial coverage of a 2.5 by 2.5 degree longitude native resolution (144 x 72) and precipitation data have a spatial coverage of 2.5 x 2.5 degree with a longitude resolution (144 x 72) from 1979–2011 (Adler et al. 2003). Using these data accomplishes two goals. First, it helps distinguish the difference between theoretical dimensions related to environmental degradation and those related to precipitation and temperature. Second, it allows for as a more direct comparison between recent studies that are starting to use shared datasets.

Lastly, I also control for El Niño/Southern Oscillation (ENSO) years, which have been demonstrated to be associated with an increased risk of civil war (Hsiang, Meng, and Cane 2011). ENSO is a cyclical phenomenon of natural climate variability that is responsible for contributing to warmer climates during years when it is active. However, the focus of this study is intended to address the influence environmental degradation and the associated inter-annual seasonality—not necessarily the natural variability of preexisting climate conditions. Time may reveal that the effects ENSO are exacerbated due to the effects of climate change, but the validity of this relationship is largely speculative and actively debated (see Collins et al. 2010; Philip and Van Oldenborgh 2006). In order to separate out this effect from my degradation measures, I include a binary variable indicating years influenced by the El Niño /Southern Oscillation in

[19] NCEP Reanalysis Derived data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their website at http://www.esrl.noaa.gov/psd/

accordance with the Center for Ocean-Atmospheric Prediction Studies ENSO index (2012).

Finally, I include a number of common controls identified in the conflict literature that are often associated with the onset of violent conflict. First is regime type, taken from the Polity IV dataset and covering the period 1946–2011 (Marshall and Jaggers 2010). Scholars have found that democratic institutions mitigate the effects of political disagreements, making violent conflict less likely (Hegre and Sambanis 2006). Some scholars have found evidence of an inverted quadratic relationship between regime type and conflict (Fearon and Laitin 2003; Hegre et al. 2001). These authors contend these regimes, named ‘anocracies’ which find themselves in the middle of Polity IV’s 21-point measure of regime type that ranges from -10 to 10, are characterized by a mix of democratic and authoritarian institutions that make them most at risk for the onset of conflict, relative to their democratic and authoritarian cousins. Although theoretically plausible, Vreeland (2008) has demonstrated this coding measure to be tautological due to the inclusion of political violence in the construction of Polity IV’s regime coding. Therefore, instead of using this contaminated measure, I follow Vreeland’s (2008) recommendation of deconstructing the Polity IV index into its component parts, when estimating the impact of regime type on the onset of violent conflict. The resulting measure of regime type is *Xpolity*, which is a summation of three ordinal measures: constraints on the chief executive (*Xconst*), competitiveness of executive recruitment (*Xrcomp*), and the openness of that recruitment (*Xropen*). This variable ranges from values of 1 to 14, with 14 being most democratic.

Larger, poorer countries are more likely to experience the onset of violent conflict (Collier Hoeffler 2004; Fearon and Laitin 2003; Hegre and Sambanis 2006). Hence, I control for *Population* size and *GDP per Capita* using data from Gleditsch's (2002) version 5.0 expanded GDP data, supplemented with data from Penn World Tables 7.0 (Heston, Summers, and Aten 2011) and the World Bank (2012) to extend the time-series through 2010. These measures are also logged to reduce skewness because some countries are much wealthier and larger than others.

In order to address issues of simultaneity between these controls and the onset of conflict, *Xpolity*, *GDP per Capita*, and *Population* variables are lagged by one year (12 months). Lastly, I also control for temporal dependence for all conflict measures using Carter and Signorinos' (2010) recommendation of the linear, quadratic, and cubic counts of time. One last item of note is that the measurement of the majority of these controls variables are aggregated at the country-year unit of analysis, and are therefore most appropriate for a country-year research design. Ideally, I would use monthly measures for these all controls, but unfortunately some monthly measures do not exist. As a result, I use the same yearly value for each month of the given year when necessary, but recognize that the inclusion of these controls, though not ideal, is neither taboo, nor theoretically inappropriate since we can believe that their effects are important.[20]

All estimations are estimated in STATA 12. Models of the onset of intrastate conflict use logistic regression, which include robust standard errors clustered on country. Additionally, I also estimate models with conditional fixed effects to correct for the

[20]For further discussion, see Raleigh and Kniveton (2012)

exclusion of potentially influential country-level attributes that may be correlated with both environmental degradation and the onset of violent conflict. The estimations of non-state conflict and social protest use negative binomial regression to account for over-dispersion in the count structure of the dependent variable. These models also use robust standard errors clustered on country as well as with conditional fixed effects. The substantive effects of the results are generated using the CLARIFY software from the resulting estimations (King, Tomz, and Wittenburg 2000; Tomz, Wittenberg, and King 2003). Finally, models that use conditional fixed effects are denoted with an even number (i.e. 2, 4, 6…).

3.4.4 Evaluating Diamond's 'Ecocide': An Issue of Multidimensionality.

According to Diamond (2006), past civilizations that have undergone an environmental and social collapse were preceded by a plethora of environmental challenges that ultimately contributed to their demise. He asserts that:

> "The process by which past societies have undermined themselves fall into eight categories, whose relative importance differs from case to case: deforestation and habitat destruction, soil problems (erosion, salinization, and soil fertility losses), water management problems, overhunting, overfishing, effects of introduced species on native species, human population growth, and increased per capita impact of people" (Diamond 2006, 6).

Considered together, these factors exhibit a degree of commonality all related to the underlying, latent concept of environmental collapse or 'ecocide'. Although Diamond (2006) notes that each of these categories may differ in their relative importance, it is possible to estimate their influence on the onset of violent conflict to the extent that these eight categories are related to each other and the theoretical notion of ecocide through the use of factor analysis, because of its ability to reveal patterns of interrelationships among variables (Agresti and Finlay 2009, 532). Considering that the majority of Diamond's (2006) cases are based on past collapses of historical societies, I am forced to use several proxies in order to operationalize his eight categories.[21] These are listed in Table 3-1 below:

Table 3-1: Diamond's (2006) Ecocide Categories & Proximate Measures

Diamond's (2006) Eight Ecocide Categories	Proximate Measures
Deforestation & Habitat Destruction	*Vegetation Change* (Pinzon, Brown, and Tucker 2005; Tucker, Pinzon, and Brown 2004; Tucker et al. 2005
Soil Problems (erosion, salinization, and soil fertility)	*Soil Quality* (Huang, van den Dool, and Georgakakos 1996; Fan and van den Dool 2004; van den Dool, Huang, and Fan 2003)
Water Management Problems	*Precipitation* Kalnay et al. (1996) *Temperature* Adler et al. (2003)
Overhunting	*Averaged Daily Caloric Intake* (FAOSTAT 2013)
Over fishing	*Averaged Daily Caloric Intake* (FAOSTAT 2013)
Effects of introduced species on native species	*Averaged Daily Caloric Intake* (FAOSTAT 2013)
Human Population Growth	*Population Growth* Gledistch (2002), Heston Summers & Aten (2011), World Bank (2012)
Increased Per Capita Impact of People	*Arable land (hectares per person)* World Bank (2012)

As illustrated in Table 3-1, the measures for each category are imperfect. *Vegetation Change* and *Soil Quality* are used as measures of Deforestation and Soil Problems (see Section

[21] Diamond's (2006) categories for overhunting, overfishing, and effects of introduced species are largely inappropriate or irrelevant for the present time. A close reading of his work implies that these measures are largely related to the issue of food consumption and availability. Therefore, I use *Averaged Daily Caloric Intake* as an approximation of these three categories.

3.4.2) and Human Population Growth is simply the logged percentage change in *Population Growth* from the previous country-year according to the *Population* measure discussed in Section 3.4.3. Water Managements problems is proxied by monthly *Precipitation and Temperature* (see Section 3.4.3). I proxy Increased Per Capita Impact of People as the degree of demographic pressure (see Section 3.2.3) according to the availability of *Arable Land* measured in hectares per person per country-year according to the World Bank (2012). Finally, for the Overhunting, Overfishing, and Effects of Introduced Species on Native Species categories, I use the yearly *Average Daily Caloric Intake* based on Crops Primary Equivalent of a country's Food Supply from the United Nation's Food and Agriculture Organization Database (2013). As mentioned previously, it is unclear to what degree each of these categories are related to each other and the underlying concept of Diamond's (2006) 'ecocide' hypothesis. Because of this ambiguity, this tool of statistical analysis is useful for measuring how various measures reflect variance within an underlying concept (Hendrix 2010, 280). Therefore, I use principal component factoring on these six proxy measures as an exploratory exercise to measure the degree that: (1) these measures relate to one another or some general dimension; (2) comprise different categories as Diamond (2006) contends. The results of this analysis are presented in the

Table 3-2, Table 3-3, and Table 3-4 below:

Table 3-2: Principal Component Factor Eigenvalues Results

Factor	Eigenvalue	Difference	Proportion	Cumulative
1	1.74765	0.22252	0.2497	0.2497
2	1.52513	0.42724	0.2179	0.4675
3	1.09789	0.23787	0.1568	0.6244
4	0.86002	0.07744	0.1229	0.7472
5	0.78258	0.19814	0.1118	0.8590
6	0.58444	0.18213	0.0835	0.9425
7	0.40230	.	0.0575	1.0000

Table 3-3: Principal Component Factors (Unrotated)

Variable	Factor 1	Factor 2	Factor 3	Uniqueness
Vegetation Change	0.1020	0.2991	0.7373	0.3565
Soil Change	0.4672	0.7493	0.0199	0.2199
Temperature	0.6260	-0.4804	-0.0562	0.3742
Precipitation	0.6647	0.5036	-0.0244	0.3040
Caloric Intake	-0.6154	0.4440	-0.2068	0.3814
Population Growth	0.3272	-0.4389	0.3536	0.5752
Arable Land (hectares per person)	-0.4467	-0.0051	0.6183	0.4182

Table 3-2 and Table 3-3 reveal the presence of three factors based on their eigenvalues being greater than a cutoff value of 1. Evaluation of the Scree Graph in Figure 3-1 further supports the need for no more than three factors needed to reduce the dimensionality of ecocide by showing only three factors above the y=0 threshold. All together, these factors explain a little more than two-thirds of the variation of the combined variance of seven variables used to proxy Diamond's (2006) concept of 'ecocide', which suggests that environmental conditions alone cannot adequately explain the underlying concept. However, they do comprise a majority of the combined variance and therefore remain an important contributor to this fundamental idea. These factors are rotated using promax rotation with a power of 3 in order to allow for collinearity between each factor.

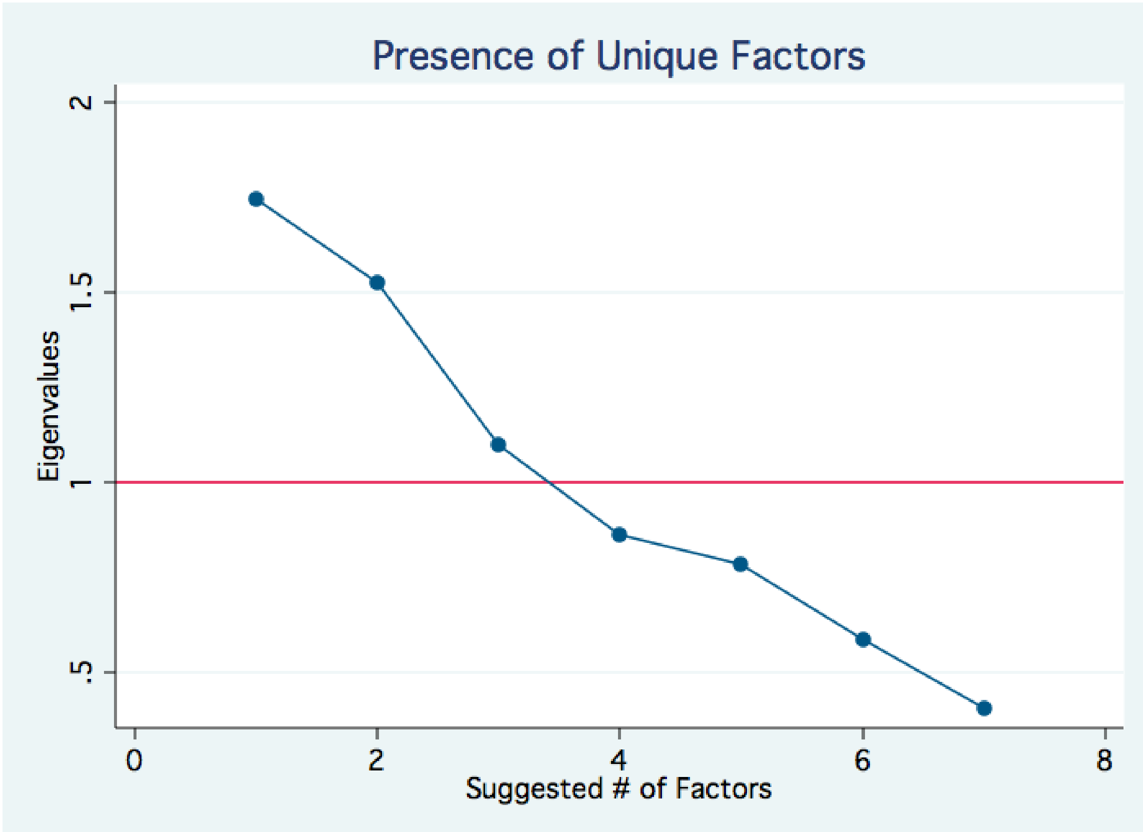


Figure 3-1: Scree Graph of Unique Ecocide Factors

As displayed in Table 3-4**,** the rotation reveals the seven proxy variables are spread across three factors, with their heaviest loading indicated in red. Three variables—*Temperature*, *Caloric Intake*, and *Population Growth*—load most heavily on Factor 1, which seems to capture a 'Habitation/Sustainability' dimension of environmental conditions because warmer human habitation requires a certain degree of warmth in order to allow for reproduction and food consumption. *Soil Quality* and *Precipitation* load most heavily on Factor 2 and seem to comprise a 'Desertification' dimension due to their relation to the presence or lack thereof water. Finally, *Vegetation Change* and *Arable Land* load most heavily on Factor 3 and suggesting an environmental 'Fertility' dimension in which increasing vegetation and availability of arable land imply the presence of agricultural productivity.

Table 3-4: Principal Component Factors (Promax Rotation)

Variables	Factor 1 'Habitation/Sustainability'	Factor 2 'Desertification'	Factor 3 'Fertility'	Uniqueness
Vegetation Change	0.0703	0.2967	0.7647	0.3565
Soil Change	-0.1521	0.8840	0.0985	0.2199
Temperature	0.7483	0.0011	-0.2143	0.3742
Precipitation	0.1387	0.8094	-0.0120	0.3040
Caloric Intake	-0.7859	-0.0220	-0.0514	0.3814
Population Growth	0.6149	-0.1515	0.2301	0.5752
Arable Land (hectares per person)	-0.1539	-0.2817	0.6580	0.4182

Overall, the results of the factor analysis reveal a theoretical consistency between variables and their dimensionality; however, the results do not suggest that concept of ecocide (to the extent to which these proxies capture Diamond's (2006) idea) is comprised of eight unique dimensions.

In order to test the veracity of the ecocide hypotheses, I generate scores of these three factors by "standardizing each variable to zero mean and unit variance, and then weighting with factor score coefficients and summing for each factor" (Hamilton 2006, 323). Once scored, these factors can then be interpreted as any other variable of interested, with their measure being in units of standard deviation from their means (Hamilton 2006, 324–325). Therefore, I use these three factor dimensions as independent variables for testing their relationship with the onset of violent conflict. These results are displayed in the 3.5 Results & Discussion section in Table 3-6.

3.5 Results & Discussion

Table 3-5 displays the results of testing Hypothesis 1 and 2. Surprisingly, the results reveal no support for Hypotheses 1(a) or 2(a), which argue that vegetation change and soil quality are associated with an increased risk of civil war onset. The relationships between these measures and the onset of less organized forms of violent conflict are less consistent. In Models 5 and 6, there is no statistically significant relationship between measures of environmental degradation and an increased risk of non-state conflict events. Model 8 provides mixed support for Hypothesis 1(b) and 2(b), showing contradictory evidence depending on the measure used in the analysis, with increasing levels of monthly vegetation being negatively associated with violent social protests in Africa and positive vegetation shocks showing a positive association. Support for these hypotheses is further attenuated when examining Models 9 and 10. Only in Model 10 do the results show any statistical relationship, and these results are in the opposite hypothesized direction—only being relevant when using the measure of *Vegetation Shock*^{2}. Finally, there is little evidence of any relationship between changing monthly soil quality or soil shock and an increased risk of less organized forms of violent conflict. Model 8 shows a positive and statistically significant relationship between *Soil Shock*^{2} and an increase in the count of violent African protests. Overall, these results do not convincingly support Hypothesis 1(b) or 2(b). Furthermore, the results are only statistically significant in the fixed effects models, which tend to have penalizing statistical assumptions (see Greene 2011).

The control variables also show mixed, but overall more consistent, results with *Population* size being associated in an increase in the risk of most forms of violent conflict and increasing *GDP per Capita* being associated in decrease in the risk of civil war onset, but an increase in the onset of violent social protest. The influence of El Niño is largely insignificant despite some evidence of a relationship in other studies (see Hsiang, Meng, and Cane 2011). *Temperature* shows inconsistent statistical results, while increasingly monthly levels of *Precipitation* are generally associated with a reduction in the onset of violent conflict. The control for regime type, *Xpolity*, is insignificant and the results of the *January* control variable reflects the coding practices for civil war onset discussed previously.

Table 3-5: Country-Month Estimation Results

Country-Month Table 3-5	**(1) ACD (25+ Dead) 1981–2006**	**(2) ACD (25+ Dead) 1981–2006**	**(3) ACD (1000+Dead) 1981–2006**	**(4) ACD (1000+Dead) 1981–2006**	**(5) UCDP 1989–2006**	**(6) UCDP 1989–2006**	**(7) SCAD 1990–2006**	**(8) SCAD 1990–2006**	**(9) ICEWS 2000–2006**	**(10) ICEWS 2000–2006**
Negative Binomial DV (lag)	---	---	---	---	.0547212	-.1432605	.1064223**	.0690792**	.0339253**	.0094963**
					(.3115011)	(.2579654)	(.0377432)	(.0162512)	(.0044017)	(.0005203)
Vegetation Change	.00246	.0213723	.0024465	.02537	.0003309	.0088921	-.0096913	-.0185366**	-.0007307	.0032404
	(.004018)	(.0137183)	(.0051343)	(.0232423)	(.0113213)	(.0199449)	(.0076843)	(.0068261)	(.0046488)	(.0034728)
Vegetation Shock	-.0022434	-.0174625	-.0026787	-.0237596	-.0010064	-.0117647	.0102493	.0190068**	-.0008355	-.0024101
	(.0042895)	(.0134476)	(.0055361)	(.0231303)	(.0120591)	(.0205527)	(.0079246)	(.0069958)	(.005442)	(.0037211)
Vegetation Shock^2	9.60e-08	-8.99e-07	2.10e-08	1.13e-06	-9.47e-07	2.49e-06	4.00e-07	2.93e-07	2.20e-06	-2.13e-06**
	(8.99e-08)	(1.23e-06)	(8.27e-08)	(2.45e-06)	(1.36e-06)	(2.34e-06)	(6.10e-07)	(7.08e-07)	(1.78e-06)	(7.07e-07)
Soil Change	-.0698955+	-.047775	-.063569	-.1327274	-.0664324	.038087	-.0462194+	.0019816	-.0067925	-.0010418
	(.0402694)	(.0754041)	(.0561384)	(.0929869)	(.0453678)	(.0663855)	(.028336)	(.0284391)	(.0148873)	(.0067731)
Soil Shock	.0705342+	.0470399	.0616557	.1263834	.0700974	-.0417397	.0473285+	-.0054073	.0081886	.0025984
	(.0406641)	(.0751807)	(.0566737)	(.0926694)	(.0464413)	(.0666444)	(.0295976)	(.0288111)	(.0153774)	(.0066795)
Soil Shock^2	-2.49e-07	-6.85e-07	5.48e-06	8.87e-06	-4.23e-06	4.87e-06	-1.49e-06	4.23e-06*	-2.44e-06	-1.14e-06
	(3.30e-06)	(5.23e-06)	(3.77e-06)	(6.96e-06)	(5.98e-06)	(6.12e-06)	(2.83e-06)	(2.11e-06)	(2.56e-06)	(1.28e-06)
Temperature	.0012511	-.053706**	.0029537	-.0321936	.0548013**	.0372189	.0042115	.0067726	.0031846	.0050803
	(.0109617)	(.0191127)	(.0139893)	(.0234704)	(.0212994)	(.0267607)	(.0117612)	(.0087184)	(.0127929)	(.0046896)
Precipitation	-.0724928	-.0913136**	-.1370928**	-.170217**	-.0635939+	-.0489429	-.0329667*	-.0103489	.0058036	-.0168202*
	(.0456188)	(.0397967)	(.0577982)	(.0624069)	(.0380876)	(.0413171)	(.0160043)	(.0154645)	(.01428)	(.0066184)
Xpolity (lag)	-.0039254	.0023498	-.0224298	-.0649693	-.0322694	.0173021	.0226278*	.0317829**	.0191124	-.0665993**
	(.0163879)	(.0316439)	(.022953)	(.0473656)	(.0237734)	(.0285908)	(.0110251)	(.0094253)	(.0263357)	(.0118189)
GDP per Capita (lag)	-.2735171**	.013177	-.1159359	-.2895125	-.51454**	.1670223	.1222732*	-.1076029+	-.0962653	.135281**
	(.0959304)	(.2888844)	(.1341672)	(.3836197)	(.1029709)	(.3115868)	(.0602772)	(.0645603)	(.0738088)	(.0345222)
Population (lag)	.287938**	.0980124	.2301317	-.0081904	.504851**	.525475	.4181313**	.1632965**	.0980186*	.1566533**
	(.0665658)	(.5312026)	(.0858287)	(.6762203)	(.0827844)	(.7108398)	(.0515874)	(.0554095)	(.0502972)	(.0310628)
El Niño	-.0992681	-.0296948	-.3506742	-.2422404	-.0910936	-.0994104	.1656182**	.1091513	-.0388971	.1221448**
	(.1758126)	(.17855)	(.3049739)	(.2556039)	(.2145181)	(.2206957)	(.0635962)	(.0699411)	(.0691512)	(.0401959)
January	1.207493**	1.042913**	1.565388**	1.419002**	.0550237	-.0929467	---	---	---	---
	(.2755584)	(.1872295)	(.3302518)	(.2347742)	(.3320671)	(.2796808)				
Peace Months	-.01512**	.0050034	-.0056889	.0086536+	-.066631**	-.0355111**	-.3084762**	-.2526448	-1.543531**	-.9183416**
	(.0027599)	(.0037831)	(.004137)	(.0050034)	(.0128096)	(.0126079)	(.0481335)	(.0145249)	(.1902625)	(.0519937)
Peace Months^2	.0000382**	-.0000431**	-7.31e-06	-.0000697**	.0006306**	.0004474**	.0072744**	.0058379	.0687024**	.0398074**
	(.000011)	(.0000179)	(.0000162)	(.0000239)	(.0001774)	(.0001875)	(.0017446)	(.0004746)	(.0172909)	(.0036427)
Peace Months^3	-3.18e-08**	7.49e-08**	1.26e-08	1.08e-07**	-1.90e-06**	-9.11e-07	-.0000455**	-.0000352	-.0008067*	-.0004526**
	(1.14e-08)	(2.27e-08)	(1.62e-08)	(2.93e-08)	(6.68e-07)	(7.17e-07)	(.0000151)	(3.99e-06)	(.0003495)	(.0000644)
Constant	-4.318395**	---	-4.675201**	---	-4.994891**	---	-5.436415**	---	1.460467	---
	(.8487203)		(1.08615)		(1.196013)		(.7761175)		(.8516119)	
Observations	42000	18312	42000	9918	30483	8920	8247	8247	2579	2579
Log Pesudolikelihood	-1180.9844	-936.34813	-659.6001	-508.61229	-942.34725	-738.31886	-3910.3259	-3724.9156	-6208.3609	-5737.5876
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses **p < 0.01; *p < 0.05; +p < 0.1 (reported, but not discussed);
Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects models

Table 3-6 shows the results of testing Hypothesis 3(a) and 3(b) using the scored factor dimensions ‘Habitation/Sustainability’, ‘Desertification’, and ‘Fertility’, which were born out of the principal component factoring. For the sake of substantive interpretation, increasing values of *Habitation/Sustainability* imply an increase in the demographic pressure of a given country, an increase in the measure of *Desertification* is counterintuitive because positive values of this factor dimension are associated with a decrease in the scarcity of water, while an increase in the level of *Fertility* implies a favorable increase in the physical conditions required for agricultural growth. Therefore for the results to be supportive of Hypothesis 3(a) and/or 3(b) one would expect to see positive and statistically significant coefficients *Habitation/Sustainability* variable, and negative and statistically significant coefficients for the *Desertification* and *Fertility* variables.

In order to fully understand the implications of Table 3-6 it is best to analyze each dimension individually. For the first dimension, the results show some tepid support for the relationship between increasing degree of *Habitation/Sustainability* and the onset of violent conflict. Among the results, the coefficients are significant and incorrectly signed in Models 2 and 10. Moreover, the sign on these coefficients flip when moving to the pooled versions of these estimations (Models 1 and 9). These results should be interpreted with caution given the loss of observations imposed under the fixed effects constraints. However, there are consistent results in Models 5-8, with Model 5 being positive and significant at the conventional 95% confidence level. Interpreted substantively, the results indicate that, holding all other variables at meaningful values, a one unit standard deviation increase in the *Habitation/Sustainability* factor score corresponds with an 52.6% increase in the expected count of non-state conflict events in a given month (.0019 to .0029).

For the second dimension, there is a strong and consistently negative and significant effect between increasing values of the *Desertification* factor score and a reduction in the onset of violent conflict. With respect to civil war onset, a one unit increase in the standard deviation of *Desertification* corresponds with a 16% decrease in the risk of low intensity civil war onset (.0084 to .0070), a 27.5% decrease in the risk of high intensity civil war onset (.0029 to .0021), and a 21.1% decrease in the expected count of non-state conflicts in a given month (.0019 to .0015). Despite the significance of *Fertility* factor score variable in Models 2, 4, and 9, the sign on the coefficient flips between the fixed effects and pooled models too frequently to make a definitive judgment on the veracity of such a relationship, particularly in the face of so many lost observations. Finally, with respect to the control variables, the patterns exhibited in these results largely mirror those found within Table 3-5. Overall, the findings of Table 3-6 indicate mixed support for Diamond's (2006) ecocide hypothesis, with the strongest findings being associated with the *Desertification*, which is intended to capture the availability of water and water management problems indicated in Table 3-1.

Table 3-6: Principal Component Factor Country-Month Estimation Results

Country-Month Table 3-6	(1) ACD (25+ Dead) 1981–2006	(2) ACD (25+ Dead) 1981–2006	(3) ACD (1000+Dead) 1981–2006	(4) ACD (1000+Dead) 1981–2006	(5) UCDP 1989–2006	(6) UCDP 1989–2006	(7) SCAD 1990–2006	(8) SCAD 1990–2006	(9) ICEWS 2000–2006	(10) ICEWS 2000–2006
Negative Binomial DV (lag)	---	---	---	---	.072824	-.2229425	.1092319**	.063685**	.0294701**	.0143241**
					(.3601459)	(.2913629)	(.039449)	(.0169435)	(.006582)	(.0008904)
"Habitation/Sustainability"	.169724	-.4409514*	.154963	-.3335829	.3899394*	.306387	.1553606+	.1392466+	.042858	-.1147808**
	(.1171201)	(.2206676)	(.1342618)	(.3285962)	(.172826)	(.2856845)	(.0946073)	(.0801639)	(.0509574)	(.0320997)
"Desertification"	-.1733214**	-.1756839	-.3225037**	-.5601404*	-.2596839*	-.3554322*	.0433432	-.1021537*	-.0749211+	.0028753
	(.0767043)	(.1555579)	(.1036861)	(.2425347)	(.1096152)	(.1553802)	(.0531473)	(.0471921)	(.0398215)	(.0251197)
"Fertility"	-.0651639	.8956372*	-.1551245	1.788067**	-.1656262	-.109446	.1290339	-.1056841	-.1419356**	.1509375
	(.0987349)	(.4148125)	(.1325673)	(.69096)	(.1942003)	(.4991725)	(.0945197)	(.1339287)	(.0248893)	(.0370243)
Xpolity (lag)	.0048233	.001654	-.0272711	-.0741305	-.0329786	.037464	.0280997*	.0357335**	.0283933	-.0649735**
	(.0180724)	(.0321692)	(.021967)	(.0498854)	(.0285232)	(.0262064)	(.0125542)	(.0096167)	(.0239078)	(.0123766)
GDP per Capita (lag)	-.2299689**	-.1457169	-.0081648	-.5202162	-.5042791**	.1797938	.1742931**	-.1822544**	-.1190987	.0103194
	(.1030125)	(.3108574)	(.1211498)	(.4109608)	(.1415938)	(.3310124)	(.0653497)	(.0656994)	(.079259)	(.0305032)
Population (lag)	.2162724**	.547426	.1669509	1.282697+	.4725268**	-.0233299	.4027607**	.1734934**	.1201164**	.1224941**
	(.0600745)	(.6030562)	(.0746701)	(.777207)	(.0805325)	(.2397869)	(.0529412)	(.0494448)	(.0302192)	(.0206094)
El Niño	-.1481981	-.0990461	-.4804901+	-.4607064	-.1297342	-.1380219	.1506604**	.0882399	-.0732394	.0770702+
	(.17191)	(.2004068)	(.2922575)	(.3099571)	(.238638)	(.2388788)	(.0612597)	(.0713974)	(.1046845)	(.0446426)
January	1.285383**	1.035811**	1.736151**	1.396435**	.1223298	-.0482183	---	---	---	---
	(.3221074)	(.2013691)	(.3566622)	(.2531607)	(.3460168)	(2916729)				
Peace Months	-.0134501**	.0056043	-.0048783	.0055904	-.071628**	-.0311127*	-.309831**	-.2535627**	-1.623115**	-.997458**
	(.0029457)	(.0041129)	(.0047054)	(.0053188)	(.0141933)	(.0136059)	(.0499467)	(.0148491)	(.1839978)	(.0590912)
Peace Months^2	.0000304**	-.0000495*	-.0000141	-.0000466+	.0006539**	.0004389*	.0071491**	.0057733**	.0954217**	.0567677**
	(.0000117)	(.0000195)	(.0000185)	(.0000246)	(.0001819)	(.0001994)	(.0017767)	(.0004763)	(.0281169)	(.0054413)
Peace Months^3	-2.23e-08+	8.45e-08**	2.15e-08	7.78e-08**	-1.86e-06**	-8.58e-07	-.0000437**	-.0000341**	-.0015057+	-.000865**
	(1.20e-08)	(2.47e-08)	(1.85e-08)	(2.93e-08)	(6.58e-07)	(7.45e-07)	(.0000151)	(3.93e-06)	(.0007792)	(.000126)
Constant	-4.576155**	---	-5.712538**	---	-3.991744**	---	-5.794784**	---	1.291846+	---
	(.8238239)		(1.015253)		(1.346906)		(.7862656)		(.7610597)	
Observations	34734	15612	34734	8574	24523	7594	7676	7676	2019	2019
Log Pesudolikelihood	-984.78099	-778.84434	-534.78634	-409.90294	-832.17707	-639.34579	-3650.7249	-3464.4359	-4329.4495	-4042.8191
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses **p < 0.01; *p < 0.05; $^+$p < 0.1 (reported, but not discussed);
Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects models

3.5 Conclusion

As tragic of issues that environmental degradation and habitat loss may be, the alarmist claims that these problems are associated with an increase in the onset of violent conflict are unfounded. Furthermore, the popular Diamond (2006) hypothesis, in which the environmental collapse that nations of the past have experienced should serve as a warning to future generations, lacks convincing statistical support. To the extent that nations may act to mitigate the risk of violent conflict via Diamond's ecocide theory, it should be achieved through the wise and efficient use of natural resources, particularly water. In any case, making substantive or policy decisions based on these results is not advisable. It is likely that there are other unidentified dimensions not captured by the principal components factoring that motivate the outbreak of conflict beyond those meteorological and physical conditions that environmental alarmists identify.

Given the anecdotal evidence tying strategy to vegetation growth, a potential area of interest would be to spatially analyze the dimensionality and duration of conflict as it relates to the availability and seasonal nature of vegetation changes. A closer look at the microfoundations of agricultural economics as they relate to soil quality and their manipulation as a rebel-recruiting tool via crop substitution may also be a worthwhile (e.g. Dube and Vargas 2012). Finally, one last interesting avenue for future research may also be in explaining how issues of environmental degradation might be used as statistical instruments for other social effects that influence on the onset of violent conflict (e.g. Acemoglu Johnson, and Robinson 2002).

3.5 References

Acemoglu, Daron, Simon Johnson, and James A. Robinson. 2002. "Reversal of Fortune: Geography and Institutions in the Making of the Modern World." *Quarterly Journal of Economics* 117: 1231-1294.

Adler, R.F., G.J. Huffman, A. Chang, R. Ferraro, P. Xie, J. Janowiak, B. Rudolf, U. Schneider, S. Curtis, D. Bolvin, A. Gruber, J. Susskind, and P. Arkin. 2003. "The Version 2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation Analysis (1979–Present)" *Journal of Hydrometeor* 4:1147–1167

Agresti, Alan and Barbara Finlay. 2009. *Statistical Methods for the Social Sciences, Fourth Edition.* Upper Saddle River, NJ: Pearson Prentice Hall.

Buhaug, Halvard and Jan Ketil Rod. 2006. "Local Determinants of African Civil Wars." *Journal of Peace Research* 39 (4): 417–433.

Buhaug, Halvard and Paivi Lujala. 2005. "Accounting for Scale: Measuring Geography in Quantitative Studies of Civil War." *Political Geography* 24 (4): 339–418.

Bearce, David. 1985. “Resource Scarcity and Economic Growth in Poor Developing Countries: Missing Links in Simon’s Cornucopian Philosophy.” *Futures* 17 (5): 440–445.

Binningsbo, Helga Malmin, Indra de Soysa, and Nils Petter Gledtisch. 2007. “Green Giant or Straw Man? Environmental Pressure and Civil Conflict 1961–1999.” *Population and Environment* 28 (6): 337–353.

Brochmann, Marit and Nils Petter Gleditsch. 2012. “Shared Rivers and Conflict—A Reconsideration.” *Political Geography* 31: 519–527.

Carter, David B. 2011. “The Compellence Dilemma: International Disputes with Violent Groups.” Unpublished Manuscript. Accessed May 6, 2013. http://www.princeton.edu/~dbcarter/David_B._Carter/Research_files/compellence_dilemma17.pdf.

Carter, David B. and Curtis S. Signorino. 2010. “Back to the Future: Modeling Time Dependence in Binary Data.” *Political Analysis* 18: 271–292.

Cedarman, Lars-Erik and Kristian Skrede Gleditsch. 2009. “Introduction to Special Issue on ‘Disaggregating Civil War.” *Journal of Conflict Resolution* 53 (4): 487–495.

Center for Ocean-Atmospheric Prediction Studies. 2012. “ESNO Index According to JMA SSTA (1868–Present).” Florida State University: Center for Ocean-Atmospheric Prediction Studies. Accessed May 6, 2013. http://coaps.fsu.edu/jma.shtml.

Chicago Tribune Watchdog Report. 2009. “Map: Agent Orange and South Vietnam.” *Chicago Tribune*. December 3. Accessed May 6, 2013. http://www.chicagotribune.com/health/agentorange/chi-091204-agentorange-gfx,0,1959445.graphic.

Collier, Paul, and Anke Hoeffler. 1998. “On the Economic Causes of Civil War.” *Oxford Economic Papers* 50: 563–573.

———.2004. “Greed and Grievance in Civil War.” *Oxford Economic Papers* 56 (4): 563–595.

Collins, Mat, Soon-Il An, Wenju Cai, Alexandre Ganachaud, Eric Guilyardi, Fei-Fei Jin, Markus Jochum, Matthieu Lengaigne, Scott Power, Axel Timmermann, Gabe Vecchi, and Andrew Wittenberg. 2010. “The Impact of Global Warming on the Tropical Pacific Ocean and El Niño.” *Nature Geoscience* 3: 391–397.

De Soysa, Indra. 2002. “Ecoviolence: Shrinking Pie, or Honey Pot?” *Global Environmental Politics* 2 (4): 1–34.

Diamond, Jared. 2006. *Collapse: How Societies Choose to Fail or Succeed.* New York: Penguin Books.

Dube, Oeindrila and Juan Vargas. 2012. “Commodity Price Shocks and Civil Conflict: Evidence from Colombia.” *Review of Economic Studies* (forthcoming).

Ellis, Frank. 2000. *Rural Livelihoods and Diversity in Developing Countries.* New York: Oxford University Press.

Elrich, Peter R. and Anne H. Elrich. 1990. *The Population Explosion.* New York: Simon & Shuster.

Ewers, Robert M. 2006. “Interaction Effects Between Economic Development and Forest Cover Determine Deforestation Rates.” *Global Environmental Change* 16 (2): 161–169.

Fan, Yu and Huug van den Dool. 2004. “Climate Prediction Center Global Monthly Soil Moisture Dataset at 0.5 Resolution for 1948–Present.” *Journal of Geophysical Research* 109:1–8.

Fearon, James D. and David D. Laitin. 2003. “Ethnicity, Insurgency, and Civil War.” *American Political Science Review* 97 (1): 75–90.

Ferguson, Andrew R.B. 2002. “The Assumptions Underlying Eco-Footprinting.” *Population and Environment* 23 (3): 303–313.

Food and Agricultural Organization of the United Nations (FAO). 2001. “Global Forest Resource Assessment: Main report.” Rome: FAO. Accessed May 6, 2013. http://www.fao.org/forestry/fra/2000/report/en/.

———. 2013. “Food Supply Database” Accessed May 8, 2013. http://faostat3.fao.org/home/index.html#DOWNLOAD.

Fund for Peace. 2012. “Failed States Index” Accessed May 6, 2013. http://ffp.statesindex.org/rankings-2012-sortable

Gleditsch, Kristian Skrede. 2002. “Expanded Trade and GDP Data.” *The Journal of Conflict Resolution* 46 (5): 712–724.

Gleditsch, Nils Petter. 2012. “Wither the Weather? Climate Change and Conflict.” *Journal of Peace Research* 49 (3): 3–9.

———.1998. “Armed Conflict and the Environment: A Critique of the Literature.” *Journal of Peace Research* 35 (3): 381–400.

Gleditsch, Nils Petter, Kathryn Furlong, Havard Hegre, Bethany Lacina, and Taylor Owen. 2006. "Conflicts over Shared Rivers: Resource Scarcity or Fuzzy Boundaries?" *Political Geography* 25: 361–382.

Gleditsch, Nils Petter, Peter Wallensteen, Mikael Erikson, Margareta Sollenberg, and Havard Strand .2002. "Armed Conflict 1946–2001: A New Dataset." *Journal of Peace Research* 39 (5): 615–637.

Gray, Clark L. 2011. "Soil Quality and Human Migration in Kenya and Uganda." *Global Environmental Change* 21: 421–430.

Gronewold, Nathanial. 2010. "Climate Change, Deforestation and Corruption Combine to Drown a Region." *The New York Times*. October 13. Accessed May 6, 2013. http://www.nytimes.com/cwire/2010/10/13/13climatewire-climate-change-deforestation-and-corruption-90465.html?pagewanted=all.

———.2009. "Environmental Destruction, Chaos Breeding Across Haitian Border." *The New York Times*, December 14. Accessed May 6, 2013. http://www.nytimes.com/gwire/2009/12/14/14greenwire-environmental-destruction-chaos-bleeding-acros-35779.html?pagewanted=all.

Hamilton, Lawrence C. 2006. *Statistics with STATA: Updated for Version 9*. Belmont, CA: Thompson Brooks/Cole.

Harbom, Lotta and Peter Wallensteen. 2010. "Armed Conflicts, 1946–2009." *Journal of Peace Research* 47 (4): 501–509.

Harding, Garrett. 1968. "The Tragedy of the Commons." *Science* 162 (3589): 1243–1248.

Hauge, Wenche and Tanja Ellingsen. 1998. "Beyond Environmental Scarcity: Causal Pathways to Conflict." *Journal of Peace Research* 43: 617–631.

Haung, Jin, Huug van den Dool, Konstantine P. Georgakakos. 1996. "Analysis of Model-Calculated Soil Moisture over the United States (1931–93) and Application to Long-Range Temperature Forecasts." *Journal of Climate* 9 (6): 1350–1362.

Hegre, Havard and Nicholas Sambanis. 2006. "Sensitivity Analysis of Empirical Results on Civil War Onset." *Journal of Conflict Resolution* 50 (4): 508–535.

Hegre, Havard, Tanja Ellingsen, Scott Gates, and Nils Petter Gleditsch. 2001. "Toward a Democratic Civil Peace? Democracy, Political Change, and Civil War, 1816–1992." *American Political Science Review* 95 (1): 33–48.

Hendrix, Cullen S. 2010. “Measuring State Capacity: Theoretical and Empirical Implications for the Study of Civil Conflict.” *Journal of Peace Research* 47: 273–285.

Hendrix, Cullen S. and Idean Salehyan. 2012. “Climate Change, Rainfall, and Social Conflict in Africa.” *Journal of Peace Research* 49 (1): 35–50.

Hensel, Paul R., Sara McLaughlin Mitchell, and Thomas E Sowers II. 2006. “Conflict Management of Riparian Disputes.” *Political Geography* 25: 383–411.

Heston, Alan, Robert Summers, and Bettina Aten. 2011. “Penn World Table Version 7.0.” University of Pennsylvania: Center for International Comparisons of Production, Income and Prices. Accessed May 6, 2013. https://pwt.sas.upenn.edu/php_site/pwt_index.php.

Homer-Dixon, Thomas.1999. *Environment, Scarcity, and Violence.* Princeton: Princeton University Press.

———.1994. “Environmental Scarcities and Violent Conflict: Evidence from Cases.” *International Security* 19 (1): 5–40.

Hsiang, Solomon M., Kyle C. Meng, and Mark A. Cane. 2011. “Civil Conflicts are Associated with Global Temperature.” *Nature* 476: 438–441.

Humphreys, Mccarten, and Jeremy M. Weinstein. 2008. “Who Fights? The Determinants of Participation in Civil War.” *American Journal of Political Science* 52 (2): 436–455.

IPCC. 2007. “IPCC Fourth Assessment Report. Climate Change 2007: Synthesis Report.” edited by R.K Pachauri and A. Reisinger. Geneva: Intergovernmental Panel on Climate Change. Accessed May 6, 2013. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

Kalnay, Eugenia, Masao Kanamitsu, Robert Kistler, William Collins, Dennis Deaven, Lev Gandin, Mark Iredell, Suranjana Saha, Glenn White, John Woollen, Yuejian. Zhu, Muthuvel Chelliah, Wesley Ebisuzaki, Wayne Higgins, John. Janowiak, Kingste C. Mo, Chester Ropelewski, J. Wang, Ants Leetmaa, Richard Reynolds, Roy Jenne, and Dennis Joseph. 1996. “The NCEP/NCAR 40-Year Reanalysis Project.” *Bulletin of the American Meteorological Society* 77 (3): 437–471.

King, Gary, Michael Tomz, and Jason Wittenberg. 2000. “Making the Most of Statistical Analyses: Improving Interpretation and Presentation.” *American Journal of Political Science* 44 (2): 347–361.

Klare, Michael T. 2001. *Resource Wars: The New Landscape of Global Conflict.* New York: Metropolitan.

Kunte, Arundhati, Kirk Hamilton, John Dixon, and Michael Clemens. 1998. “Estimating National Wealth: Methodology and Results.” *Indicators and Environmental Evaluation.* Unpublished. January No. 57. Washington, DC: World Bank Environment Department.

Marshall, Monty J. and Keith Jaggers. 2010. “Polity IV Project: Political Regime Characteristics and Transitions, 1800–2010.” Version p4v2010.” College Park, MD: University of Maryland. Accessed May 6, 2013. http://www.systemicpeace.org/inscr/inscr.htm.

Martin, Adrian. 2005. “Environmental Conflict Between Refugees and Host Communities.” *Journal of Peace Research* 42 (3): 329–346.

Matthews, Emily. 2001. “Understanding the FRA 2000.” *World Resources Institute* Forest Briefing No. 1: 1–12. Accessed May 6, 2013. http://rmportal.net/library/content/Deforestation/world-resources-institute-forest-briefing-understanding-the-fao-forest-resources-assessment-2000/view.

Meier, Patrick, Doug Bond, and Joe Bond. 2007. “Environmental Influences on Pastoral Conflict in the Horn of Africa.” *Political Geography* 26: 716–735.

Mendelsohn, Robert, Ariel Dinar, and Larry Williams. 2006. "The Distributional Impact of Climate Change on Rich and Poor Countries." *Environment and Development Economics* 11: 159–178.

Monfreda, Chad, Mathis Wackernagel, and Diana Deumling. 2004. "Establishing National Natural Capital Accounts Based on Detailed Ecological Footprint and Biological Capacity Accounts." *Land Use Policy* 21 (3): 231–246.

Nordas, Ragnhild and Nils Petter Gleditsch. 2007. "Climate Change and Conflict." *Political Geography* 26 (6): 627–638.

O'Loughlin, John, Frank D. W. Witmer, Andrew M. Linke, Arlene Laing, Andrew Getteleman, and Jimy Dudhia. 2012a. "Climate Variability and Conflict Risk in East Africa, 1990–2009." *Proceedings of the National Academy of Sciences* 109: 18344–18349.

O'Loughlin, John, Frank D. W. Witmer, Andrew M. Linke, Arlene Laing, Andrew Getteleman, and Jimy Dudhia. 2012b. "Supporting Information 10.10173/pnas1205130109" *Proceedings of the National Academy of Sciences*. 109: 18344–18349. Accessed May 6, 2013. http://www.pnas.org/content/suppl/2012/10/18/1205130109.DCSupplemental/pnas.201205130SI.pdf.

O'Brien, Sean P. 2010. "Crisis Early Warning Decision Support: Contemporary Approaches and Thoughts on Future Research." *International Studies Review* 12 (1): 87–104.

Peluso, Nancy Lee and Peter Vandergeest. 2011. "Political Ecologies of War and Forests: Counterinsurgencies and the Making of National Natures." *Annals of the Association of American Geographers* 101 (3): 587–608

Percival, Val and Thomas Homer-Dixon. 1998. "Environmental Scarcity and Violent Conflict: The Case of South Africa." *Journal of Peace Research* 35 (3): 279–298.

Philip, Sjoukje and Geert Jan van Oldenborgh. 2006. "Shifts in ESNO Coupling Process Under Global Warming." *Geophysical Research Letters* 33 (L11704): 1–5.

Piazza, James A. 2008. "Incubators of Terror: Do Failed and Failing States Promote Transnational Terrorism?" *International Studies Quarterly* 52: 469–488.

Pinzon, Jorge E., Brown, Molly E., and Tucker, Compton J. 2005. "Satellite Time Series Correction of Orbital Drift Artifacts Using Empirical Mode Decomposition." In, *Hilbert-Huang Transform: Introduction and Applications* edited by Norden Eh Huang and Samuel S. Shen. pp. 167–186. Hackensack, NJ: World Scientific Publishing Co.

Raleigh, Clionadh and Dominic Kniveton. 2012. “Come Rain or Shine: An Analysis of Conflict and Climate Variability in East Africa.” *Journal of Peace Research* 49 (1): 51–64.

Raleigh, Clionadh and Henrik Urdal. 2007. “Climate Change, Environmental Degradation, and Armed Conflict.” *Political Geography* 26 (6): 674–694.

Rothberg, Robert I., Editor. 2000. *When States Fail: Causes and Consequences*. Princeton: Princeton University Press.

Rudel, Thomas K., Oliver T. Coomes, Emilio Moran, Frederic Achard, Arild Angelsen, Jianchu Xu, and Eric Lambin. 2005. “Forest Transitions: Towards a Global Understanding of Land Use Change.” *Global Environmental Change* 14 (4): 23–31.

Rudel, Thomas K. and Jill Roper.1997. “The Paths to Rainforest Destruction: Cross-National Patterns of Rainforest Destruction, 1975–1990.” *World Development* 25: 53–65.

Salehyan, Idean. 2008. “From Climate Change to Conflict? No Consensus Yet.” *Journal of Peace Research* 45 (3): 315–326.

Salehyan, Idean, Cullen S. Hendrix, Jesse Hamner, Christina Case, Christopher Linebarger, Emily Stull, and Jennifer Williams. 2012. "Social Conflict in Africa: A New Database." *International Interactions* 38 (4): 503–511.

Salehyan, Idean and Kristian Skedre Gleditsch. 2006. "Refugees and the Spread of Civil War." *International Organization* 60 (2): 335–366.

Stalley, Philip. 2003. "Environmental Scarcity and International Conflict." *Conflict Management and Peace Science* 20 (2): 33–50

Stocking, M.A. 2003. "Tropical Soils and Food Security: The Next 50 Years." *Science* 302: 1356–1359.

Sundberg, Ralph, Kristine Eck, and Joakim Kreutz. 2012. "Introducing the UCDP Non-State Conflict Dataset." *Journal of Peace Research* 49 (2): 351–362.

Tejedor, M., C Jimenez, C. Monteverde, and J Parra. 2004. "The Influence of Deforestation on Soil Water Conservation in a Pine Forest in Tenerife (Canary Islands, Spain)." Paper Presented at 13th International Soil Conservation Conference, Brisbane, July 2004.

The Economist. 2012. "Green Growth: Shoots, Greens and Leaves." *The Economist*, June 16.

———.2011. “No Easy Fix: Simply Using More of Everything to Produce More Food Will Not Work.” *The Economist*, October 24.

———.2010. “Forests and How to Save Them: The World’s Lungs.” *The Economist*, September 23.

Theisen, Ole Magnus. 2008. “Blood and Soil? Resource Scarcity and Internal Armed Conflict Revisited.” *Journal of Peace Research* 45 (6): 801–818.

Tir, Jaroslav and Paul F. Diehl. 1998. “Demographic Pressure and Interstate Conflict: Linking Population Growth and Density to Militarized Disputes and Wars 1930–1989.” *Journal of Peace Research* 35 (3): 319–339

Tollefsen, Andrea Foro, Havard Strand, and Halvard Buhaug. 2012. “PRIO-GRID: A Unified Spatial Data Structure.” *Journal of Peace Research* 49 (2): 363–374.

Tomz, Michael, Wittenberg, Jason, and King, Gary. 2003. “CLARIFY: Software for Interpreting and Presenting Statistical Results.” *Journal of Statistical Software* 8 (1).

Tucker, Compton.J., Jorge.E. Pinzon, and Molly.E. Brown. 2004. “Global Inventory Modeling and Mapping Studies, NA94apr15b.n11-VIg, 2.0.” Global Land Cover

Facility, University of Maryland, College Park, Maryland, 04/15/1994. Accessed May 6, 2013. http://glcf.umd.edu/data/gimms/.

Tucker, Compton J., Jorge E. Pinzon, Molly E. Brown, Daniel A. Slayback, Edwin W. Pak, Robert Mahoney, Eric F. Vermote, and Namzi El Saleous. 2005. "An Extended AVHRR 8-km NDVI Dataset Compatible with MODIS and SPOT Vegetation NDVI Data." *International Journal of Remote Sensing* 26 (20): 4485–4498.

Urdal, Henrik. 2008. "Population, Resources, and Political Violence: A Subnational Study of India, 1956–2002." *Journal of Conflict Resolution* 52 (4): 590–617.

Urdal, Henrik. 2005. "People vs. Malthus: Population Pressure, Environmental Degradation, and Armed Conflict Revisited." *Journal of Peace Research* 42 (4): 417–434.

Van den Dool, Huug, Jin Huang, Yun Fan. 2003. "Performance and Analysis of the Constructed Analogue Method Applied to U.S. Soil Moisture Over 1981–2001." *Journal of Geophysical Research* 108 (D16): 1–16.

Vreeland, James Raymond. 2008. "The Effect of Political Regime on Civil War: Unpacking Anocracy." *Journal of Conflict Resolution* 53 (2): 401–425.

Ye, Liming and Eric Van Ranst. 2009. “Production Scenarios and the Effect of Soil Degradation on Long-Term Food Security in China.” *Global Environmental Change* 19 (4): 464–481.

Wackernagel. Mathis, Chad Monfreda, Dan Moran, Paul Wermer, Steve Goldfinger, Diana Deumuling, and Michael Murray. 2005. “National Footprint and Biocapacity Accounts 2005: The Underlying Calculation Method.” May 25, 2005:1–33. Oakland, CA: Global Footprint Network Research, Science, & Technology Department. Accessed May 6, 2013. www.footprintnetwork.org.

Wang, Xunming, Fahu Chen, and Zhibao Dong. 2006. “The Relative Role of Climatic and Human Factors in Desertification in Semiarid China.” *Global Environmental Change* 16: 48–57.

Weinan, Chen, Dong Zhibao, Li Zhenshan, and Yang Zuotao. 1996. “Wind Tunnel Test of the Influence of Moisture on Erodibility of Loessial Sandy Loam Soils by Wind.” *Journal of Arid Environments* 34: 391–402.

World Bank. 2012. “World Development Indicators.” *World Bank.* Accessed July 31, 2012. http://data.worldbank.org.

Zhang, Bin, Yan-Sheng Yang, and H. Zepp. 2004. “Effect of Vegetation Restoration on Soil and Water Erosion and Nutrient Losses of a Severely Eroded Clayey Plinthudult in Southeastern China.” *Catena* 57 (1): 77–90.

Chapter 4

Catastrophizing Conflict? The Changing Relationship Between Measures of Natural Diasters, State Capacity & Violent Conflict

The expectation that global climate change increases the variability of extreme weather events has generated much interest in investigating how these events may be tied to our understanding of violent conflict. Although the destructiveness that comes in the wake of a serious natural disaster is unequivocal, what remains unclear is whether these events are associated with the onset of violent conflict. Even though natural disasters have recently received an increased interest in the ecoviolence literature, the evidence that they are associated with the onset of violent conflict is mixed. Despite their strong, perceived influence on the integrity of a state's institutional capacity, a serious discussion of how the effects of natural disasters affect state capacity is missing from existing theories of the ecoviolence debate. My study makes three contributions to this field of research. First, I begin by examining the conditional relationship that state capacity and natural disasters may share in elevating, or mitigating, the onset of violent conflict. Not only does this provide a closer consideration of the foundations of ecoviolence hypothesis, specifically in regards to natural disasters, it also finally addresses the belief by scholars that state capacity may share a role in the theoretical discussion. Second, I draw a distinction that the risks for violent conflict produced by natural disasters are theoretically stronger at lower levels of organizational capacity. This motivates my testing for these relationships across various forms of violent conflict. Finally, I use a country-month research design, which captures the effects of seasonality—something that is largely ignored in the ecoviolence literature. I argue that this research design more accurately captures the relationship between the introduction of natural disaster and the onset of violent conflict. I show that this relationship is not systematic, but varies dramatically and is often contrary to theoretical expectations.

4.1 Introduction

Following a major earthquake that damaged much of northern Pakistan in October of 2005, the Pakistani government upgraded the construction of its Alpurai-Besham road to a national highway for efficiently transporting goods from Peshwar to the Chinese border (Kahn 2010). Coincidentally, this road not only served as a means for increasing Pakistan's economic output, but Alpurai-Besham also played an important role in the resupplying of the Pakistani army in its 2009 offensive against Taliban forces in the Swat Valley. In short, the road was a direct representation of Pakistan's state capacity because Alpurai-Besham allowed Pakistani government to both mobilize its resources and exercise coercion throughout its territory. In the summer of 2010 however, the Alpurai-Besham road was suddenly and unexpectedly destroyed—washed away in the worst monsoon season in 80 years that left one fifth of the country underwater (CRED 2012; Guha-Sapir et al. 2011; Kahn 2010). In the words of one citizen, "everything is gone - the buildings, the fixtures, the generators, the roads, and the land on which it was all built." (quoted in Kahn 2010, 1).

Events like these fuel fears that climate change may motivate violent conflict because disasters have the potential for immediately undermining a state's capacity for economic growth by destroying its transportation networks and power facilities, all while impairing its coercive capabilities. When these conditions arise in the wake of a disaster, some theories suggest that the risk violent conflict rises because the political opportunities and grievances for rebellion grow relative to a state's ability to repress them. In response, governments may take extraordinarily measures to divert and stifle these sentiments. Although most conflict scholars agree that natural disasters severely impair a state's capacity (Bergholt and Lujala 2012; Berrebi and Ostwald 2011; Brancati 2007; Nel and Righarts 2008), and that such capacity is important in studying the onset of violent conflict (particularly in civil wars) (Braithwaite 2010; Hendrix 2010; Holtermann 2012; Sobek 2010; Thies 2010), only *one* study has ever looked at the interactive effects between natural disasters and any form of state capacity on the onset of conflict (see Brancati 2007).

This expectation that global climate change increases the variability of extreme weather events (IPCC 2007, 46; National Research Council 2013) has generated interest in investigating how these events may be connected to the onset of violent conflict. In 2011, 332 natural disasters killed more than 30,000 people, affected over 244 million others, and caused more than $366 billion of economic damages (quoted in Guha-Sapir et al. 2011, 1). Statistics like these leave little room for disagreement that disasters are extremely destructive, but what remains unanswered is if their consequences are associated with the onset of violent conflict. Despite the interest that natural disasters have recently received in the ecoviolence literature (Bergholt and Lujala 2012; Berrebi and Ostwald 2011; Brancati, 2007; Nel and Righarts 2008; Slettebak 2012), the evidence that they are associated with outbreaks of mass violence is quite mixed (Gledtisch 2012). Moreover, a serious discussion of how the effects of natural disasters are tied to state capacity is missing from existing theories of this debate.

My study makes three contributions to this field of research. First, I start by examining the conditional relationship that state capacity and natural disasters may share in elevating, or mitigating, the onset of violent conflict. Not only does this provide a closer consideration of the foundations of ecoviolence hypothesis, specifically in regards to natural disasters, it also finally addresses the belief by scholars that state capacity may share a role in the ecoviolence debate (Barnett and Adger 2007; Berrebi and Ostwald 2011; Brancati 2007; Nels and Righarts 2008). Second, I draw a distinction that the risks for violent conflict produced by natural disasters are theoretically stronger at lower levels of organizational capacity. This motivates my testing for these relationships across various forms of violent conflict. Finally, I use a country-month research design, which represents a departure from existing studies on natural disasters and violent conflict. I believe this design more accurately captures the relationship between the introduction of a natural disaster and the onset of violent conflict. Past studies that use country-year designs risk over-aggregating the time between the disaster and the onset of conflict, which subsequently conflates the existence of such relationships. My method avoids this conflation.

4.2 A Review of the Literature

The belief that global climate change increases the variability of extreme weather events has generated an enormous interest in investigating their impacts on human behavior

(IPCC 2007, 46; for further discussion see Salehyan 2008; Gledistch 1998; 2012). In particular, scholars are looking into what, if any, consequences climate change may have for the onset of violent conflict. Among these consequences, natural disasters have received a considerable amount of attention in existing literature because of their potential for immense destruction and mass disruption to state infrastructure (Bergholt and Lujala 2012; Brancati 2007; Nel and Righarts 2008; Slettebak 2012). Scholars argue that one way natural disasters may be linked to the onset of violent conflict is through the mechanism of an ‘eco shock’, an exogenously generated disturbance that disrupts the sources of state’s wealth and control. The extant literature almost uniformly focuses on their disruptions for economic growth at the expense of considering the broader negative effects they create for a state’s operational capacity. In the sections that follow, I briefly review the literate on natural disasters and explain how they are more salient in states that have limited capacity to absorb them.

4.2.1 Economic Growth, Natural Disasters & Violent Conflict

Inequality brought about by extreme poverty and negative economic growth rates are two of the most widely theorized correlates with the onset of violent conflict (Collier and Hoeffler 1998; 2004). Sharp, negative changes in income can increase inequality among social classes, which then exacerbate the latent grievances between them. This subsequently serves as a motivation for the poor to seek income redistribution through revolution (Boix 2003). In countries marked by abject poverty, recruitment is easier for rebel groups, because when people are poor they have a lower opportunity cost for joining a revolution.

(Humphreys and Weinstien 2008). In some instances, poverty can encourage income appropriation and low-level crime, while in more extreme cases it can even serve as the motivation for rebellion (Collier and Hoeffler 1998). Indeed, whatever the exact causal mechanism may be, income and income growth are two of strongest and most consistent predictors of violent conflict. Collier and Hoeffler (2004) find that conflict episodes are usually preceded by lower economic growth rates, while Hegre and Sambanis (2006) subsequently show that changes in GDP per capita is one of the most robust predictors of civil war onsets.

Ecoviolence theory suggests that natural disasters may affect the onset of violent conflict through changes in income because of the disruptions they create in a state's economic growth. These disruptions are typically referred to as 'eco shocks' because they have acutely negative influences on economic growth, but originate exogenously from environmental conditions (see Bergholt and Lujala 2012; Hendrix and Salehyan 2012 for further discussion). Whether it is large swings in seasonal temperatures, long-term changes in rainfall patterns, or the onset of natural disasters, these shocks are strongly associated with negative changes in economic growth rates (Bergholt and Lujala 2012; Ciccone 2011; Hidalgo et al. 2010; Miguel, Satyanath, and Sergenti 2004 2011; Oh and Reuveny 2010).

Eco shocks are the most salient for the comparatively poorer countries of the world with economies that are dependent on agricultural exports (Ellis 2000). These countries suffer the most because when weather events deviate from expected seasonal patterns these countries' crops often fail in extreme heat and wash away in extended downpours. When these shocks occur, the risk of violent conflict is expected to increase through the mechanisms brought about by acute changes in poverty from economic losses discussed in the civil war literature (see Collier and Hoeffler 1998; 2004; Humphreys and Weinstien 2008). Miguel, Satyanath, and Sergenti (2004) find evidence for these indirect effects in their initial study of rainfall variability in sub-Saharan Africa. However, these findings were subsequently challenged by Ciccone (2011) who argues that their study uses an operationalization of rainfall deviation that is mean reverting, which leads them to make a false conclusion on the relationship between rainfall, economic growth, and the onset of civil war. Miguel and Satyanath (2011) address Ciccone's (2011) concerns and, when using his alterative measure of rainfall variability, show that the initial statistical relationship remains unchanged. Support for a relationship between climate-induced income shocks and civil war onset also come from comparative politics as well. Hidalgo et al. (2010) demonstrate that droughts decrease economic productivity and increase the risk of conflict across Brazilian municipalities.

Unlike rainfall shocks, natural disasters may have even stronger and more interesting implications because these events usually occur more quickly and often without warning across a more diverse number of countries. This implies that analyses of these shocks from natural disasters should allow us make a firmer conclusion on the validity of such a theory because the spatial domain encompasses a larger and more heterogeneous sample. Moreover, natural disasters constitute the extreme end of an eco shock, and thus allows for a more obvious test of this theory. The following two examples illustrate this point.

In less than a day, on January 12^{th}, 2010 Haiti experienced a catastrophic earthquake that not only destroyed its capital, Port-au Prince, but also generated economic damages that totaled more than 123% of its GDP (quoted in Guha-Sapir et al. 2011). Similarly, the total economic losses results from Japan's March 11th, 2011 Tohoku earthquake and tsunami are estimated to cost between $250 and $309 billion dollars, or four times as much as the economic losses incurred by the United States in the aftermath Hurricane Katrina (quoted in Nanto, Cooper, and Donnelly 2011). The destructive effects of natural disasters affect thousands and cost countries millions of dollars (see Guha-Sapir et al. 2011 for a comprehensive discussion). Extrapolating the theory of eco shocks to these events, Bergholt and Lujala (2012) have looked for a similar indirect effect between natural disasters, economic decline, and the onset of violent conflict but cannot find evidence of similar relationship.

Overall, the connections between economic growth, environmental shocks, and the onset of conflict have received a great deal of attention, but their causal connections remain uncertain because it is not evident from existing studies what and a reduction in a state's economic growth may mean for the outbreak of conflict (for further discussion on the ambiguity of GDP and violent conflict see Holtermann 2012). Do economic losses imply a lower opportunity cost for rebellion or do they undermine a state's capacity for repression? Eco shocks aside, economic growth is largely a function of policy choices by political leadership and a state's institutional capacity to generate such growth (Arbetman-Rabinowitz and Johnson 2007, 4–6). Therefore, a more substantively interesting question is to ask what effects natural disasters may have for altering the risk of violent conflict at different levels of a state's capacity. It stands to reason that in the event of a natural disaster, the risk of violent conflict should be more salient for a country like Haiti than a like country like Japan, but is it?

4.2.2 State Capacity, Natural Disasters, & Violent Conflict

Natural disasters may also increase the risk of violent conflict in weak states with comparatively low levels of state capacity. Weak states are susceptible to the outbreak of civil war because they are less able to project military force and police their populations. Therefore:

> Most important for the prospects of a nascent insurgency, however, are the government's police and military capabilities and the reach of government institutions into rural areas. Insurgents are better able to survive and prosper if the government and military they oppose are relatively weak—badly financed, organizationally inept, corrupt, politically divided, and poorly informed about goings-on at the local level. (Fearon and Laitin 2003, 80)

It follows from the passage above that the risk of conflict is *a priori* larger in countries with weak and underdeveloped infrastructure because organizing is likely to go both unnoticed and unchallenged. Rebel groups are aware of these factors because they are considered predatory organizations (see Beardsley and McQuinn 2009). Thus, as Hendrix (2010, 273) notes, "the decision to rebel takes into account the government's capacity for repression and accommodation." Studies show that state capacity plays an important role in the ability of rebels to effectively challenge a government (Braithwaite 2010; Holtermann 2012). Highly capable states are not only more likely to win civil wars, but they are more likely to end them because they are better at credibly committing to negotiated settlements

(De Rouen et al. 2010; Sobek 2010). Although natural disasters may be related to the onset of violent conflict by changing economic opportunities for rebellion, disasters may also increase the risk of conflict because they undermine state capacity, which increases both the opportunity for survival and the operational capacity of a nascent insurgency (see Holtermann 2012 for a discussion of weak states and the onset of civil war). Economic growth differs from state capacity because the former is largely a reflection of the policy choices of resource allocation that can be changed by elites whereas state capacity is a measure of government extractive capability and resource mobilization (see Arbetman-Rabinowitz and Johnson 2007 for further discussion). Moreover, economic well being may also be a reflection of other possible mechanisms that are not directly related to state capacity, because of the aggregate nature of GDP per capita measures (Hendrix 2010). This is all to say that fiscal well being compared to the ability of a government project influence through its country are two theoretically different concepts, and therefore should be considered differently (for further discussion see Holtermann 2012).

The notion that natural disasters can directly affect state capacity is hardly disputed within the ecoviolence literature. The following excerpts provide evidence of this belief:

> Because the role of the state is often critical in reducing both vulnerability to climate change and the risk of violent conflict, and because the capacity of states is itself at risk from climate change, a third key aim of the research to enhance understanding of climate insecurity should be to examine the challenges climate change pose to states, including the capacity of the states to protect the livelihoods and sustain peace, recognizing of course that these may not be the goals of some states. (Barnet and Adger 2007, 650)

> Disasters, however, can reduce the capacity of states to suppress rebellion and concurrently increase the capacity of groups to fight, providing them with new

> sources of funding and new opportunities to attract support and recruit members. (Brancati 2007, 720)
>
> Natural disasters affect the structures of society by disrupting economic development, increasing income and wealth inequality, marginalizing certain groups, and by leading to large-scale migrations. Crucially, natural disasters can also weaken state capacity and legitimacy, creating opportunities for the disgruntled to engage in violent resistance. (Nel and Righarts 2008, 162)

Curiously, and despite the acknowledgement that the harmful effects of natural disasters are contingent on state capacity, there are few studies that investigate this possible connection. Although Gleditsch (1998) and Salehyan (2008) have both argued for the importance of studying interactive effects between environmental changes and political/economic institutions, only three studies have conducted such analyses.

Gizelis and Wooden (2007) find evidence that political institutions mitigate disputes over water scarcity; Slettebak (2012) shows that the risk of civil war increases when natural disasters occur within countries with larger populations; and Brancati (2007) finds that earthquakes are more likely to induce violent conflict in poorer countries. To the best of my knowledge, no published study considers the interactive relationship between natural disasters and *multiple facets* of state capacity across various forms of violent conflict.

4.3 Theory Refinement & Delineation of Causal Mechanisms

The principal contribution of this study is twofold. First, I assess the popular claim that certain aspects of state capacity mitigate (or exacerbate) the likelihood of violent conflict that arises from the destructive effects of natural disasters through a set of specific causal mechanisms. My point of departure begins with the premise that state capacity is multidimensional and comprised of the three dimensions that Hendrix (2010) finds most salient: ‘rational legality,’ ‘rentier-autocraticness’, and ‘neopatrimonialism’. ‘Rational legality’ captures the qualities associated with a modern, democratic state such as efficient bureaucracies, technological advancement and democratically elected representation; ‘rentier-autocraticness’ speaks to a state’s reliance on rents as its primary economic resource; finally, ‘neopartimonialism’ refers to aspects of a state’s extractive capacity to mobilize resources from its citizenry in a time of need (Hendrix 2010, 282). Even though the natural disasters have received a significant amount of attention in recent years from political scientists, (Beardsley and McQuinn 2009; Bergholt and Lujala 2012; Berrebi and Ostwald 2011; Brancati 2007; Nels and Righarts 2008; Slettebak 2012) there are surprisingly few specific theoretical expectations that assert what sort of effects natural disasters should have on each aspect of a state capacity. Rather, it is generally acknowledged that: (i) natural disasters either weaken or destroy state capacity, and (ii) that states with lower levels of capacity are more likely to experience the onset of violent conflict.

My second contribution regards the issue of measurement. Existing research does not adequately address the role to which seasonality influences the risk of violent conflict. The result of this shortcoming is that past research as uniformly uses a country-year research design. Doing so is problematic because it forces researchers to treat each month of the year as having an equivalent likelihood of experiencing a natural disaster; however, established meteorological research contradicts this claim. Therefore, research designs which test the relationship between natural disasters and the onset of violent conflict must account for monthly seasonal changes, where some months are more likely to have an increased frequency of natural disasters. If they do not, researchers risk misattributing the timing of the onset of a natural disaster with the onset of violent conflict, which can lead to a false conclusion on the veracity of such hypothesized relationships. Finally, by recognizing the importance of seasonality, one can distinguish between various causal pathways from natural disasters to conflict. Given the variation in forms of state capacity and importance of seasonality, I first present two different causal mechanisms by which natural disasters may increase the likelihood of violent conflict: the favorable, seasonal conditions for violent conflict and the unexpected disruption in people's lives brought about by unusual, extreme weather. Next, I follow with a detailed discussion of the how different aspects of state capacity act to mitigate the risk of conflict through these causal mechanisms.

4.3.1 Mechanism 1: Seasonality & Strategic Viability

The importance of seasonality for changes in weather patterns is an established fact within the meteorological community. Changes in temperature and precipitation oscillate according to various months of the year[22], not surprisingly so does the frequency of extreme weather. Indeed, NOAA's National Hurricane Center issues an annual report on the expected number of hurricanes to occur in the Atlantic Ocean, noting the Atlantic hurricane season begins June 1st and ends November 30th (National Weather Service 2013). During these months, countries in and around the Caribbean are likely to experience an increased risk of hurricanes as the warm water and tropical climate become more conducive for the

[22] See Chapter 2

onset of tropical depressions. Seasonal patterns of extreme weather are important because of their economic disruptiveness and overall threats to public safety. Indeed, the Chinese government regularly encourages its industrial sectors to exercise increased caution during its annual flood season due to an increased risk of accidents related to the negative effects of extreme weather (Xinhua 2012). Given the established changes in the frequency of extreme weather, it stands to reason that in months that have this increased frequency, states are at a higher risk for incurring heavy economic losses and damage to their infrastructure. In the aftermath of such destructiveness, the strategic viability of conflict increases for rebel groups because the state is temporarily weakened (see Section 4.2.2). Therefore, if ecoviolence theorists are correct, it is within these months of the year when extreme weather is most frequent, that we should observe an increased risk of violent conflict. These motivate the following set of hypotheses:

> Hypothesis 1(a): The probability of civil war onset increases as monthly count of natural disasters increases.

> Hypothesis 1(b): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as monthly count of natural disasters increases.

4.3.2 Mechanism 2: Extreme Weather & Equilibrium Disruption

The second pathway by which natural disasters may increase the onset of violent conflict is via an eco shock, which is an extreme deviation from expected weather patterns. Seasonal changes in weather patterns are events that societies experience throughout the year. Indeed, Steinberg reports (2000, 12) that the Philippines experiences more than twenty typhoons per season. Although this figure may sound high, it is not unusual for the Philippines because its geographic location places it in within the Pacific typhoon belt. Simply, this constitutes the normal frequency of storms for that area and the average Filipino will likely regard this a predictable, seasonal expectation.

The notion of an eco shock is concerned with the *unexpected* changes in established seasonal patterns, in which a country that usually experiences few (if any) natural disasters in a given month suddenly experiences several. For instance, there are an average of 12 named Atlantic hurricanes every season, but the last few years have seen this number be closer to 20, with the recent Hurricane Sandy being one of the most destructive storms ever recorded (quoted in Armario 2012). Indeed, such was the rarity of this storm that one New York resident remarked, “The wind may be strong, the noise, the sound, but I really don’t think it will be as bad as they say it will be” (quoted in ABC News 2012). Unfortunately, for this resident and many others, it was.

These extreme events represent unexpected deviations from long-term patterns, which the mechanism of an eco shock is intended to capture. Unexpected and extreme changes in expected climate patterns disrupt behavior and generate feeling of uncertainty in people's lives because they cannot adjust to their effects when those affected are not anticipating such events. Unexpected changes in the number and subsequent intensity of seasonal patterns of natural disasters are so salient because they have so much potential for widespread economic disruption and social dislocation. It is under these circumstances, when events deviate so dramatically from people's expectations and impact great portions of society that we may observe an increased risk in the outbreak of violent conflict because people are unable to respond rationally to such unexpected changes. Under these circumstances, this mechanism suggests the following hypotheses:

Hypothesis 1(c): The probability of civil war onset increases as number of people affected by natural disasters deviate positively from their long-term monthly means

Hypothesis 1(d): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as number of people affected by natural disasters deviate positively from their long-term monthly means

4.3.3 The Role of State Capacity in Violence Mitigation

Hendrix (2010) contends that, 'rational legality' speaks to the political and legal qualities that make a state democratic, modern, and functional. I argue that these characteristics are concomitant with democratic states because they usually imply the existence of a functioning social contract, efficient bureaucracies, the rule of law, and an atmosphere of political participation that is characterized by norms of peace and nonviolent competitiveness (Dixon 1994; Doyle 1986). By design, these states are more responsive to their constituents because they have comparatively large winning coalitions that force elected leaders to survive in office based on policy performance and the provision of public goods (Bueno de Mesquita et al. 1999). States that lack these characteristics have smaller winning coalitions with institutions based on the distribution of private goods to key political supporters. These states also often lack the rule of law and have little need for maintaining good public policy performance, or being sensitive to public demands because the institutional design does not encourage responsible governance.

Natural disasters affect a state's 'rational legality' through a state's institutional responsiveness to their citizens in these times of crises. According to Oh and Reuveny (2010, 244), when natural disasters occur they reduce spending and investments. In democracies, this reduction in public goods provisions (discretionary income for public spending) can translate into failed public policy and leadership turnover, but usually not the outbreak of mass violence. The institutional design of democracies means that those in power 'live to fight another day' because one leader's failure to provide public goods simply means that citizens will just elect another leader who can (Bueno de Mesquita et al. 1999). Simply put, most citizens usually perceive the institutional system as fair in a democracy. Its construction makes leaders sensitive to the demands of the public because the distribution of resources is largely non-excludable. Existing research suggests that citizens of democracies enjoy a higher standing of living from this public goods provision mechanism than autocracies. Citizens of democracies eat more, live longer, and are generally healthier (Blaydes and Kayser 2010; Bueno de Mesquita et al. 2003).

In autocracies however, leadership survival rests on the provision of private goods, which implies that autocrats are not as sensitive to public discontent. On average, citizens of autocracies are more likely to go hungry and are more likely to rebel because of it (Blaydes and Kayser 2010; Pinstrup-Anderson and Shimokaka 2008; Sen 1999; Sobek and Boehmer, Unpublished). Compounding this situation is trend that there are often no legal mechanisms for removing an autocrat who fails to reward his constituents with private goods. As a result, research shows that autocratic removal is often irregular and violent (Chiozza and Goemans 2003; Goemans 2008). Therefore, natural disasters that occur in states with low levels of 'rational legality' (i.e. autocracies) exacerbate two correlates with the onset of violent conflict. First, they reduce the pool of private goods used to reward an autocrat's supporters (Bueno de Mesquita et al. 1999, 2003). Second, and more directly related to issues of environmental scarcity, disasters create shortages of basic needs—like food and water—that further raises the risk of violent protest and armed rebellion from the poor and starving. And because autocrats are on average less likely to respond to the demands of a disgruntled public who have little influence in legitimizing their rule, the overall levels of latent political grievances are higher. In conjunction with the onset of a natural disaster, these factors create conditions that are ripe for violent conflict both through the existing favorable conditions for rebellion and by generating new, widespread grievances throughout an already repressed and (likely) disgruntled public. This motivates my second set of hypotheses:

Hypothesis 2(a): The probability of civil war onset increases as monthly count of natural disasters increases in states with low levels of ‘rational legality’.

Hypothesis 2(b): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as monthly count of natural disasters increases in states with low levels of ‘rational legality’.

Hypothesis 2(c): The probability of civil war onset increases as number of people affected by natural disasters deviate positively from their long-term monthly means in states with low levels of ‘rational legality’.

Hypothesis 2(d): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as number of people affected by natural disasters deviate positively from their long-term monthly means in states with low levels of ‘rational legality’.

‘Rentier-autocraticness’ is the dimension of state capacity that captures a state’s reliance on rents from nontax revenue as its primary economic resource. “Nontax revenue is anything that a government can spend without having to tax its citizens” (Morrison 2009, 114). For some states, this revenue comes from a high level of dependence on primary commodity exports sold in international markets. Oil, gemstones, and precious metals all generate enormous rents but employ a relatively small labor force for their extraction. Ross

(2001, 332) contends that if the revenue generated from these forms of rents is sufficiently large then it allows "…governments to either tax their citizens less heavily or not at all, which in turn makes the public less likely to demand accountability from or representation in their government." Another form of nontax revenue includes foreign aid, which also undermines state capacity by reducing political accountability, encouraging corruption, and sustaining authoritarian governments (Moyo 2009; Van de Walle 2001).

The evidence of a relationship between civil war and nontax revenue from primary commodities is uncertain within the literature (Collier and Hoeffler 1998; Fearon 2005; Humphreys 2005; Le Billion 2001; Lujala 2010; Morrison 2009; Ross 2004; 2012; Smith 2004). To the extent that natural disasters increase the risk of conflict through a state's 'rentier-autocraticness', one should expect them to do so by reducing the rents generated from primary commodities—specifically by damaging the infrastructure used in extraction and exportation.[23] A high dependence on resource rents makes these countries susceptible to the negative economic shocks created by natural disasters and subsequently reduces a state's ability to generate revenue (Oh and Reuveny 2010). For instance, in 2005 Hurricane Katrina crippled 95% of US oil production and 88% of its natural gas extraction in the Gulf of Mexico (Smith 2005). Although the sale of primary commodities only account for 1% of US's GDP, it is not a stretch to imagine that events like these may have serious destabilizing effect on the revenue for less stable states like Chad (Failed States Index 2012; World Bank

[23] I exclude from this analysis foreign aid because it is extremely difficult to distinguish between annually received aid and disaster assistance aid. Moreover, other forms of aid (i.e. military aid) are generally unreported. Therefore, I focus on rents based measures from primary commodities.

2012a) that has over 43% of its GDP comprised of rents from the sale of primary commodities (World Bank 2012a). Commodity rents not only obviate the need for taxation, and therefore representation, they also enhance a state's repressive capabilities (Ross 2001).

This combination of limited political accountability, high appropriation of rents, corruption, and widespread repression creates significant, latent political grievances. These may include demands for more representation, a fairer redistribution of these rents, or a complete change in government. When natural disasters destroy the economic infrastructure of these types of states, they open a window of opportunity for rebellion and other forms of political violence by temporarily limiting a state's ability to exercise coercion because these states sources of revenue are constrained. Since food and fuel subsides are often a typical feature of these regimes, used to placate the demands for political accountability and reward regime supporters, the threat of a natural disaster is extremely volatile. It may undermine the accommodative functions of the state because there is no revenue to fund these activities. Thus, natural disasters create multiple scarcities in basic needs and in the provision of subsidies and income, all while raising the overall level of latent grievances. Even the repressive arm can turn against the regime when the police and military go without paychecks because there are no rents left to pay them. This complex interaction between latent political grievances and resource scarcities in these states, and the frequency (and or major shock of) a natural disaster, creates a precarious situation that may manifest into conflicts ranging from violent protests to full-scale rebellions. This motivates my third set of hypotheses:

Hypothesis 3(a): The probability of civil war onset increases as monthly count of natural disasters increases in states with high levels of ‘rentier-autocraticness’.

Hypothesis 3(b): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as monthly count of natural disasters increases in states with high levels of ‘rentier-autocraticness’.

Hypothesis 3(c): The probability of civil war onset increases as number of people affected by natural disasters deviate positively from their long-term monthly means in states with high levels of ‘rentier-autocraticness’.

Hypothesis 3(d): The onset of non-state conflict, social protest, and other forms of people affected by spontaneous violence increases as number of natural disasters deviate positively from their long-term monthly means in states with high levels of ‘rentier-autocraticness’.

‘Neopatrimonialism’ is the final dimension of state capacity that natural disasters damage. This dimension simultaneously captures a state’s extractive capacity, ability to project force, and the overall economic development of its territory. Organski and Kugler (1980, 86) argue that, “the capacity of the political system to extract and aggregate resources is a critical element in the power of any nation.” However, the effects of ‘neopatrimonialism’ on the onset of conflict are somewhat ambiguous. One the one hand, there is anecdotal evidence in some countries with high levels of 'neopartimonialism' that they may actually have higher than expected levels extractive capacity, as well as an efficient system for rewarding its supporters or punishing its dissenters. Mexico is an example of such a country. The Institutional Revolutionary Party (PRI) successfully leveraged its large public works system and comparatively modern infrastructure via a poverty relief program (PRONASOL) to sustain its rule for decades (Magaloni 2006). However, this seems to be the exception rather than the rule.

Most states with high levels of 'neopartimonialism' have lower than expected levels of extractive capacity and a severely limited ability to mobilize resources from their territories. Van de Walle (2001) argues that many of the economic conditions we see today in Africa are a result of widespread 'neopatrimonialism' that resulted in a deliberate neglect of sustainable economic development. Indeed, it is hard to refute such an argument when over 700 million Africans are nearly as poor as they were thirty years ago, have a continent-average life expectancy of 50 years, with over 50 percent of these countries still under authoritarian rule (Moyo 2009, 5–6). Even the distribution of resources is severely constrained despite the billions of US dollars in assistance that Africa has received over the past several decades. Indeed, it is shocking that the transportation of goods and services from East Africa to West Africa by land takes longer than sailing the same goods and services around the entire continent (Moyo 2009). Hence, 'neopatrimonialism' seems more likely to be negatively correlated with state capacity than positively correlated, and Africa's historical experience is a sad, stark example of this phenomenon.

This implies that we should expect countries with low levels of ‘neopatriomonialism’ to have higher levels of overall extractive capacity (Hendrix 2010), and generally be more capable in resource extraction for mobilizing their resources in times of need. These differences in ‘neopatrimonialism’ call attention to how, and if, a government can mobilize resources in the event of violent conflict, whether it is for generating revenue, monitoring its citizens, or moving military forces throughout its territory (see introduction). These abilities have consequences for the onset of violent conflict because the ability to extract and mobilize resources from society requires both a certain level infrastructure and willingness. States that are capable of extracting resources from their societies can accomplish two things: identify individuals, or groups, for the purposes of collecting such resources, and if needed, apply coercion to obtain those resources. Hendrix (2010, 273) contends that, “for a state to repress, it must be able to identify potential rebels and apply coercion. For a state to accommodate, it must be able to redistribute resources and power.” States with high levels of ‘neopatrimonialism’ will not or largely, cannot accomplish these tasks.

Natural disasters affect the extractive capacity of a state because they damage the infrastructure necessary for allowing states to extract resources and repress their populations. When disruptions in extractive and distributional capacity occur, as in the case of Pakistan’s Alpurai-Besham highway (see introduction), states cannot mobilize the resources to disaster stricken areas for purposes of alleviating the suffering from scarcities in food, water, and shelter. This raises political grievances.

Recently, the Chinese province of Lushan experienced a 6.6 magnitude earthquake that killed 186 people and affected over 11,000 (NBC News 2013). Given the remoteness of the area and the level of devastation inflicted, this earthquake serves to illustrate the degree of frustration experienced by those affected. A resident is quoted, "We are in the open air here. No place to sleep, nothing to eat. No one is paying any attention to us" (quoted in NBC News 2013). The level of remoteness impairs the Chinese government's ability to effectively deal with the situation, and consequently serves to increase grievances. As another citizen remarked "If they continue to ignore us like we are trivial, we will have no choice but to protest" (quoted in NBC News 2013).

In addition to raising political grievances, these disruptions also impair the coercive capacity by limiting its reach throughout the country. Consequences of this include an increase in the political opportunity of resource looting, low-level crimes, and engaging in armed rebellions. It also creates domestic crises, which threatens leadership tenure and undermines the combat readiness of a country's armed forces. Thus, states with high levels of 'neopatrimonialism' and low levels of extractive capacity appear the most at risk for violent conflict when natural disasters cripple their already weak extractive and distributional capacity either through an increased seasonal frequency or from dramatic deviational shocks. This motivates my final set of hypotheses:

> Hypothesis 4(a): The probability of civil war onset increases as monthly count of natural disasters increases in states with high levels of 'neopatrimonialism'.

Hypothesis 4(b): The onset of non-state conflict, social protest, and other forms of spontaneous violence increases as monthly count of natural disasters increases in states with high levels of ‘neopatrimonialism’

Hypothesis 4(c): The probability of civil war onset increases as number of people affected by natural disasters deviate positively from their long-term monthly means in states with high levels of ‘neopatrimonialism’

Hypothesis 4(d): The onset of non-state conflict, social protest, and other forms of people affected by spontaneous violence increases as number of natural disasters deviate positively from their long-term monthly means in states with high levels of ‘neopatrimonialism’

4.4 Research Design & Data

The purpose of this study is to assess the claim that state capacity mitigates (or inflames) the risk of violent conflict from natural disasters. Because it is unclear whether these effects are systematic, I test these assertions across various forms of violent conflict in accordance with the hypotheses previously specified. I use a country-month as my unit of observation, which represents a departure from existing studies of natural disasters and violent conflict. I believe that this design more accurately capture the relationship between the introduction of such a high-profile event and the onset of violent conflict. Past studies that use country-year units of analysis risk over-aggregating the time between the disaster and the onset of conflict and conflating the existence of such relationships. Using this more disaggregated research design avoids conflation.

4.4.1 Dependent Variables

My dependent variable for testing intrastate conflict is civil war onset from 1948–2010 from the UCDP/PRIO Armed Conflict Database (Gleditsch et al. 2002; Harbom and Wallensteen 2010). This is a binary variable indicating the annual onset of an internal or international intrastate conflict that results in 25 or more annual battle deaths. Because I am interested in the onset of civil war rather than incidences, I use the standard convention in the literature of assigning a value of 1 to indicate when a new onset emerges, when a conflict remerges after two years of peace, or when a new rebel party becomes a new combatant in an ongoing war to which it was not a party in the previous year. For a more stringent test of this relationship, I also include separate models that estimate the effect of natural disasters on the risk of high intensity civil war using the 1,000 or more battle death threshold

For my analyses of organized, violent events short of a civil war, I use the Uppsala Conflict Data Programs (UDCP)'s Non-State Conflict Dataset Version 2.4 (Sundberg, Eck, and Kreutz 2012). Non-state conflicts are defined as "the use of armed formed between two organized armed groups, neither of which is a government of a state, which results in at least 25 battle related deaths in a year" (Sundberg, Eck, and Kreutz 2012, 352–353). Finally, for my analysis of more spontaneous forms of violent conflict, I use two regional databases. The first database is the Social Conflict in Africa Database (SCAD) 1990–2010, which provides information on protests, riots, and other social disturbances in Africa (Salehyan et al. 2012). From SCAD, I use the count of violent social protest events—specifically organized violent riots, spontaneous violent riots, pro-government violence, anti-government violence, extra-government violence, and intra-government violence in a given month (see Salehyan et al. 2012). The second database is the Integrated Conflict Early Warning System (ICEWS) Asia dataset, which collects data on a variety of political instability indicators including violent conflict events (O'Brien 2010). From ICEWS, I use the count of assaults, fights, and unconventional mass violence in a given month.

These regional datasets are preferable over others because the negative effects of extreme weather are expected to be felt disproportionately in less developed countries with comparatively lower than average levels of state capacity (IPCC 2007; Mendelsohn, Dinar, and Williams 2006). Countries with these characteristics are located primarily within the Africa and Asia. If we are to expect the onset of violent conflict from natural disasters, it is reasonable to assume that this area of the world be where we should observe it.

Unlike my analyses at the intrastate level, these non-state conflicts, social protests, and spontaneous violent events are often correlated across time as one event makes another more likely to occur. This tendency makes it is more difficult to discern their independence from one another for the purposes of coding unique and independent onsets. Therefore, my dependent variables for these events report the 'counts' violent protests in a given month.

4.4.2 Independent Variables

Data on natural disasters are from the Emergency Events Database (EM-DAT) from the Centre for Research on the Epidemiology of Disasters (CRED 2012) from 1945–2010. According to CRED, an event is defined as a natural disaster when it meets one of four criteria: 10 or more disaster-related deaths, 100 or more affected people, an official declaration of a state of emergency, or an official call for international relief assistance. Because I am interested in the effects of natural, exogenous processes, I exclude man-made natural disasters in my analysis and use only meteorological, hydrological, climatological, and geological disasters. Table 4-1 lists the main disaster types of each of these categories according to EM-DAT.

Table 4-1: EM-DAT Disaster Categories

Table 4-1

Climatological	Geological	Hydrological	Meteorological
Storm	Earthquake	Flood	Extreme Temperature
	Volcanic Eruption	Mass Movement (wet)	Drought
	Mass Movement (dry)	Landslide	Wildfire
		Avalanche	
		Subsidence	

For operationalizing my tests of ‘Seasonality and Strategic Viability’ mechanism, I use *Disaster Frequency*, which is the count of the number of meteorological, hydrological, climatological, and geological disaster in a given month. The expectation this measures is that a higher frequency of natural disasters in a given month increases the strategic viability for violent conflict as it weakens state infrastructure making it difficult to maintain its monopoly of violence.

For my tests of 'Extreme Weather Shocks and Equilibrium Disruption', I use an eco shock measure similar to Hendrix and Salehyans' (2012) measure for rainfall deviation. *Disaster Shock* is measured as the monthly deviation in the number of people affected by natural disasters difference from a country's long-term monthly average (mean) number of people affected, indicated by $(X_{itz}-X_{it-bar})/\sigma_{it}$ where X_{itz} is the mean number of people affected by natural disasters in a country (i) in a given month (t) in year (z) and X_{it-bar} is the panel mean of country's (i) long-term monthly (t-bar) average number of people affected from 1945–2010, and σ_{it} is the standard deviation of that panel. Employing this operationalization of an eco shock measure is preferable compared to other measures because its construction acknowledges that climate is different than weather, speaking to extended periods of time rather than changes from month-to-month. Moreover, this measure is standardized, allowing for meaningful comparisons of deviational differences between countries. The expectation with this measure is that larger deviations in the expected number of people affected by natural disasters in a given month from the historical average increases the degree of frustration and disruptiveness throughout society, which may motivate violent conflict as more people who typically unaffected become affected.

The multidimensionality of state capacity necessitates a variety of different measures (see for further discussion see Hendrix 2010) to robustly capture the intended concept. I proxy 'rational legality' using Vreeland's (2008) *Xpolity*, which is a measure of regime type that is summation of three ordinal measures of the Polity IV index: constraints on the executive, competitiveness of executive recruitment, and the openness of that recruitment (Marshall and Jaggers, 2010). *Xpolity (lag)* ranges from 1945–2010 on a scale from most autocratic and exclusive (1) to most democratic and inclusive (14). I use, *Resource Rent as % of GDP (lag)*, which is the total natural resource rents as a percentage of GDP as a proxy for the 'rentier-autocraticness' of state capacity. These rents include the sum of all rents derived from oil, natural gas, coal, minerals, and forestry. The data have a temporal range 1960–2010 with global coverage and are taken from the World Bank's World Development Indicators (2012). Lastly, for measuring 'neopatrimonialism' I use *Relative Political Reach (lag)*, 1960–2007, from Arbetman-Rabinonwitz, et al. (2011; 2012). This measure is calculated as the ratio of a state's actual activity rate to is predicted activity rate. Arbetman-Rabinonwitz et al. (2011, 2) contend that relative political reach "establishes the degree to which the government influences and penetrates the daily lives of individuals." Each state capacity measure is aggregated at the country-year level of analysis. Ideally, I would use monthly measures of these variables, however these do not exist. As a result, I assign the same yearly value for each month of a given year, but recognize the preferable measure is lacking. Despite this drawback, it is important to note that measures of state capacity change relatively slowly over time, especially month-to-month. Thus, what is most important is for this study is when disasters occur, the frequency and unusualness of these occurrences in terms of the number of people affected, and how these patterns relates to a state's general level of capacity and whether the interactions are associated with a higher probability of violent conflict onset.

4.4.3 Controls & Estimators

Unfortunately, the onset of civil wars are not known with precision in Uppsala datasets and because the focus of this analysis seeks to explain the importance of seasonality and temperature, I include a binary variable indicating the first month of the year in all intrastate and non-state conflict models to address the uncertainty in this coding practice. I control for country size with the log of *Population* (in thousands) using data from Gleditsch's (2002) expanded trade and GDP data, supplemented with Penn World Tables version 7.0 (Heston, Summers, and Aten 2011) and the World Bank (2012b) to broaden and extend the time series from 1948–2010.[24] Larger countries require larger amounts of resources for coercion and are at a higher risk for the onset of violent conflict. Extant research has routinely demonstrated that countries with large populations are more likely to experience the onset civil war and social protest (Collier and Hoeffler 2004; Fearon and Laitin 2003; Hegre and Sambanis 2006; Hendrix and Salehyan 2012).

Wealthier, more economically developed countries face a higher political opportunity for rebellion. Their standards of living are far greater relative to poorer countries, which implies that their grievances are not nearly as salient (Collier and Hoeffler 2004; Hegre and Sambanis 2006). Thus, I control for *GDP per Capita* in constant US dollars using Gledistch's (2002) expanded trade and GDP data supplemented with Penn World Tables version 7.0 (Heston, Summers, and Aten 2011) and the World Bank (2012b) to

[24] Note that all of these measures correlated at $x > .90$

broaden and extend the time series from 1948–2010.[25] These economic measures are logged to account for outlying observations that may inadvertently influence the analysis. I also control for the regime type using *Xpolity*, 1948–2010, and other measures of state capacity by sequentially adding them in estimations of Hypotheses 1–4.

In addition, I also include a binary variable indicating years influenced by the El Niño /Southern Oscillation in accordance with the Center for Ocean-Atmospheric Prediction Studies ENSO index (2012). Among other things, ENSO is responsible for warmer ocean temperatures and unusual shifts in meteorological factors, which can subsequently contribute to an increased likelihood of extreme weather. In order to distinguish this general effect from natural disasters specifically, I control for its influence.

I also include a time trend to account for temporal dependence in conflict using Carter and Signorinos' (2010) linear, quadratic, and cubic counts of time. Finally, all variables except the measures of natural disasters use the same yearly value for each month, and are therefore lagged 12 months to address the simultaneity with the onset of conflict.[26]

All estimations are estimated in STATA 12. Models of the onset of intrastate conflict use logistic regression, which include robust standard errors clustered on country. Additionally, I also estimate models with conditional fixed effects to correct for the exclusion of potentially influential country-level attributes that may be correlated with both natural disasters and the onset of conflict. Estimations of non-state conflict and social protest use negative binomial regression to account for over-dispersion in the count structure

[25] See above footnote

[26] For a detailed discussion of simultaneity with state capacity measures and economic growth see Thies (2010), Miguel, Satyanath, and Sergenti (2004), or Vreeland (2008).

of the dependent variable. These models also use robust standard errors clustered on country as well as with conditional fixed effects. Substantive effects of the results of Table 4-2 are generated using the CLARIFY software from the estimations (King, Tomz, and Wittenburg, 2000; Tomz, Wittenberg, and King 2003) and illustrations of the conditional marginal effects for estimations in the remaining tables are generated using modified STATA 11 code from Brambor, Clark, and Golder (2006). Fixed effects models are denoted with an even number (i.e. 2, 4, 6…). Finally, for the sake of relevance, redundancy, and reader convenience, I only present and discuss graphical illustrations of conditional marginal effects when they are substantively interesting and/or statistically significant.[27]

4.5 Results & Discussion

The results of the empirical results of testing Hypotheses 1(a), 1(b), 1(c), and 1(d) are displayed in Table 4-2**.** The results indicate strong variation the in risks posed by natural disasters with respect to both theoretical mechanisms and the types of violent conflict they are expected to illicit. As shown in Table 4-2 the results indicate tepid support for Hypothesis 1(a) and 1(b) which argue that an increase in the number of natural disasters a country experiences in a given months increases the risk of violent conflict. Holding all corresponding measures at their relevant means and modes, a change in the monthly modal value of natural disasters (0 to 1) increases the probability of high intensity civil war onset by 38.7% (.0031 to .0043) and the expected count of violent social protests in Africa by

[27] Figures for the conditional marginal effects of the remaining estimations are contained within the "4.7 Appendix" Section of this chapter.

15.2% (.0780 to .0899). These results are supportive of the argument within the literature that contends natural disasters generally raise the risk of violent conflict.

These results are contradicted however, when measuring natural disasters by their degree of shock in a given month. The results in Table 4-2 contradict Hypothesis 1(c) and reject 1(d). Curiously, when using a measure of *Disaster Shock*, which measures the degree to which the number of people affected by a disaster deviates from its long-term monthly mean, the results show that positive deviations are associated with a strong decrease in the probability of low intensity civil wars by 108% (.0094 to -.0007) and high intensity civil war onsets by 106% (.0033 to -.0002).

When looking at various measures of state capacity results are generally supportive of the existing arguments within the literature. Across the majority of models, the sign on the coefficient for *Relative Political Reach (lag)* is negative, and statistically significant in Models 1, 2 and 8. The sign on the coefficient for *Resource Rents as % of GDP* is uniformly positive, consistent with the argument that rents increase the risk of violent conflict (see Ross 2001) and statistically significant in Models 1, 5, 6, 8, and 9. The coefficient on for regime type, *Xpolity (lag)* shows no consistency with respect to the sign of the coefficient and is in some cases significant and positive (in Models 7, 8, and 10). Although this may be surprising to the informed observer, I suspect these findings are largely the result of missingness on the other measures of state capacity, some multicollinearity, and the penalizing influence of fixed estimations in half the estimations. The sign of the coefficient of the binary indicator for El Niño is positive and statistically significant in Models 7 and 8, which is supportive of the argument that ESNO may increase the risk of violent conflict during years when it is active (Hsiang, Meng, and Cane 2011). This result is particularly interest because it suggests that this effect influences the onset of violent conflict in spite of these various measures for natural disasters—a finding which perhaps implies a different casual mechanism than the ones proposed in this chapter. Finally, the results for the remaining controls behave largely as expected with *Population* size associated with an increased in the probability of violent conflict, and *GDP per Capita* acting to reduce the risk of more organized forms of violent conflict (i.e. civil war and non-state conflict).

Table 4-2: Country-Month Estimation Results

Country-Month Table 4-2	**(1) ACD (25+ Dead) 1960–2007**	**(2) ACD (25+ Dead) 1960–2007**	**(3) ACD (1000+Dead) 1960–2007**	**(4) ACD (1000+Dead) 1960–2007**	**(5) UCDP 1989–2007**	**(6) UCDP 1989–2010**	**(7) SCAD 1990–2007**	**(8) SCAD 1990–2007**	**(9) ICEWS 2000–2007**	**(10) ICEWS 2000–2007**
Negative Binomial DV (lag)	---	---	---	---	.0468216	-.1708967	.0976723**	.0390947**	.0266254**	.0150417**
					(.3390332)	(.2779143)	(.0393297)	(.0125484)	(.0042898)	(.0035159)
Disaster Frequency	.2235957+	.1849296	.3417615**	.2923532*	-.1906591	-.0380914	.1409436**	.1447423**	-.0476383	.0025898
	(.1382953)	(.1293839)	(.1559244)	(.1469717)	(.1578689)	(.1418492)	(.033182)	(.0470912)	(.0302564)	(.0180568)
Disaster Shock	-1.64e-06 **	-1.65e-06	-1.48e-06**	-1.67e-06	-6.35e-08	-2.80e-08	1.97e-08	9.45e-09	-3.58e-10	-1.12e-09
	(5.36e-07)	(1.07e-06)	(4.70e-07)	(1.31e-06)	(4.05e-08)	(6.66e-08)	(1.86e-08)	(2.73e-08)	(1.70e-09)	(1.16e-09)
Relative Political Reach (lag)	-.5589749**	-2.435913**	-.6403806+	-1.594536	-.041953	-1.315407	.1369871	2.414736**	-.5469221	-.7095713
	(.255354)	(.8584367)	(.3846704)	(1.126579)	(.53059)	(1.062563)	(.1664731)	(.3804051)	(.3834797)	(.8236222)
Resource Rents as % GDP (lag)	.0100989**	.0036933	.003098	.0062203	.012405*	.0403497**	.0017426	.0138651**	.0172463**	.0078336
	(.0037757)	(.0094133)	(.0061556)	.0109481	(.0063643)	(.0144274)	(.0029106)	(.0052712)	(.0040717)	(.0052285)
Xpolity (lag)	.0010343	.0316752	-.0434015+	-.0080859	-.0558051+	.0082072	.0332723**	.0373513**	-.0026087	-.0671714**
	(.0199522)	(.0277806)	(.0270364)	(.0384021)	(.0304548)	(.0256817)	(.0134827)	(.0111424)	(0557541)	(.0211162)
GDP Per Capita (lag)	-.3200006**	-.3074259	-.0927769	-.1739449	-.540606**	.0369418	.0366013	.0045479	-.0624507	.35036**
	(.0780757)	(.2079352)	(.1203701)	(.2946573)	(.0905008)	(.1916211)	(.0629953)	(.0657634)	(.0557541)	(.0911987)
Population (lag)	.1878109**	.0019919	.0788163	.1277121	.4178337**	.1501952	.3250467**	.772082**	.1609155**	2.333005**
	(.0715214)	.3465837	(.0836842)	(.4638789)	(.0730945)	(.1636546)	(.0516109)	(.3140601)	(.0399439)	(1.125332)
El Niño	-.1524602	-.1371881	-.2883401	-.2475274	-.0833823	-.2327302	.1640297*	.1762385*	.0395042	.197376**
	(.1692258)	(.1947551)	(.2431052)	(.2733872)	(.2181686)	(.2286736)	(.0746224)	(.0591853)	(.0466219)	(.0756047)
January	1.590786**	1.576744***	1.903082***	1.832569***	.0852375	.0362165	---	---	---	---
	(.3046282)	(.1653483)	(.3726742)	(.2103581)	(.2477938)	(.2898045)				
Peace Months	-.0146116**	-.0021189	-.0095192**	-.0019358	-.0713006**	-.0296882**	-.3819125**	-.3956068**	-1.567189**	-1.291646**
	(.0000106)	(.0036206)	(.0036125)	(.0047896)	(.0138844)	(.0132794)	(.0724094)	(.0179807)	(.2287576)	(.2270437)
Peace Months^2	.0000362**	-.0000129	7.17e-06	-.0000182	.00065**	.0002083	.0099321*	.0108095**	.0942112**	.0775282**
	(1.03e-08)	(.0000163)	(.0000146)	(.0000213)	(.0001609)	(.0001963)	(.003186)	(.0007208)	(.0237367)	(.0223827)
Peace Months^3	-2.86e-08**	4.03e-08**	-2.05e-09	4.35e-08+	-1.81e-06**	2.60e-07	-.0000693*	-.0000779**	-.0014708**	-.0012003*
	(.7690242)	(1.96e-08)	(1.43e-08)	(2.46e-08)	(5.10e-07)	(7.54e-07)	(.0000326)	(7.32e-06)	(.000561)	(.0005118)
Constant	-3.118094**	---	-3.416585**	---	-2.73002*	---	-4.013885	---	1.191847**	---
			(1.104526)		(1.266734)		(.6575876)		(.3913057)	
Observations	32965	19154	32965	9359	19898	7048	5685	5685	1993	1993
Log Pesudolikelihood	-1035.3496	-847.18895	-563.76169	-455.69761	-824.77045	-654.78961	-3059.8029	-2909.9328	-5651.3695	-5389.6693
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses **p < 0.01; *p < 0.05; $^{+}$p < 0.1 (reported, but not discussed);

<u>Note:</u> Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects models

Although the results of displayed in Table 4-2 are interesting in their own regard, the persistent belief within the literature is that natural disasters influence the risk of violent conflict *contingent* on their relationship to a state's capacity. Therefore, what is of most theoretical interest is not the marginal effects of these measures (natural disasters and state capacity), but their conditional marginal effects on the onset of violent conflict. Therefore, in the remaining estimations, I search for evidence of these relationships. Table 4-3 and Table 4-4, display the results for testing Hypotheses 2(a) –2(b) and Hypotheses 2(c)–2(d), respectively.

Table 4-3: Country-Month Estimation Results

Country-Month Table 4-3	**(1) ACD (25+ Dead) 1960–2007**	**(2) ACD (25+ Dead) 1960–2007**	**(3) ACD (1000+Dead) 1960–2007**	**(4) ACD (1000+Dead) 1960–2007**	**(5) UCDP 1989–2007**	**(6) UCDP 1989–2010**	**(7) SCAD 1990–2007**	**(8) SCAD 1990–2007**	**(9) ICEWS 2000–2007**	**(10) ICEWS 2000–2007**
Negative Binomial DV (lag)	---	---	---	---	.0485595	-.1715315	.0985045*	.0519915*	.0266564**	.0150657**
					(.3431363)	(.2783499)	(.0390598)	(.026067)	(.0044564)	(.0035164)
Disaster Frequency	.6680889*	.8861545**	.7893237*	.9133777**	-.2233447	-.0266767	-.0204863	.080164	-.0355726	.0435998
	(.3254154)	(.2965508)	(.3722608)	(.3321425)	(.2509398)	(.3179692)	(.1443968)	(.0857073)	(.1151709)	(.0448427)
Disaster Shock	-1.70e-06**	-1.71e-06	-1.58e-06**	-1.80e-06	-6.38e-08+	-2.78e-08	2.04e-08	1.40e-08	-3.64e-10	-1.12e-09
	(5.20e-07)	(1.08e-06)	(4.32e-07)	(1.33e-06)	(3.96e-08)	(6.68e-08)	(1.84e-08)	(2.01e-08)	(1.72e-09)	(1.17e-09)
Xpolity X Disaster Frequency	-.0429521	-.0667388**	-.0442476	-.0607931*/+	.003343	-.0011718	.0162937	.0071458	-.001159	-.0038308
	(.0333247)	(.0274063)	(.0410446)	(.0313849)	(.0253277)	(.0292637)	(.0145591)	(.0079971)	(.0111122)	(.0046418)
Relative Political Reach (lag)	-.5628959*	-2.453008	-.6374957+	-1.555905	-.0419537	-1.31572	.1323695	2.179593+	-.546906	-.7076702
	(.2625518)	(.8627584)	(.3920419)	(1.132947)	(.5305248)	(1.062278)	(.1665809)	(1.122097)	(.3830721)	(.8201256)
Resource Rents as % GDP (lag)	.0096993**	.0027004	.0026427	.0052497	.012409*	.0403462**	.001766	.013657	.0172274**	.0078445
	(.0038232)	(.0094086)	(.0062438)	(.0109393)	(.0063663)	(.0144268)	(.0028956)	(.0053857)	(.0041761)	(.005224)
Xpolity (lag)	.0097586	.0494745+	-.0322959	.0131031	-.0564684+	.0084365	.030861*	.0288973	-.0017107	-.0657526**
	(.0205686)	(.0291415)	(.0256161)	(.0402695)	(.0329473)	(.026312)	(.0135605)	(.0234831)	(.0289344)	(.0202111)
GDP Per Capita (lag)	-.318538**	-.28651	-.0860305	-.1481011	-.5406309**	.0371334	.0363655	.0030466	-.0629691	.3495679**
	(.0788147)	(.2096169)	(.1227614)	(.2979365)	(.0906031)	(.1916901)	(.062328)	(.0909986)	(.0573382)	(.0916174)
Population (lag)	.1879382**	-.0122108	.0784285	.1424245	.417612**	.149839	.3245189**	.8594865*	.1607255**	2.333771**
	(.0729355)	(.3463607)	(.0816518)	(.4627179)	(.0736939)	(.1638909)	(.0514107)	(.3999695)	(.0407209)	(1.125373)
El Niño	-.1567044	-.1432352	-.2960793	-.26071	-.0839779	-.2327996	.1650253*	.1714734*	.0388775	.197173*
	(.1711441)	(.1952156)	(.244094)	(.274508)	(.2187049)	(.2286825)	(.0737986)	(.0792618)	(.0465636)	(.0755601)
January	1.594537**	1.574516**	1.910671**	1.843357**	.0850242**	.0364446	---	---	---	---
	(.3035075)	(.1655155)	(.3747954)	(.2107693)	(.2482797)	(.2898656)				
Peace Months	-.0145932**	-.0018984	-.0094347+	-.0014576	-.0712937**	-.0296769*	-.3816259**	-.339604**	-1.566784**	-1.29139**
	(.0027972)	(.0036218)	(.0036677)	(.0047981)	(.013906)	(.0132826)	(.0724642)	(.0693777)	(.2279416)	(.2269993)
Peace Months^2	.0000361**	-.0000135	6.83e-06	-.0000199	.0006501**	.0002082	.0099242**	.0089003*	.0941858**	.0775174**
	(.0000107)	(.0000163)	(.0000147)	(.0000213)	(.0001608)	(.0001963)	(.0031859)	(.0030732)	(.0236983)	(.0223855)
Peace Months^3	-2.85e-08**	4.07e-08*	-1.74e-09	4.54e-08+	-1.81e-06**	2.60e-07	-.0000692*	-.0000618*	-.0014704**	-.0012002**
	(1.03e-08)	(1.96e-08)	(1.43e-08)	(2.45e-08)	(5.10e-07)	(7.54e-07)	(.0000326)	(.0000313)	(.0005607)	(.0005119)
Constant	-3.199717**	---	-3.557367**	---	-2.722937*	---	-3.983045**	---	1.188189**	---
	(.7811779)		(1.149825)		(1.278763)		(.6552935)		(.3863295)	
Observations	32965	19154	32965	9359	19898	7048	5685	5685	1993	1993
Log Pesudolikelihood	-1034.1558	-844.45364	-562.73514	-453.91547	-824.76427	-654.78881	-3059.3377	-2966.5481	-5651.352	-5389.4624
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses **p < 0.01; *p < 0.05; $^{+}$p < 0.1 (reported, but not discussed);
Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects models

Table 4-3 shows the results of the multiplicative interaction between the monthly frequency of natural disasters and ‘rational legality’. An interpretation of these results rests on the relationship to values of each other measure. Therefore, the marginal effects of these interacted variables, which are displayed in Table 4-3 are now conditional marginal effects in light of their multiplication for the remaining estimations, and therefore must be interpreted with extreme caution. Thus, although the sign on *Disaster Frequency* is both positive and statistically significant for Models 1,2, 3, and 4 in Table 4-3, the effect is only interpreted when the measure of *Xpolity (lag)*, is effectively zero. This result is ultimately of little interest as there are actual cases under which this condition can be true.[28] Conversely, *Xpolity (lag)* is now interpreted relative *to Disaster Frequency* when it is zero. In this latter case, it is possible to consider this coefficient with *Disaster Frequency* is zero because it is realistically possible and constitutes the modal value observed through the dataset; however, the results are inconsistent and largely insignificant. Moreover, what is most interesting is not the marginal effects, but their conditional marginal effects produced by their interaction between these two measures. As indicated in Table 4-3, the sign on the coefficient for the interaction term is negative and statistically significant in Models 2 and 4 (low intensity and high intensity civil wars), indicating initial support for the Hypothesis 2(a), which argues that increasing frequency of natural disasters is mitigated by increasing levels of a state’s ‘rational legality’ as proxied by increasing values of *Xpolity*. However, these results are

[28] Somalia probably being the only case. However, given the nature of the Vreeland’s (2008) *Xpolity* coding, it is impossible in this instance.

better understood via graphical illustration across the range of values for regime type. These results are shown in Figure 4-1 and Figure 4-2 below:

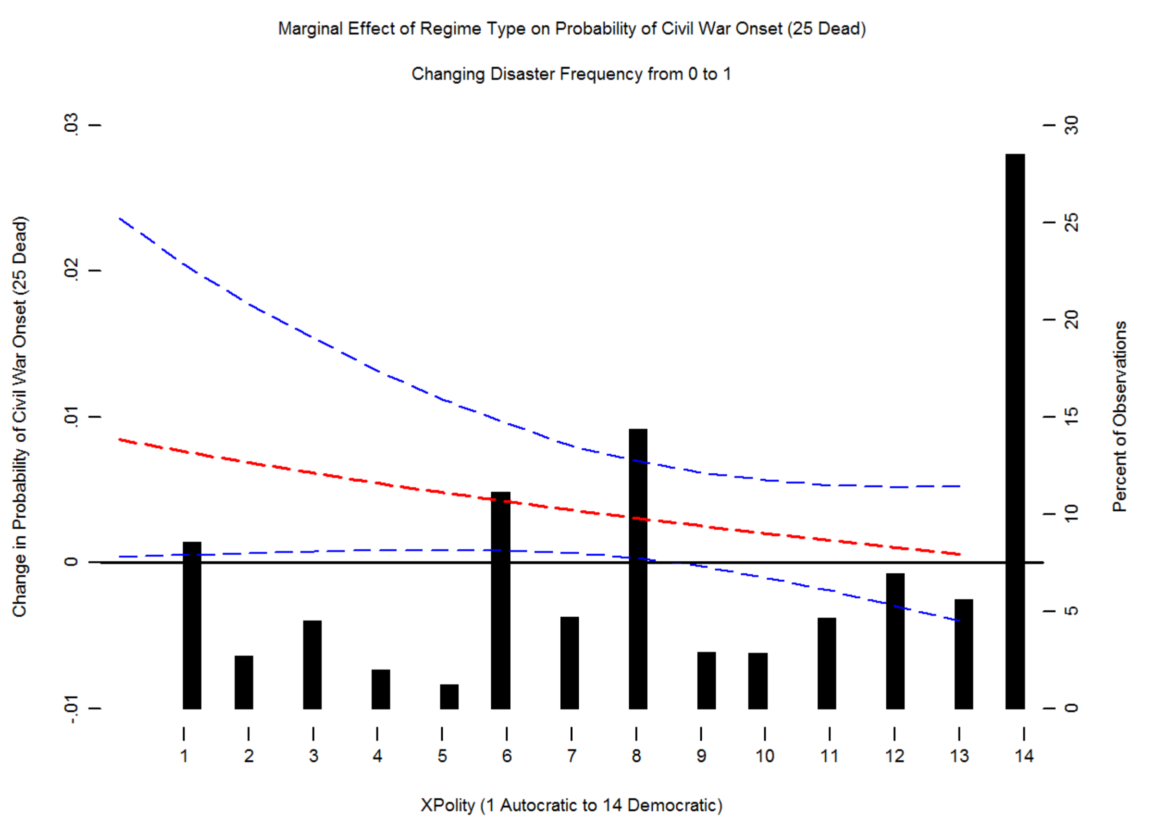


Figure 4-1: Marginal Effect of Regime Type on the Probability of Low Intensity Civil War Onset Using Disaster Frequency Measure

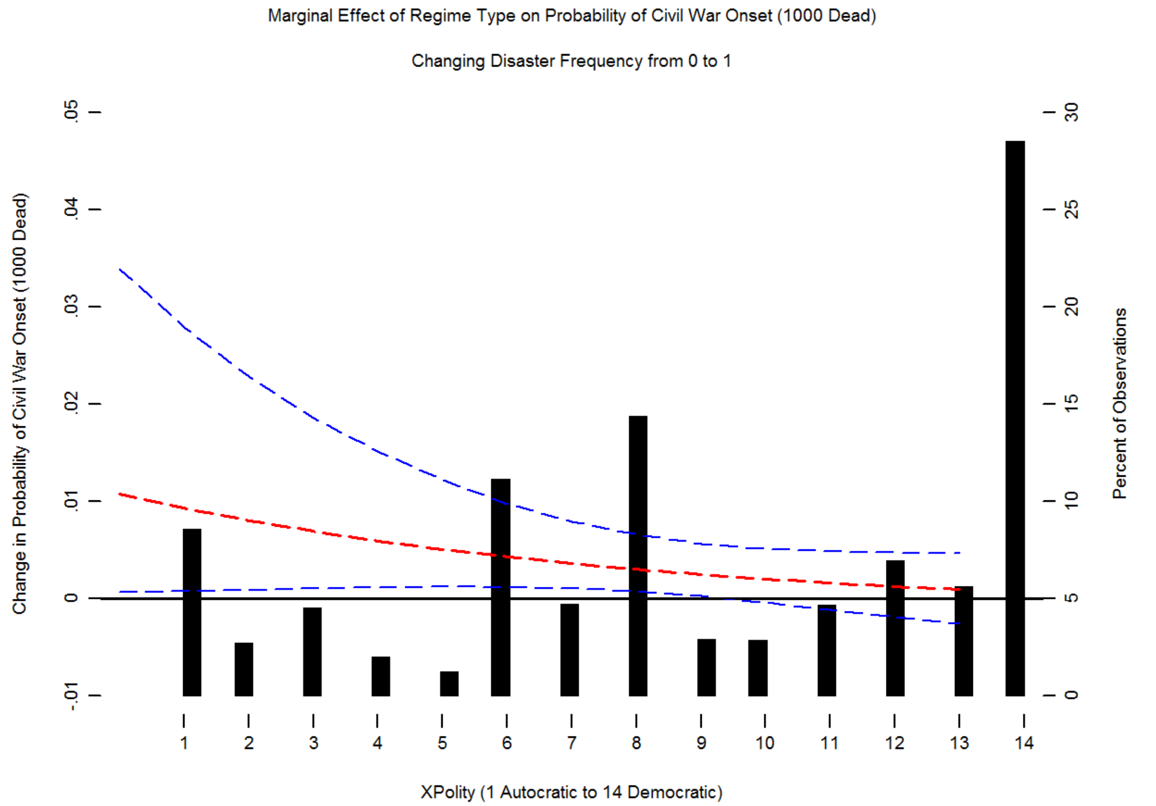


Figure 4-2: Marginal Effect of Regime Type on the Probability of High Intensity Civil War Onset Using Disaster Frequency Measure

As shown in the figures above, the results indicated that instances of both low intensity civil wars and high intensity civil wars, increasing the frequency of natural disasters from its modal value of 0 to 1 in a given month is attenuated by increasing a country's overall level of democracy, *Xpolity*. However, these illustrations above show that the effect of 'rational legality' on reducing the probability of civil war is statistically significant only between values 1 to 8 on the *Xpolity* scale (as indicated by both blue 95% confidence intervals being above the y=0 line). This suggests that 'rational legality' is effective for reducing the risk posed by natural disasters, but only in improving democracy in the most autocratic of countries. Perhaps not surprisingly, this implies the existence of a threshold effect in which the influence of democracy on reducing violent conflict is strongest in regimes where citizens are likely to have little say in politics, have little opportunity to vent their grievances peacefully, and limited access to the provision of public goods—goods which are likely to be needed in the event of a natural disaster.

When looking at the other models in Table 4-3, the sign on the interaction term is insignificant and inconsistent in Models 5 and 6, positive and insignificant in Models 7 and 8, and negative and insignificant in Models 9 and 10. However, as Brambor, Clark, and Golder (2006) note, the inference of multiplicative interaction models are best understood when examining conditional marginal affects across the wide range of the modifying variable (in this case *Xpolity (lag)*). Thus, after crosschecking these results against their graphical plots, surprisingly I find that increasing levels of democracy serves to raise the probability of violent social protest in Africa when *Disaster Frequency* is increased from 0 to 1.

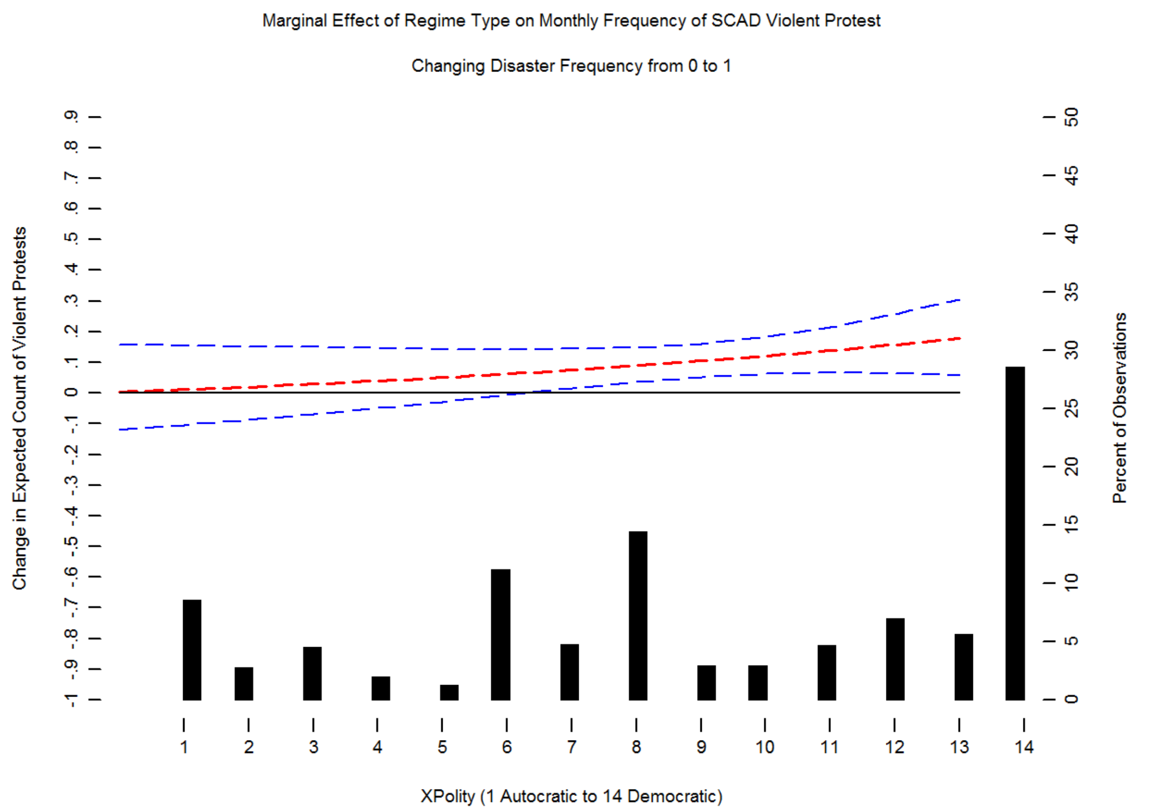


Figure 4-3: Marginal Effect of Regime Type on the Change in the Expected Count of African Social Protests Using Disaster Frequency Measure

These results are displayed Figure 4-3, and they reveal that countries with *Xpolity (lag)* values of approximately 7–14 (i.e. semi-democratic and democratic) are likely to experience an increase in the expected count of violent social protests in months where the frequency of natural disasters is increased from 0 to 1. This result runs contrary to Hypothesis 2(b), but may be consistent with the belief that democracy works differently in Africa, particularly at lower levels of state capacity (something not captured by these various measures).

Table 4-4: Country-Month Estimation Results

Country-Month Table 4-4	**(1) ACD (25+ Dead) 1960–2007**	**(2) ACD (25+ Dead) 1960–2007**	**(3) ACD (1000+Dead) 1960–2007**	**(4) ACD (1000+Dead) 1960–2007**	**(5) UCDP 1989–2007**	**(6) UCDP 1989–2010**	**(7) SCAD 1990–2007**	**(8) SCAD 1990–2007**	**(9) ICEWS 2000–2007**	**(10) ICEWS 2000–2007**
Negative Binomial DV (lag)	---	---	---	---	.0516513	-.168679	.0977761*	.051686*	.026465**	.0150609**
					(.3404752)	(.2782119)	(.0392099)	(.0262518)	(.0043067)	(.0035156)
Disaster Frequency	.225156+	.1887942	.3420431**	.2937281*	-.1649485	-.0253853	.1411401**	.1520169**	-.04435	.0032519
	(.1381193)	(.1297734)	(.1561848)	(.1472754)	(.1641318)	(.1432606)	(.0331616)	(.0284371)	(.0300955)	(.01814)
Disaster Shock	-9.52e-07	-6.39e-07	-1.34e-06	-1.27e-06	-8.24e-07+	-4.71e-07	1.88e-09	-2.65e-08	-1.27e-08**	-7.69e-09**
	(8.64e-07)	(1.77e-06)	(1.20e-06)	(2.49e-06)	(4.69e-07)	(9.42e-07)	(5.49e-08)	(5.25e-08)	(3.36e-09)	(2.82e-10)
Xpolity X Disaster Shock	-7.26e-08	-1.08e-07	-1.45e-08	-4.38e-08	5.75e-08+	3.26e-08	1.79e-09	4.03e-09	1.04e-09**	5.59e-10**
	(1.01e-07)	(1.86e-07)	(1.18e-07)	(2.50e-07)	(3.35e-08)	(6.75e-08)	(4.69e-09)	(3.98e-09)	(2.76e-10)	(4.43e-11)
Relative Political Reach (lag)	-.5585294*	-2.434572**	-.6399884+	-1.592095	-.0403779	-1.306558	.1372675	2.181281+	-.5482465	-.6959947
	(.0037752)	(.8587268)	(.3841975)	(1.126824)	(.5302247)	(1.066163)	(.1667703)	(1.128391)	(.3863243)	(.8261109)
Resource Rents as % GDP (lag)	.0100935**	.0036722	.0031	.0062119	.0123011+	.0401751**	.0017404	0135288*	.0172742**	.007742
	(.2554548)	(.0094138)	(.0061529)	(.0109478)	(.0063061)	(.0144321)	(.0029117)	(.0054311)	(.0040429)	(.0052497)
Xpolity (lag)	.0017492	.0329297	-.0432023+	-.0074222	-.0583195+	.0069098	.0331912*	.0295484	-.0051325	-.0671522**
	(.0200095)	(.0278903)	(.026636)	(.0385895)	(.0306264)	(.0257563)	(.0135252)	(0236363)	(.024343)	(.0211183)
GDP Per Capita (lag)	-.3206588**	-.3084866	-.0929868	-.1746375	-.5394645**	.0356288	.0365343	.0016403	-.0607117	.3488936**
	(.0781512)	(.2080363)	(.1200422)	(.294741)	(.0907056)	(.1916222)	(.0630675)	(.0911001)	(.0557238)	(.0914638)
Population (lag)	.1878678	.0009246	.0788277	.1279953	.4186838**	.152153	.3249973**	.858558*	.1623746**	2.332112**
	(.0716181)	(.3466025)	(.0836839)	(.4638116)	(.0721332)	(.1638214)	(.0515855)	(.4003475)	(.0403841)	(1.12446)
El Niño	-.1516512	-.1354541	-.2880393	-.2465614	-.0836793	-.232673	.1640394*	.1712564*	.0409888	.1958753*
	(.1688892)	(.1947781)	(.2428643)	(.2734416)	(.2181655)	(.2287897)	(.0746004)	(.0795305)	(.0466905)	(.0754331)
January	1.589981**	1.574532	1.902798**	1.831926**	.0885768	.0393261	---	---	---	---
	(.3040281)	(.1653852)	(.372134)	(.2103832)	(.2477089)	(.2897371)				
Peace Months	-.0146231**	-.0021504	-.0095218**	-.0019415	-.0711745**	-.0297197*	-.3818655**	-.3394327**	-1.569273**	-1.292083**
	(.0027581)	(.0036208)	(.0036161)	(.0047898)	(.0139041)	(.0132786)	(.0723919)	(.0692378)	(.2293183)	(.2270147)
Peace Months^2	.0000362**	-.0000128	7.18e-06	-.0000181	.0006498**	.0002087	.0099306**	.0088928**	.0943512**	.0775575**
	(.0000106)	(.0000163)	(.0000146)	(.0000213)	(.0001608)	(.0001963)	(.0031856)	(.003069)	(.023746)	(.022381)
Peace Months^3	-2.86e-08**	4.02e-08	-2.05e-09	4.35e-08+	-1.81e-06**	2.59e-07	-.0000693*	-.0000617*	-.001473**	-.0012008*
	(1.03e-08)	(1.96e-08)	(1.43e-08)	(2.46e-08)	(5.10e-07)	(7.54e-07)	(.0000326)	(.0000313)	(.000561)	(.0005118)
Constant	-3.119532**	---	-3.416903**	---	-2.732745*	---	-4.012726**	---	1.194234**	---
	(.769232)		(1.104984)		(1.265549)		(.6582281)		(.3918809)	
Observations	32965	19154	32965	9359	19898	7048	5685	5685	1993	1993
Log Pesudolikelihood	-1035.2918	-847.03957	563.75992	-455.6828	-824.04027	-654.5284	-3059.7924	-2966.5854	-5649.0311	-5388.772
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses $^{**}p < 0.01$; $^{*}p < 0.05$; $^{+}p < 0.1$ (reported, but not discussed);
Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects models

Table 4-4 displays the results of testing Hypotheses 2(c) and 2(d). As evidenced by the significance of the coefficients for the interaction between *Disaster Shock and Xpolity (lag)*, they are significant only in Models 9 and 10, which shows that increasing levels of democracy is associated with a strong increase in the expected count of violent events in Asia when moving from the mean of *Disaster Shock* to one standard deviation above it. These results are shown in Figure 4-4 below and they reject Hypothesis 2(d).

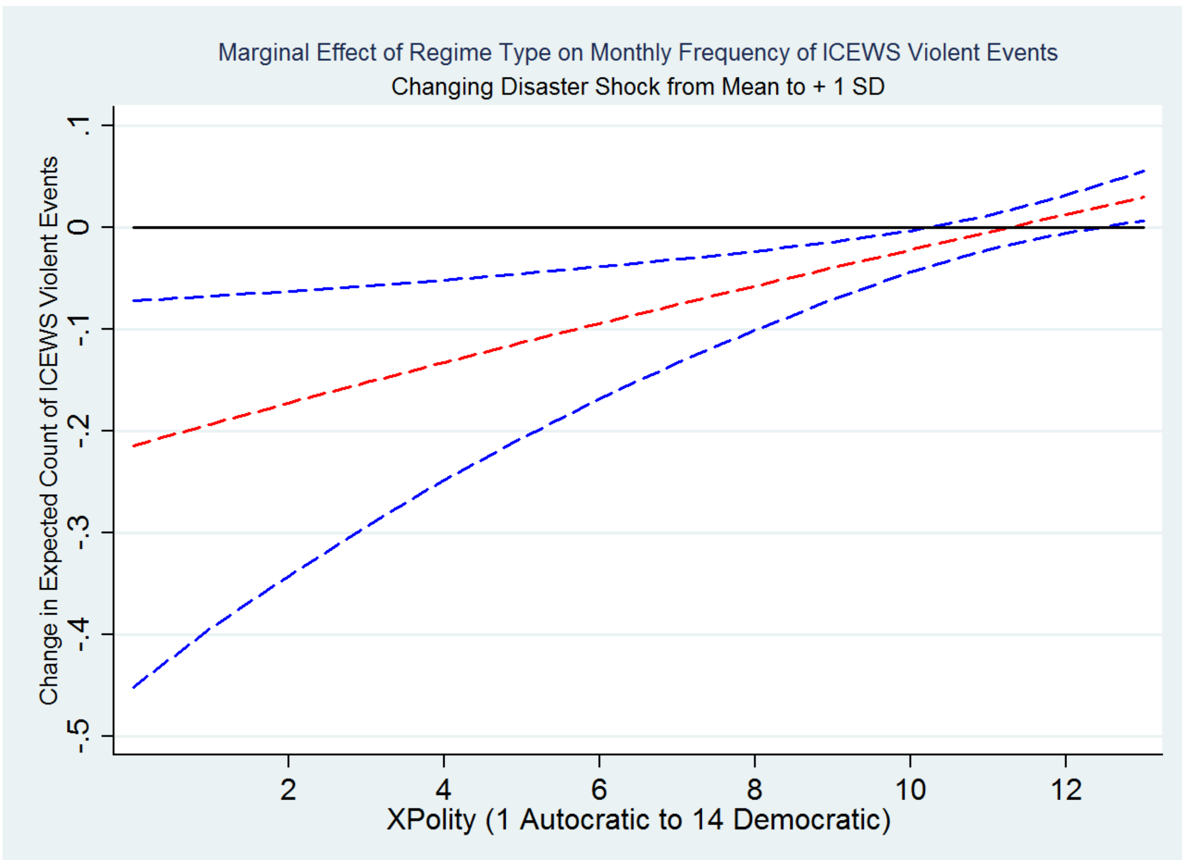


Figure 4-4: Marginal Effect of Regime Type on the Change in Expected Count of Asian Violent Events Using Disaster Frequency Measure

Upon closely reviewing the plots of the other models, the results show that the 'rational legality' as proxied by *Xpolity (lag)* acts to marginally reduce the probability of high intensity civil war on values of *Xpolity (lag)* ranging from 5–14. These findings are displayed in Figure 4-5 and lead me to weakly confirm Hypothesis 2(c).

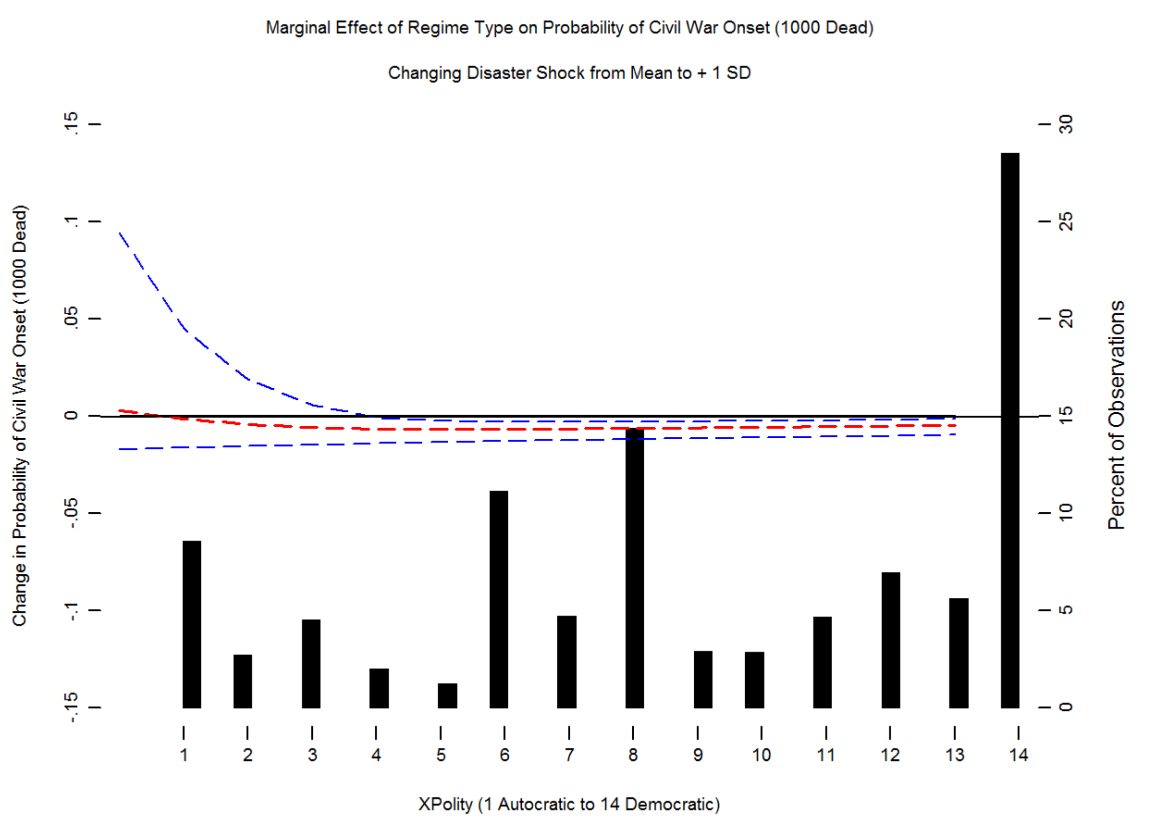


Figure 4-5: Marginal Effect of Regime Type on the Probability of High Intensity Civil War Onset Using Disaster Shock Measure

Table 4-5 contains the results of testing Hypotheses 3(a) and 3(b) which relate to the 'rentier-autocraticness' dimension of state capacity. The multiplicative interaction term between *Disaster Frequency* and *Resource Rents as % of GDP (lag)* is statistically insignificant across a majority of models, except in the case of violent social protests in Africa. Upon reviewing the graphical plots of these relationships, the findings are consistent with these initial findings.

Table 4-5: Country-Month Estimation Results

Country-Month Table 4-5	**(1) ACD (25+ Dead) 1960–2007**	**(2) ACD (25+ Dead) 1960–2007**	**(3) ACD (1000+Dead) 1960–2007**	**(4) ACD (1000+Dead) 1960–2007**	**(5) UCDP 1989–2007**	**(6) UCDP 1989–2010**	**(7) SCAD 1990–2007**	**(8) SCAD 1990–2007**	**(9) ICEWS 2000–2007**	**(10) ICEWS 2000–2007**
Negative Binomial DV (lag)	---	---	---	---	.0441996	-.1703829	.0976768*	.0515071*	.0265691**	.0149395**
					(.3421201)	(.2780013)	(.0392604)	(.0263262)	(.004419)	(.0036021)
Disaster Frequency	.17039	.084581	.3865704+	.2395124	-.2419577	-.028418	.1414325**	.151799**	-.0536616	-.008381
	(.1863706)	(.1626557)	(.2016349)	(.1851015)	(.2176006)	(.186229)	(.0501276)	(.0483037)	(.0350025)	(.0212082)
Disaster Shock	-1.60e-06**	-1.59e-06	-1.51e-06**	-1.64e-06	-5.99e-08+	-2.86e-08	1.97e-08	1.36e-08	-3.28e-10	-1.09e-09
	(5.56e-07)	(1.07e-06)	(5.03e-07)	(1.31e-06)	(3.70e-08)	(6.73e-08)	(1.91e-08)	(2.04e-08)	(1.73e-09)	(1.17e-09)
Resource Rents X Disaster Frequency	.0051353	.0098979	-.0044758	.0058395	.0050694	-.0008284	-.0000326**	-.0000139	.001072	.0017273
	(.0073477)	(.0088253)	(.0099806)	(.0118663)	(.0071507)	(.0104181)	(.0017454)	(.0017481)	(.0027166)	(.0016244)
Relative Political Reach (lag)	-.5623607*	-2.500054**	-.6359175+	-1.641219	-.046255	-1.313702	.1370083	2.170194+	-.5559386	-.7122533
	(.2579407)	(.8636428)	(.3846789)	(1.134583)	(.5309953)	(1.062899)	(.1662788)	(1.122579)	(.4023851)	(.8331034)
Resource Rents as % GDP (lag)	.0089482*	.0013211	.0041684	.0050244	.0116273+	.0405338**	.0017502	.0135452**	.0167562**	.0070892
	(.0042878)	(.0097405)	(.0065848)	(.0112839)	(.0069122)	.0146114)	(.0027685)	(.00564)	(.0033395)	(.0050256)
Xpolity (lag)	.0009999	.031861	-.0433354+	-.0079521	-.0561189	.0084926	.0332724*	.0297204	-.0024136	-.0674356**
	(.0200127)	(.027784)	(.0270169)	(.0383934)	(.0301684)	(.0259201)	(.0134845)	(.0237915)	(.024758)	(.0212841)
GDP Per Capita (lag)	-.317708**	-.3021651	-.0958944	-.1662011	-.5385392**	.0372268	.0366104	.0018758	-.0633084	.3488723**
	(.0796248)	(.2084029)	(.1228272)	(.2955244)	(.089999)	(.1916432)	(.0628795)	(.0913882)	(.0560579)	(.0899802)
Population (lag)	.1900864**	.0056456	.0767638	.1299503	.421007**	.1495122	.3250316**	.857655*	.1608562**	2.323543*
	(.0723817)	(.3466705)	(.0842346)	(.4639519)	(.0742586)	(.1638488)	(.051229)	(.3999907)	(.0399004)	(1.12185)
El Niño	-.1526282	-.134539	-.2899725	-.2457017	-.0816148	-.2330966	.1640186*	.1712643*	.0378623	.1947894*
	(.1695732)	(.1947579)	(.2438886)	(.2734135)	(.2183643)	(.2287161)	(.074637)	(.079625)	(.046902)	(.0751706)
January	1.584324**	1.562185	1.908903**	1.827214**	.0837009	.0364915	---	---	---	---
	(.3009559)	(.1659246)	(.3670331)	(.2106173)	(.247539)	(.2898284)				
Peace Months	-.0146168**	-.0020242	-.0094844**	-.0018418	-.0711336**	-.029715*	-.3819115**	-.3394907**	-1.567218	-1.292618**
	(.002762)	(.0036255)	(.0035824)	(.0047941)	(.0138157)	(.0132827)	(.072401)	(.069321)	(.2287349)	(.2270314)
Peace Months^2	.0000363**	-.0000132	7.04e-06	-.0000186	.0006481**	.0002087	.0099321**	.0088942**	.0942141	.0775929**
	(.0000106)	(.0000163)	(.0000145)	(.0000213)	(.0001606)	(.0001963)	(.0031857)	(.0030718)	(.0237304)	(.0223876)
Peace Months^3	-2.87e-08**	4.06e-08*	-1.93e-09	4.41e-08+	-1.81e-06**	2.59e-07	-.0000693*	-.0000617*	-.0014709	-.0012014*
	(1.03e-08)	(1.96e-08)	(1.42e-08)	(2.46e-08)	(5.10e-07)	(7.54e-07)	(.0000326)	(.0000313)	(.0005609)	(.000512)
Constant	-3.142586**	---	-3.390294	---	-2.763701*	---	-4.013926**	---	1.211445	---
	(.7835613)		(1.116152)		(1.255851)		(.6578172)		(.390619)	
Observations	32965	19154	32965	9359	19898	7048	5685	5685	1993	1993
Log Pesudolikelihood	-1035.1643	-846.60216	-563.66623	-455.58222	-824.66019	-654.78643	-3059.8028	-2966.6465	-5651.2222	-5389.1688
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses **p < 0.01; *p < 0.05; $^+$p < 0.1 (reported, but not discussed);
Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects models

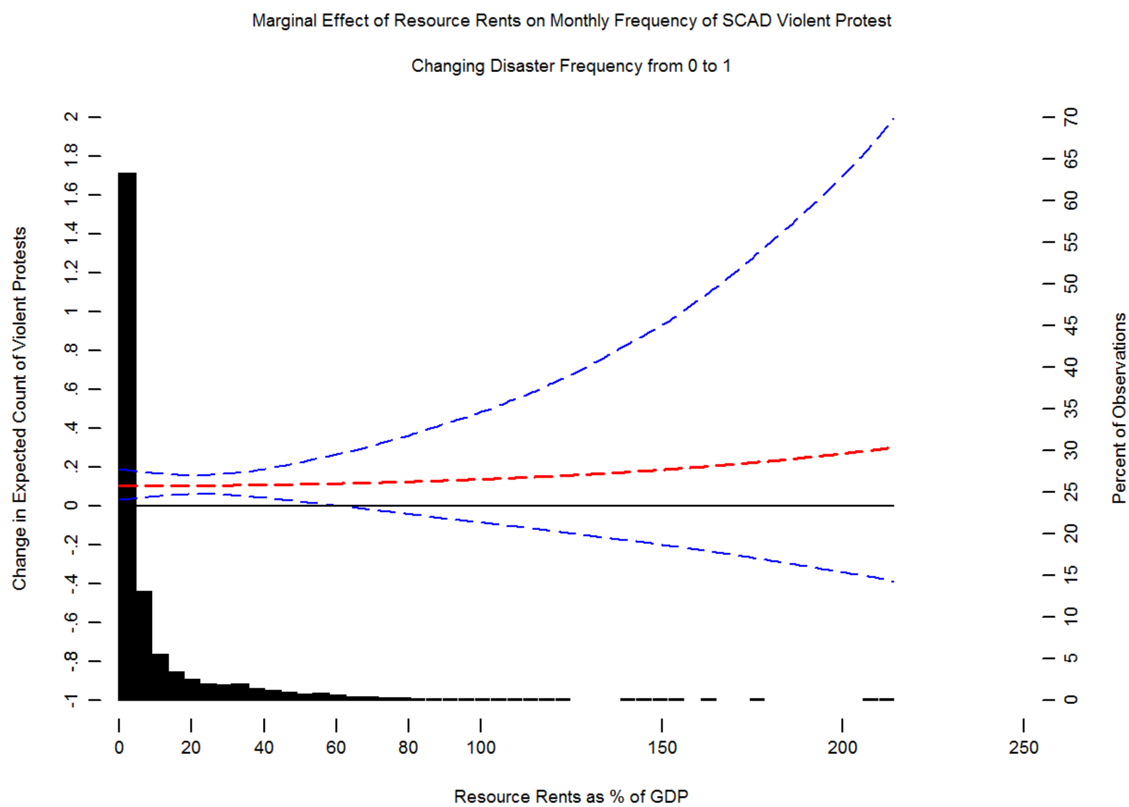


Figure 4-6: Marginal Effect of Resource Rents as % of GDP on the Change in the Expected Count of African Social Protests Using Disaster Frequency Measure

As shown in Figure 4-6, increasing a country's dependency on natural resource rents as a percentage of its GDP is associated with attenuation in the expected count of violent protests in Africa, but this effect is weak and not consistent across the full range of observations. As evidenced in Figure 4-6, the net reduction has little influence on reducing the count of social protests and this effect is only statistically significant for countries with dependency on rents between approximately 5% and 40% of their GDP. The weakness of this finding, combined with the lack of statistically significant results in the other nine models, leads to firmly reject Hypothesis 3(a) and 3(b).

The ultimate insignificance of these findings also carries into measuring the interaction of *Disaster Shock* and *Resource Rents as % of GDP (lag)* on the risk of various forms of violent conflict. As shown in Table 4-6 and Figure 4-7, the results show the presence of a statistically significant interaction effect in only Model 1. Once examining the plots of these interaction models, the findings are consistent with this trend.

Table 4-6: Country-Month Estimation Results

Country-Month Table 4-6	**(1) ACD (25+ Dead) 1960–2007**	**(2) ACD (25+ Dead) 1960–2007**	**(3) ACD (1000+Dead) 1960–2007**	**(4) ACD (1000+Dead) 1960–2007**	**(5) UCDP 1989–2007**	**(6) UCDP 1989–2010**	**(7) SCAD 1990–2007**	**(8) SCAD 1990–2007**	**(9) ICEWS 2000–2007**	**(10) ICEWS 2000–2007**
Negative Binomial DV (lag)	---	---	---	---	.0456005	-.1706253	.0975219*	.0512028+	.026633**	.0150465**
					(.339394)	(.2779454)	(.0392922)	(.0263365)	(.0042911)	(.0035138)
Disaster Frequency	.2286775+	.1933717	.3423092*	.2917668*	-.184859	-.0393304	.1373072**	.1464456**	-.0482336	.0017262
	(.1373845)	(.1295741)	(.1585554)	(.1471029)	(.1591503)	(.1437922)	(.032807)	(.0283164)	(.0307255)	(.0178107)
Disaster Shock	-2.95e-06**	-3.04e-06+	-1.43e-06**	-1.84e-06	5.60e-09	-3.51e-08	4.45e-09	-6.84e-09	-3.23e-09	-4.51e-09
	(1.03e-06)	(1.72e-06)	(4.91e-07)	(1.69e-06)	(6.46e-08)	(1.51e-07)	(3.05e-08)	(3.09e-08)	(5.77e-09)	(4.01e-09)
Resource Rents X Disaster Shock	1.19e-07*	1.24e-07+	-8.60e-09	2.59e-08	-1.97e-08	2.51e-09	7.80e-09	1.07e-08	9.97e-10	1.17e-09
	(4.96e-08)	(6.55e-08)	(7.58e-08)	(1.44e-07)	(2.40e-08)	(4.78e-08)	(1.48e-08)	(1.37e-08)	(1.90e-09)	(1.08e-09)
Relative Political Reach (lag)	-.5574985*	-2.456889**	.6406743+	-1.597266	-.0447751	-1.315386	.1368395	2.173263+	-.5476437	-.7134756
	(.2561092)	(.8600251)	(.3840403)	(1.127045)	(.5294389)	(1.062644)	(.1664127)	(1.118906)	(.3833716)	(.8210041)
Resource Rents as % GDP (lag)	.0091745*	.002653	.0031489	.0060859	.012514+	.0402968**	.0016871	.0133159*	.0172294**	.0078931
	(.0038371)	(.0094425)	(.0061342)	(.0109771)	(.0064132)	(.0144615)	(.0029284)	(.0054425)	(.0040676)	(.0052265)
Xpolity (lag)	.0011298	.031726	-.0434152+	-.0079918	-.0561888+	.0082762	.0334237*	.0300693	-.0026484	-.0671865**
	(.0199773)	(.0277804)	(.0269885)	(.038404)	(.0302575)	(.0257169)	(.0134516)	(.0235722)	(.0246507)	(.0210889)
GDP Per Capita (lag)	-.3207755**	-.3096025	-.0928873	-.1723629	-.5411672**	.0370346	.0365873	.0020022	-.0621075	.3516626**
	(.0779029)	(.2082012)	(.1206863)	(.2948427)	(.0906069)	(.1916228)	(.0629708)	(.0910242)	(.0560178)	(.0909015)
Population (lag)	.1893607**	.0096029	.0787224	.1294407	.4184481**	.1501565	.3252807**	.8611387*	.1610695**	2.328502*
	(.0717554)	(.3466423)	(.0838385)	(.4639821)	(.0729592)	(.1636582)	(.0517191)	(.4001507)	(.0399394)	(1.124503)
El Niño	-.1485427	-.1310884	-.2884745	-.2469822	-.0857065	-.2322994	.1646705**	.1725104*	.0397825	.1978904**
	(.169123)	(.194768)	(.2431581)	(.2733868)	(.2174463)	(.2288202)	(.0748239)	(.0798247)	(.0469271)	(.075794)
January	1.584104**	1.5701**	1.903547**	1.831621**	.0857766	.0362382	---	---	---	---
	(.3040484)	(.1654016)	(.3716391)	(.2104071)	(.2479185)	(.2898029)				
Peace Months	-.0146356**	-.0021186	-.0095148**	-.0019327	-.0712244**	-.0296859*	-.3819285**	-.3394878**	-1.566947**	-1.291628**
	(.002768)	(.1654016)	(.0036017)	(.0047898)	(.0138975)	(.0132801)	(.0723876)	(.0692476)	(.2288392)	(.227077)
Peace Months^2	.0000363**	-.0000129	7.16e-06	-.0000182	.0006491**	.0002083	.0099324**	.0088934**	.0941987**	.0775274**
	(.0000107)	(.0000163)	(.0000146)	(.0000213)	(.0001609)	(.0001963)	(.0031854)	.0030693	(.0237372)	(.022384)
Peace Months^3	-2.87e-08**	4.03e-08*	-2.03e-09	4.35e-08+	-1.81e-06**	2.60e-07	-.0000693*	(.0000313)	-.0014706**	-.0012003*
	(1.03e-08)	(1.96e-08)	(1.42e-08)	(2.46e-08)	(5.10e-07)	(7.54e-07)	(.0000326)	-.0000617	(.000561)	(.0005118)
Constant	-3.119155**	---	-3.415159**	---	-2.728298*	---	-4.016601*	---	1.188598**	---
	(.7665042)		(1.108238)		(1.266472)		(.6569631)		(.394696)	
Observations	32965	19154	32965	9359	19898	7048	5685	5685	1993	1993
Log Pesudolikelihood	-1034.2242	-845.87635	-563.76007	-455.68302	-824.65062	-654.78826	-3059.7571	-2966.5478	-5651.3304	-5389.5793
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses **p < 0.01; *p < 0.05; $^{+}$p < 0.1 (reported, but not discussed);
Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects models

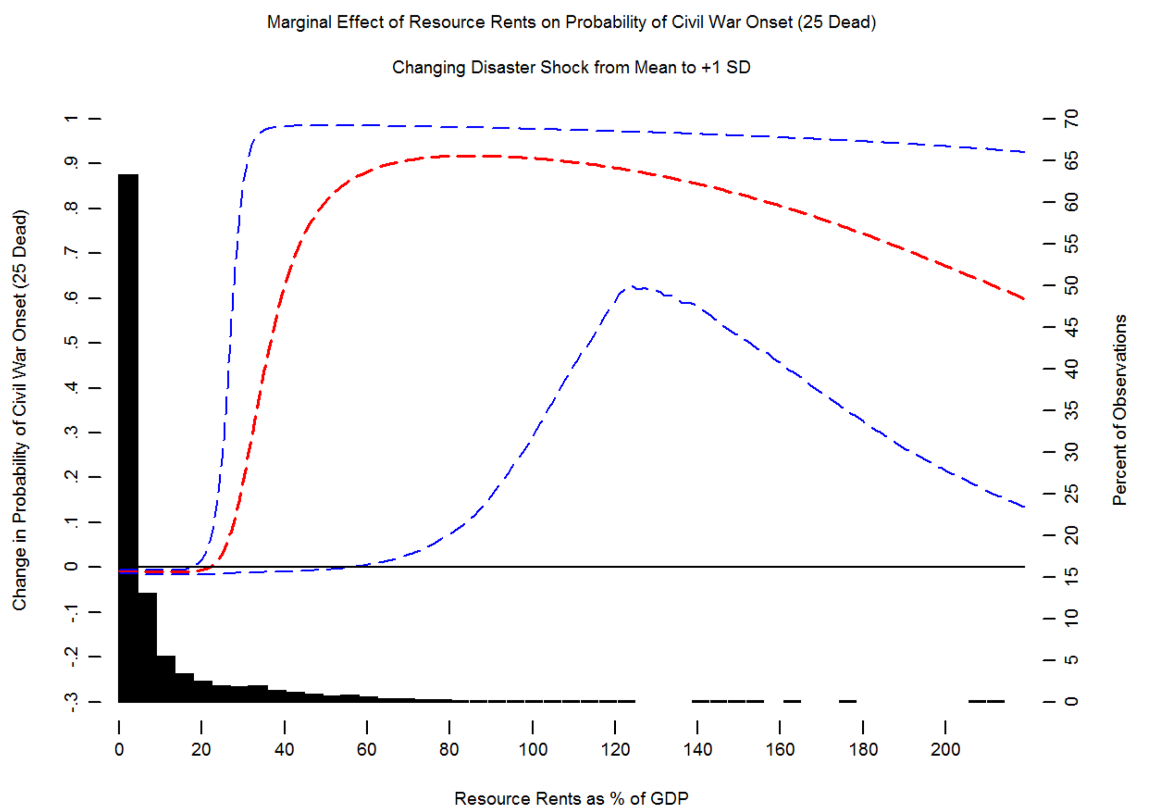


Figure 4-7: Marginal Effect of Resource Rents as % of GDP on the Probability of High Intensity Civil War Onset Using Disaster Shock Measure

As shown in Figure 4-7 the interaction between *Disaster Shock* and *Resource Rents as % of GDP (lag)* on the risk of low intensity civil war is statistically significant on the extreme end of the sample of observations indicated by the position of both blue 95% confidence intervals above the y=0 axis line, where resource rents comprise over 80% of a country's GDP. This effect is bounded by extremely wide confidence intervals, which suggests the strength of the effect of this relationship is uncertain. Moreover, the trend is in the opposite of the prediction of Hypothesis 3(c).[29] In short, given that few countries are so heavily dependent on the extraction of natural resources, the conditions under which this effect is true is extremely unlikely. Therefore, based on the scant evidence of any strong relationships, I also reject Hypothesis 3(c) and 3(d).

Finally, the results of testing Hypothesis 4(a), 4(b), 4(c) and 4(d) are shown in Table 4-7 and Table 4-8. The findings reveal no evidence of a significant relationship between the interaction between *Disaster Frequency* and 'neopatrimonialism' as proxied by *Relative Political Reach (lag)* in Table 4-7. However, upon examination of the graphical plots of the multiplicative interaction terms, I find extremely weak evidence of a statistically significant relationship in support of Hypothesis 4 (a)—only in values of *Relative Political Reach (lag)* ranging between .75 and 1.0, when increasing the count of natural disasters in a given month from 0 to 1 as shown in Figure 4-8 and Figure 4-9.

[29] Although opposite of my hypothesis, it may be consistent with the theoretical argument that in these types of countries the level of rents are so high that the state can engage in absolute repression; hence, making any form of conflict unlikely (e.g. Ross's (2001) 'repression effect')

Table 4-7: Country-Month Estimation Results

Country-Month Table 4-7	(1) ACD (25+ Dead) 1960–2007	(2) ACD (25+ Dead) 1960–2007	(3) ACD (1000+Dead) 1960–2007	(4) ACD (1000+Dead) 1960–2007	(5) UCDP 1989–2007	(6) UCDP 1989–2010	(7) SCAD 1990–2007	(8) SCAD 1990–2007	(9) ICEWS 2000–2007	(10) ICEWS 2000–2007
Negative Binomial DV (lag)	---	---	---	---	.0424888	-.181587	.0978893**	.0514126+	.0266103**	.0150403**
					(.3395063)	(.2786973)	(.03946)	(.0263395)	(.004294)	(.0035135)
Disaster Frequency	.6706655	.7629285	.3861046	1.068374	-.0488186	.2005268	.2291946+	.0939084	-.0303017	.0187317
	(.4583835)	(.5986555)	(.6130306)	(.7691852)	(.4675067)	(.5499868)	(.1340405)	(.1234683)	(.1989061)	(.1076544)
Disaster Shock	-1.63e-06**	-1.65e-06	-1.48e-06**	-1.62e-06	-6.49e-08+	-2.99e-08	2.06e-08	1.32e-08	-3.64e-10	-1.12e-09
	(5.53e-07)	(1.08e-06)	(4.81e-07)	(1.30e-06)	(3.92e-08)	(6.75e-08)	(1.94e-08)	(2.03e-08)	(1.70e-09)	(1.15e-09)
Relative Political Reach X Frequency	-.4456393	-.5804537	-.0430012	-.7503592	-.1387948	-.2318355	-.0811814	.0533905	-.0173649	-.0162548
	(.4663222)	(.5947785)	(.5972046)	(.7400662)	(.4561924)	(.5211968)	(.1302076)	(.1225556)	(.2045069)	(.1082662)
Relative Political Reach (lag)	-.4895414+	-2.344201**	-.6322876	-1.458365	-.0216105	-1.263288	(.1494973)	2.153115+	-.5406347	-.7074072
	(.2639996)	(.8649477)	(.3834674)	(1.139306)	(.5689438)	(1.074576)	(.1669197)	(1.125603)	(.387354)	(.8306549)
Resource Rents as % GDP (lag)	.0099881**	0035844	.0030939+	.0063968	.012493*	.0401702**	.0017246	.0136167**	.0172697**	.0078403
	(.003773)	(.0094274)	(.0061568)	(.0109515)	(.0063118)	(.014422)	(.0028961)	(.005446)	(.0041371)	(.0052486)
Xpolity (lag)	.0007912	.0327028	-.0434031+	-.0071529	-.0556613+	.0092731	.0334636**	.0296167	-.0026929	-.0671221**
	(.0200204)	(.0277792)	(.0270887)	(.0383866)	(.0306291)	(.025785)	(.0133804)	(.0236211)	(.024964)	(.0209954)
GDP Per Capita (lag)	-.3166355**	-.3062778	-.0927516	-.0071529	-.5392158**	.0354548	.0354695	.0023239	-.0626298	.3504402**
	(.0785537)	(.2076969)	(.1203851)	(.2941465)	(.0902657)	(.1917285)	(.0631415)	(.0911943)	(.0548012)	(.090966)
Population (lag)	.1864681**	.0066086	.0786969	.1379676	.4162575**	.1466968	.3253036**	.8522116*	.1606417**	2.329837**
	(.0714108)	(.3467176)	(.0836085)	(.4642796)	(.0751407)	(.1642355)	(.0512772)	(.4012043)	(.0405406)	(1.136546)
El Niño	-.1508898	-.1325258	-.288179	-.2425213	-.082928	-.2329325	.1642373*	.1711627	.0392029	.1972046**
	(.16957)	(.1948103)	(.2437746)	(.2736227)	(.2177738)	(.2288254)	(.0745797)	(.079564)	(.0455917)	(.0758546)
January	1.592071**	1.576944**	1.903338**	1.838884**	.0880793	.0430384	---	---	---	---
	(.3049016)	(.1654262)	(.3734777)	(.2105886)	(.2482301)	(.2900633)				
Peace Months	-.0145407**	-.0019942	-.0095172**	-.0016249	-.0713448**	-.0299485**	-.3816795**	-.3395425**	-1.567383**	-1.291645**
	(.0027727)	(.0036265)	(.0036162)	(.0047969)	(.0139082)	(.0132969)	(.0724567)	(.0692733)	(.2285155)	(.2270069)
Peace Months^2	.0000359**	-.0000134	7.17e-06	-.0000193	.0006502**	.0002109	.009926**	.0088953**	.0942216**	.0775282**
	(.0000107)	(.0000163)	(.0000146)	(.0000214)	(.000161)	(.0001965)	(.0031875)	(.0030707)	(.0237365)	(.0223808)
Peace Months^3	-2.84e-08**	4.08e-08*	-2.04e-09	4.46e-08+	-1.81e-06**	2.53e-07	-.0000692*	-.0000617*	-.001471**	-.0012004*
	(1.04e-08)	(1.96e-08)	(1.43e-08)	(2.46e-08)	(5.10e-07)	(7.55e-07)	(.0000326)	(.0000313)	(.0005611)	(.0005118)
Constant	-3.199855**	---	-3.424185**	---	-2.74589*	---	-4.02411**	---	1.191575**	---
	(.784899)		(1.123025)		(1.261098)		(.6466196)		(.3916832)	
Observations	32965	19154	32965	9359	19898	7048	5685	5685	1993	1993
Log Pesudolikelihood	-1034.9859	-846.72312	-563.75945	-455.21043	-824.74104	-654.69202	-3059.7124	-2966.6065	-5651.3574	-5389.6574
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses **p < 0.01; *p < 0.05; $^{+}$p < 0.1 (reported, but not discussed);
Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects model

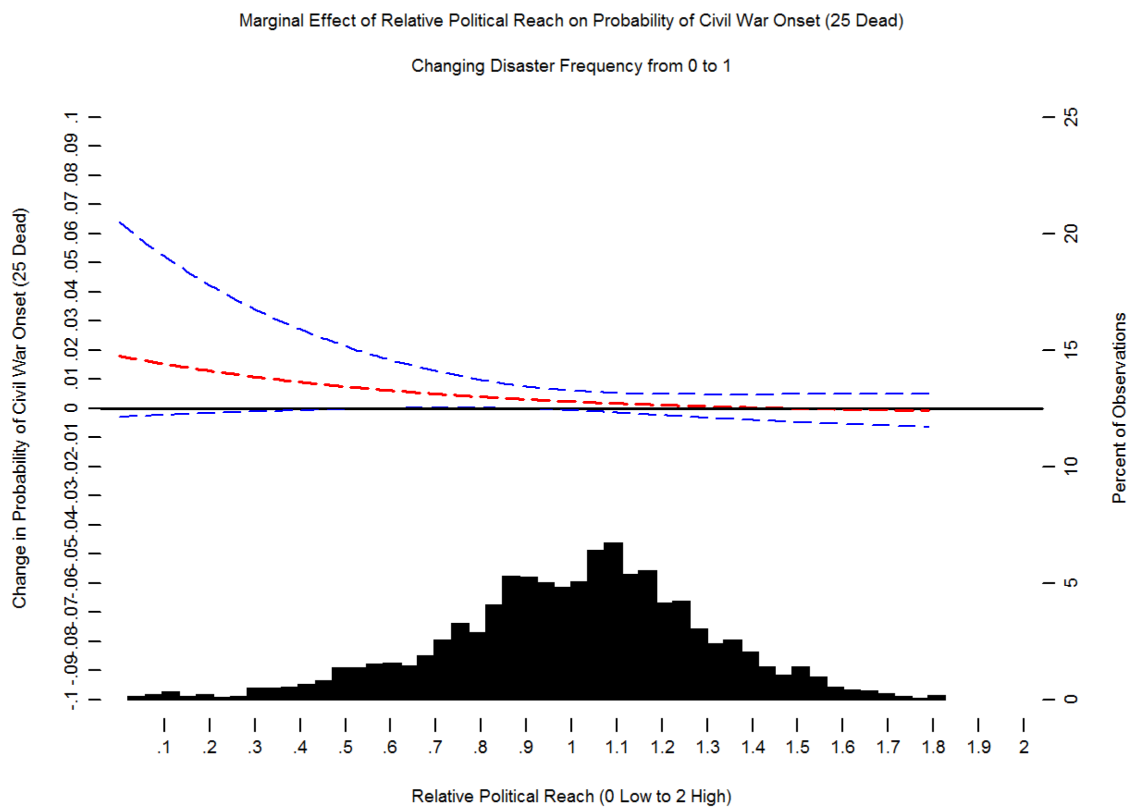


Figure 4-8: Marginal Effect of Relative Political Reach on Probability of Low Intensity Civil War Onset Using Disaster Frequency Measure

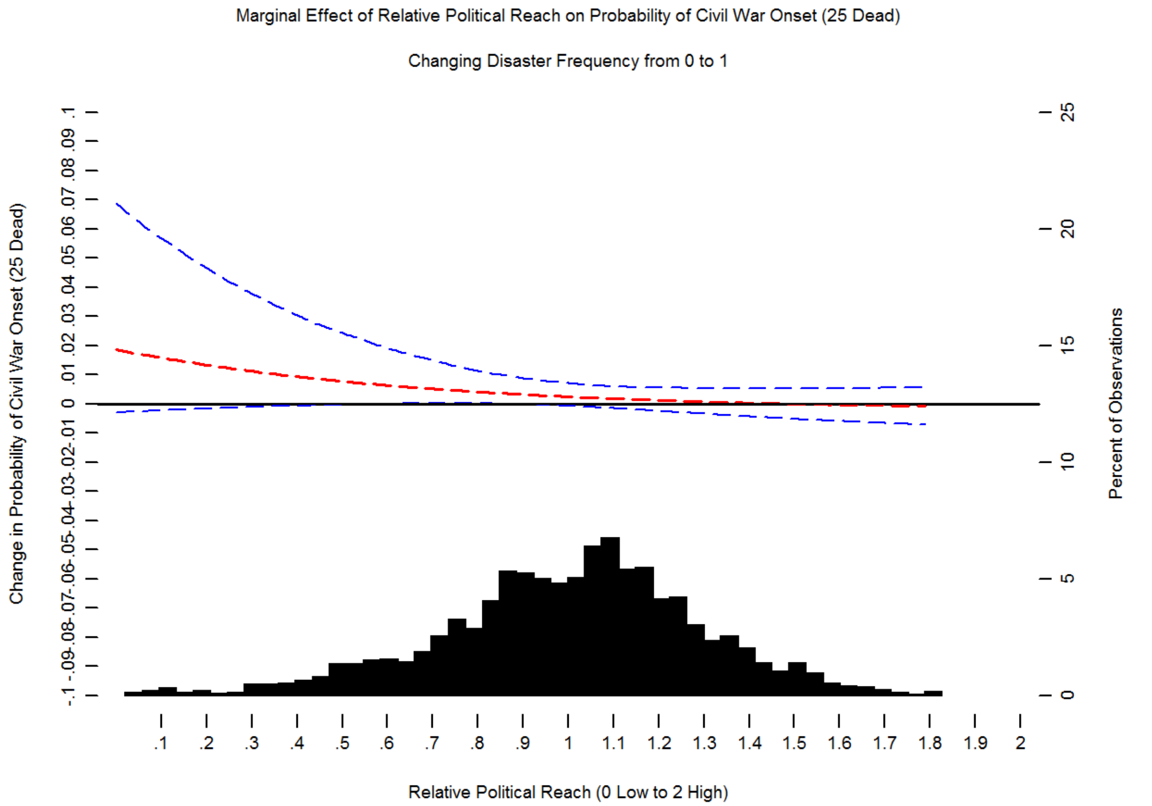


Figure 4-9: Marginal Effect of Relative Political Reach on Probability of High Intensity Civil War Onset Using Disaster Frequency Measure

I also find support for a statistically significant and negative relationship in the event of violent social protests in Africa. Figure 4-10 shows that decreasing the degree of ‘neopatrimonialism’, *Relative Political Reach (lag)*, serves to attenuate the expected count of violent social protests between values of .3 and 1.3. This is finding weakly supports Hypothesis 4(b) and is reassuring given the pervasiveness of patrimonial rule throughout Africa (see Section 4.3.3 for further discussion).

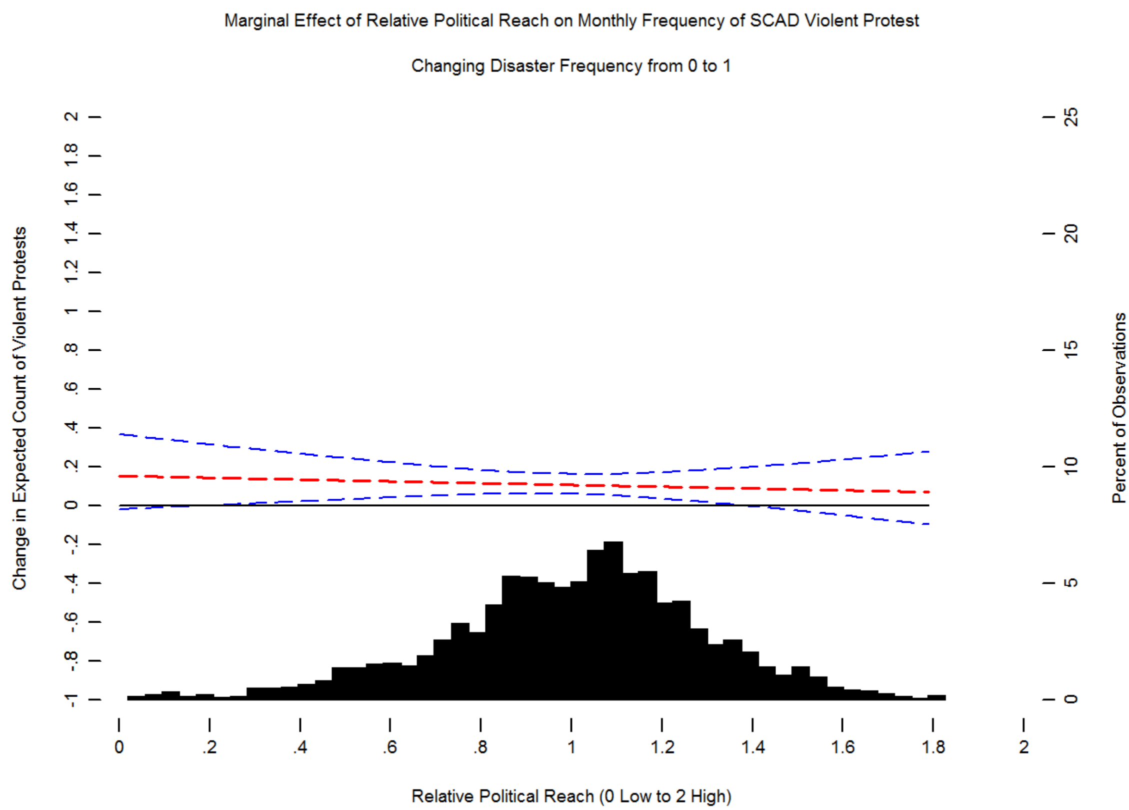


Figure 4-10: Marginal Effect of Relative Political Reach on the Change in the Expected Count of African Social Protests Using Disaster Frequency Measure

These findings remain consistent when looking at the interaction between *Disaster Shock* and *Relative Political Reach (lag).* Although the sign on coefficient for the interaction terms is statistically significant and negative only in Models 9 and 10, I find some small indication that reducing levels of 'neopartimonialism' reduces the probability of low and high intensity civil war between values of .8 and 1.4 on *Relative Political Reach (lag)*;

however, the substantive effects are nearly indistinguishable from zero and almost flat.[30] Overall, the findings lead me to reject Hypotheses 4(c).

[30] Not shown due to its general insignificance

Table 4-8: Country-Month Estimation Results

Country-Month Table 4-8	**(1) ACD (25+ Dead) 1960–2007**	**(2) ACD (25+ Dead) 1960–2007**	**(3) ACD (1000+Dead) 1960–2007**	**(4) ACD (1000+Dead) 1960–2007**	**(5) UCDP 1989–2007**	**(6) UCDP 1989–2010**	**(7) SCAD 1990–2007**	**(8) SCAD 1990–2007**	**(9) ICEWS 2000–2007**	**(10) ICEWS 2000–2007**
Negative Binomial DV (lag)	---	---	---	---	.0461781	-.1697989	.0976202*	.0514774*	.0265001**	.0150749**
					(.3381129)	(.278049)	(.039299)	(.0263227)	(.004305)	(.0035197)
Disaster Frequency	.2280001+	.1902565	.3433596*	.2923759*	-.1841087	-.0356147	.1406325**	.1513957**	-.0436295	.003989
	(.1391405)	(.1292762)	(.1556357)	(.1470293)	(.1608074)	(.1413244)	(.0331949)	(.0284478)	(.0301043)	(.0180257)
Disaster Shock	8.92e-07	1.06e-06	-3.29e-06	-2.09e-06	3.81e-07	2.18e-07	-4.86e-09	-5.26e-09	3.04e-08**	1.92e-08**
	(2.66e-06)	(3.57e-06)	(2.47e-06)	(6.89e-06)	(7.21e-07)	(5.20e-07)	(3.66e-08)	(8.51e-08)	(7.79e-09)	(4.82e-09)
Relative Political Reach X Shock	-2.67e-06	-2.90e-06	1.65e-06	3.88e-07	-4.97e-07	-2.77e-07	2.13e-08	1.64e-08	-3.46e-08**	-2.28e-08**
	(2.78e-06)	(4.04e-06)	(1.85e-06)	(6.21e-06)	(8.19e-07)	(6.07e-07)	(4.05e-08)	(7.59e-08)	(8.73e-09)	(5.38e-09)
Relative Political Reach (lag)	-.539787*	-2.417053**	-.6559225+	-1.597268	-.026729	-1.299424	.1355463	2.163794+	-.5430823	-.6847628
	(.2588493)	(.8589864)	(.3856507)	(1.127345)	(.5366121)	(1.065357)	(.1678054)	(1.136456)	(.3862021)	(.8291027)
Resource Rents as % GDP (lag)	.0100951**	.00374	.0030721	.0062198	.0123981+	.0403876**	.0017395	.0135456*	.0172534**	.0076838
	(.0037768)	(.0094112)	(.0061494)	(.0109485)	(.0063529)	(.0144324)	(.0029092)	(.0054291)	(.0040476)	(.0052569)
Xpolity (lag)	.0011711	.032114	-.0434803+	-.0081267	-.0558228+	.0082362	.0332921*	.0297455	-.0046796	-.0671286**
	(.0199279)	(.0277837)	(.0269975)	(.038408)	(.0305137)	(.0256772)	(.013488)	(.0235958)	(.0243829)	(.0211545)
GDP Per Capita (lag)	-.3190926**	-.3070073	-.0936475	-.1738453	-.5392291**	.0354332	.0367087	.0018619	-.0618399	.3480433**
	(.0779572)	(.2078718)	(.1205202)	(.2946698)	(.0908517)	(.1916582)	(.0630556)	(.0910099)	(.0557452)	(.0915211)
Population (lag)	.1870164**	.0029856	.0795233	.1274436	.4164578**	.1505103	.3252549**	.8562319*	.1616439**	2.331441*
	(.0716708)	(.3466089)	(.0836981)	(.4638927)	(.0736531)	(.1637977)	(.051747)	(.4010342)	(.0403296)	(1.124456)
El Niño	-.1517338	-.1357768	-.2882276	-.2476008	-.0824219	-.2345986	.164052*	.1712947*	.039978	.1952794**
	(.169287)	(.1947865)	(.2430747)	(.2733812)	(.2176688)	(.2286709)	(.0746174)	(.079545)	(.0468878)	(.0753441)
January	1.591351**	1.576588**	1.902326**	1.832346**	.0855066	.0333991	---	---	---	---
	(.3045795)	(.1653578)	(.3729259)	(.2103884)	(.2478294)	(.2898614)				
Peace Months	-.0145917**	-.0020972	1.902326**	-.0019451	-.0713795**	-.0298832*	-.381916**	-.3394645**	-1.568753**	-1.291413**
	(.0027577)	(.0036211)	(.0036076)	(.004792)	(.0138572)	(.0132865)	(.0724347)	(.0693431)	(.2290363)	(.2267282)
Peace Months^2	.0000361**	-.000013	7.20e-06	-.0000181	.0006509**	.0002103	.0099324**	.0088934**	.0943072**	.0775137**
	(.0000106)	(.0000163)	(.0000146)	(.0000213)	(.0001605)	(.0001963)	(.0031866)	(.0030721)	(.0237324)	(.0223663)
Peace Months^3	-2.85e-08**	4.04e-08*	-2.07e-09	4.35e-08+	-1.81e-06**	2.55e-07	-.0000693*	-.0000617*	-.0014723**	-.0012001**
	(1.03e-08)	(1.96e-08)	(1.42e-08)	(2.46e-08)	(5.09e-07)	(7.54e-07)	(.0000326)	(.0000313)	(.0005608)	(.0005115)
Constant	-3.138046**	---	-3.399965**	---	-2.740321*	---	-4.015259**	---	1.201338**	---
	(.77201)		(1.098841)		(1.262088)		(.658816)		(.3925037)	
Observations	32965	19154	32965	9359	19898	7048	5685	5685	1993	1993
Log Pesudolikelihood	-1035.1467	-846.95729	-563.70332	-455.69561	-824.54579	-654.63894	-3059.7814	-2966.633	-5649.1927	-5388.4549
Fixed Effects?	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Clustered Standard Errors?	**Yes**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Standard errors in parentheses **p < 0.01; *p < 0.05; $^+$p < 0.1 (reported, but not discussed);
Note: Even numbered models include conditional fixed effects in their estimations; constant omitted in fixed effects model

Finally, with respect to Models 9 and 10, Figure 4-11 reveals that the effects of reducing 'neopatrimonalism' is associated with a significant reduction in the expected count of violent events in Asia. Moving from the mean of *Disaster Shock* to one standard deviation above the mean is associated with a reduction of approximately '2' in the expected count of violent social protests across nearly the entire range of *Relative Political Reach (lag).* The absence of other support for this relationship in Models 5-8 leads me only to weakly confirm Hypothesis 4(d).

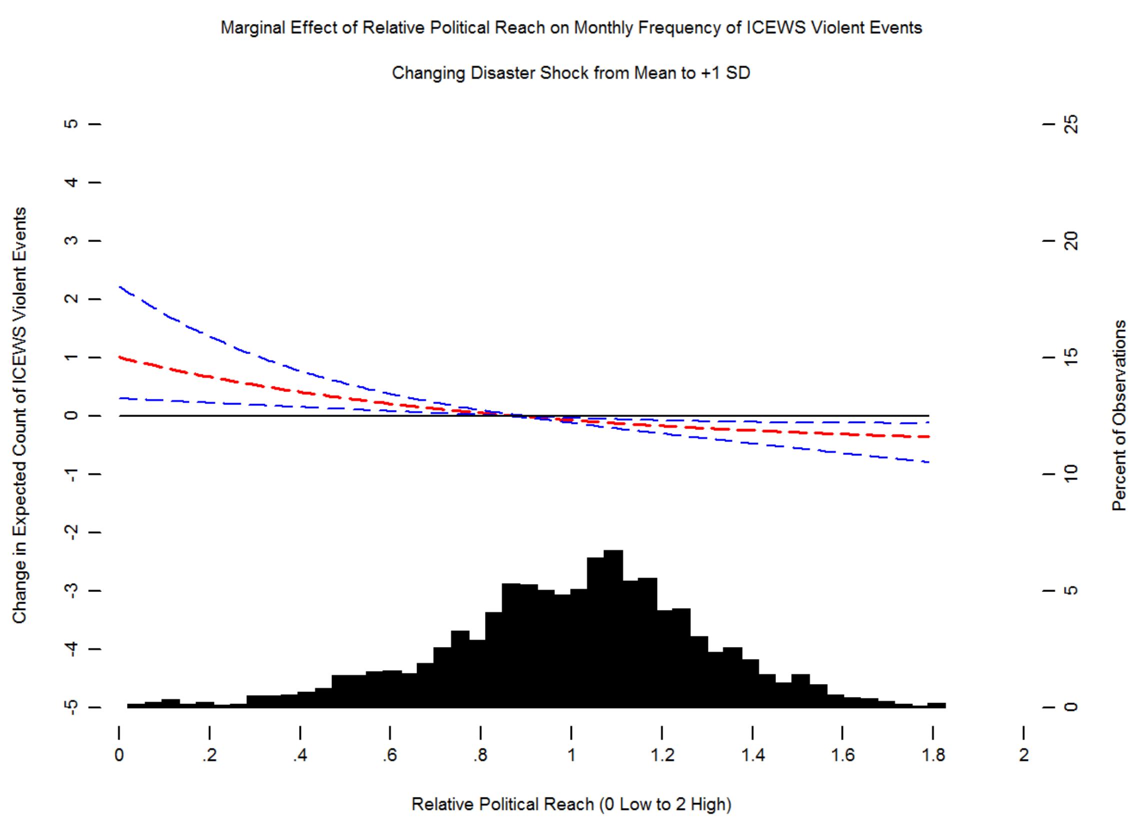


Figure 4-11: Marginal Effect of Relative Political Reach on the Change in the Expected Count of Asian Violent Events Using Disaster Shock Measure

4.6 Conclusion

Given all of the recent concern regarding the state of the Earth's climate and the uptick in extreme weather, the lack of support for a strong connection between natural disasters, the weakening state capacity, and the subsequent increase in the onset of violent conflict should be reassuring. Although experts believe that the effects of climate change will be most acute in the poorest and least developed countries (Mendelsohn, Dinar, and Williams 2006), and that these countries are often at significant risk for being embroiled in armed conflicts (Collier and Hoeffler 2004; Hegre and Sambanis 2006), the evidence largely does not support the belief that extreme weather will generate violent conflict in counties with low levels state capacity.

The results indicate some support that an increasing frequency of natural disasters in a given month is associated with the onset of civil war and violent social protest generally, but this is mostly independent of the state capacity measures as shown by their marginal effects in Table 4-2. Curiously, the results also show that findings regarding the frequency of natural disasters differ when considering the number of people actually affected by these catastrophes. The marginal effect of using this measure indicates that the probability of civil war actual declines as the number of people affected by a disaster in a given month deviates positively from its long term monthly mean. This finding runs counter to the theoretical argument of the 'eco shock' mechanism and alarmist interpretations regarding extreme weather. By contrast, the finding is suggestive that what may be most important for the onset of conflict is damage to state infrastructure and not people directly. In this sense, the state is weakened via an increased frequency of events people remain unaffected in order to organize effectively. An alternative implication is that perhaps disasters that have a large human impact actually induce a feeling of social cohesion where people become concerned for the welfare of others via their common traumatic experience, as described by Fritz (1996, 10) in his report on the mental health of Japanese and German civilians who were subjected to heavy Allied bombing during WWII. Indeed, one only needs to remember the extraordinary displays of heroism and self-sacrifice shown by the first responders and ordinary citizens in response to September 11th, 2001 Terrorist Attacks to find further anecdotal evidence of Fritz' (1996) supposition that traumatic events increase social cohesion and social empathy.

With regard to the interactive effects between these various measures of natural disaster and state capacity, the findings are strongly dependent on the measure of natural disasters used, the dimension of state capacity tested, and the form of violent conflict that one expects to be produced. When using a frequency based measure of natural disasters, increasing a values of a state's 'rational legality' acts to moderately reduce the probability of civil war onset; however this only appears effective in states that autocratic and semi-autocratic. Once a halfway point toward a consolidated democracy is reached, the effect of 'rational legality' shows no statistically significant relationship associated with reducing the probability of civil war onset. Curiously, the pacifying influence of increasing 'rational legality' does not adhere for incidence of violent social protest. Quite the opposite from the pattern for civil war onset, the analysis reveals that an increase in the frequency of a natural disaster in states with high levels of 'rational legality' act to increase the expected count of violent social protests. When using a measure of *Disaster*

Shock, the results are largely null with ‘rational legality’ doing nothing to attenuate or strengthen the risk of violent conflict except in Asia where increasing levels are associated with an increase in the expected count of violent events.

Even more surprisingly, the relationship between natural disasters and ‘rentier-autocraticness’ was almost uniformly lacking regardless of the type of disaster measurement used. In the few cases where statistically significant relationships were present, the results were nearly incredible or substantively uninteresting. Finally, the interactive relationship between disasters and the ‘neopartimonialism’ dimension of state capacity shows the most consistent relationship in line with theoretical expectations, with decreasing levels of ‘neopatrimonalism’ reducing the risk of civil war, violent social protests and violent events in months which a disaster occurs or the number of people affected deviate from long term climate trends. Considering the sum of these findings, the results indicate that natural disasters have limited influence on the onset of violent conflict as it relates to multiple dimensions of state capacity.

For all the destructiveness and disruption that extreme weather can create there is relatively little support for the claims made within the ecoviolence literature that these events are most likely produce conflict in states with vulnerable levels of state capacity. Interestingly, to the extent that natural disasters are associated with the onset of violent conflict, it appears they are related to the frequency at which they occur rather than the number of people these events affect. Future research should seek out what other causal mechanisms may be driving the reason for the difference in these patterns searching for why the frequency of occurrences is more salient for raising the risk of violent conflict than the number of people affected by a disaster. More attention is also needed for developing explanations of how disasters impact the propensity for various forms of conflict at the micro-level. This would include a consideration of how disasters appear to reduce the motivation for civil war, but raise the risk of less organized forms of violent conflict. As it now stands, these results are generally consistent with Homer-Dixon's (1999) theory that violent conflict relating to environmental changes is most probable at the lowest levels of organized violence (riots etc.). Lastly, it may be that the lack of findings stem from the high degree of aggregation in the various measures of state capacity. Future research should focus its efforts on developing disaggregated measures of these concepts.

Although the results of this analysis are not supportive of the alarmism in climate-change-to-conflict debate (and the ecoviolence literature broadly), we should not over-emphasize the impotence of natural disasters in informing our studies of conflict. Many people around the world suffer from the destructiveness produced by natural disasters. A larger goal of this research is to develop an understanding that helps people in these situations so governments may respond effectively and efficiently for the overall well being of their citizens.

This analysis has demonstrated the importance of measurement and theoretical clarity in understanding the connection between swift environmental changes and social outcomes. Moreover, these findings provide a lesson in investigative caution: gauging the success or failure of a model based on the statistical significance of p-values misses the larger point of whether they can improve our understanding of violent conflict (for further discussion see Ward, Greenhill, and Bakke 2010; Brambor, Clark, and Golder 2006). Due to the concern within the US government that the effects of a changing climate are important for geostrategic interests, the end goal of this line of research should answer the question of how these events can help explain the emergence of violent conflict in response to unpredictable events.

4.7 References

ABC News. 2012. "Hurricane Sandy: Some Don't Believe the Hype." *ABC News*, October 29. Accessed May 7, 2013. http://abcnews.go.com/blogs/headlines/2012/10/hurricane-sandy-people-dont-believe-the-hype/.

Arbetman-Rabinowtiz, Marina, Jacek Kugler, Mark Abdollahian, Kristin Johnson, and Kyungkook Kang. 2012. "Relative Political Capacity: Definitions and Calculations." In *Performance of Nations*, edited by Ronald Tammen and Jacek Kugler. Lanham: Roman and Littlefield. Accessed May 7, 2013.

———. 2011-10-04. "Replication data for: Relative Political Capacity Dataset." Accessed May 7, 2013. http://hdl.handle.net/1902.1/16845. Transresearch Consortium [Distributor] V3 [Version].

Arbetman-Rabinowtiz, Marina and Kristin Johnson. 2007. "Relative Political Capacity: Empirical and Theoretical Underpinnings." Unpublished Manuscript, Claremont, CA, accessed July 31, 2012 http://www.cgu.edu/Include/spe/Conf%20Pol%20Econ%20Indicators%202007/Arbetman-Rabinowitz%20Johnson%20RPC%202007%20Claremont.pdf.

Armario, Christine. 2012. “Deadly, Destructive, Hurricane Season 2012 Ends.” *Associated Press,* November 30. Accessed May 7, 2013. http://bigstory.ap.org/article/2012-hurricane-season-another-record-books.

Barnett, Jon, and W. Neil Adger. 2007. “Climate Change, Human Security, and Violent Conflict.” *Political Geography* 26: 639–655.

Beardsley, Kyle, and Brian McQuinn. 2009. “Rebel Groups as Predatory Organizations: The Political Effects of the 2004 Tsunami in Indonesia and Sri Lanka.” *The Journal of Conflict Resolution* 53 (4): 624–645.

Berrebi, Claude, and Jordan Ostwald. 2011. “Earthquakes, Hurricanes, and Terrorism: Do Natural Disasters Incite Terror?” *Public Choice* 149 (3): 383–403.

Bergholt, Drago, and Paivi Lujala. 2012. “Climate-Related Natural Disasters, Economic Growth, and Armed Conflict.” *Journal of Peace Research* 49 (1): 147–162.

Blaydes, Lisa, and Mark Andreas Kayser. 2011. “Counting Calories: Democracy and Distribution in the Developing World.” *International Studies Quarterly* 55: 887–908.

Braithwaite, Alex. 2010. “Resisting Infection: How State Capacity Conditions Conflict Contagion.” *Journal of Peace Research* 47 (3): 311–319.

Brambor, Thomas, Williams Robert Clark, and Matt Golder. 2006. "Understanding Interaction Models: Improving Empirical Analysis." *Political Analysis* 14 (1): 63–82.

Brancati, Dawn. 2007. "Political Aftershocks: The Impact of Earthquakes on Intrastate Conflict." *The Journal of Conflict Resolution* 51 (5): 715–753.

Boix, Carles. 2003. *Democracy and Redistribution*. Cambridge: Cambridge University Press.

Bueno de Mesquita, Bruce, James D. Morrow, Randolph M. Siverson, and Alastair Smith. 1999. "An Institutional Explanation of the Democratic Peace." *American Political Science Review* 93: 791–807.

Bueno de Mesquita, Bruce, Alastair Smith, Randolph M. Siverson, and James D. Morrow. 2003. *The Logic of Political Survival.* Cambridge: MIT Press.

Carter, David B., and Curtis Signorino. 2010. "Back to the Future: Modeling Time Dependence in Binary Data." *Political Analysis* 18 (3): 271–292.

Centre for Research on the Epidemiology of Disasters (CRED). 2012. "EM-DAT: The OFDA/CRED International Disaster Database." Brussels: Université Catholique de Louvain. Accessed July 31, 2012. www.emdat.be.

Chiozza, Giacomo, and Hein E. Goemans. 2003. "Peace Through Insecurity: Tenure and International Conflict." *Journal of Conflict Resolution* 47(4): 443–467.

Ciccone, Antonio. 2011. "Economic Shocks and Civil Conflict: A Comment." *American Economic Journal: Applied Economics* 3 (4): 215–227.

Collier, Paul, and Anke Hoeffler. 1998. "On the Economic Causes of Civil War." *Oxford Economic Papers* 50: 563–573.

———. 2004. "Greed and Grievance in Civil War." *Oxford Economic Papers* 56 (4): 563–595.

DeRouen, Karl R., Mark J. Ferguson, Samuel Norton, Young Hwan Park, Jenna Lea, and Ashley Streat-Bartlett. 2010. "Civil War Peace Agreement Implementation and State Capacity."*Journal of Peace Research* 47 (3): 333–346.

Dixon, William J. 1994. "Democracy and the Peaceful Settlement of International Conflict." *American Political Science Review* 88 (1): 14–32.

Doyle, Michael R. 1986. "Liberalism and World Politics." *The American Political Science Association* 80 (4) 1151–1169.

Failed States Index. 2013. "Country profile: Chad." *Fund for Peace,* October. Accessed July 31, 2012. http://www.fundforpeace.org/global/states/ccppr11td-countryprofile-chad-10u.pdf.

Fearon, James D., and David D. Laitin. 2003. "Ethnicity, Insurgency, and Civil War." *American Political Science Review* 97 (1): 75–90.

Fearon, James D. 2005. "Primary Commodity Exports and Civil War." *The Journal of Conflict Resolution* 49 (4): 483–507.

Fritz, Charles E. 1996. "Disasters and Mental Health: Therapeutic Principles Drawn from Disaster Studies." *Historical and Comparative Disaster* Series *#10.* University of Delaware: Disaster Research Centre. Accessed May 7, 2013. http://udspace.udel.edu/bitstream/handle/19716/1325/HC%2010.pdf?sequence=1.

Gizelis, Theodora-Ismene, and Amanda E. Wooden. 2010. "Water Resources, Institutions, & Intrastate Conflict." *Political Geography* 29: 444–453.

Gleditsch, Kristian Skrede. 2002. "Expanded Trade and GDP Data." *The Journal of Conflict Resolution* 46 (5): 712–724.

Gleditsch, Nils Petters. 1998. "Armed Conflict and the Environment: A Critique of the Literature." *Journal of Peace Research* 35 (3): 381–400.

Gleditsch, Nils Petter, Peter Wallensteen, Mikael Erikson, Margareta Sollenberg, and Havard

Strand. 2002. “Armed Conflict 1946–2001: A New Dataset.” *Journal of Peace Research* 39 (5): 615–637.

Gleditsch, Nils Petters. 2012. “Wither the Weather? Climate Change and Conflict.” *Journal of Peace Research* 49 (3): 3–9.

Goemans, Hein. 2008. *The Causes of War Termination and the First World War*. Princeton: Princeton University Press.

Guha-Sapir, Debby, Femke Vos, Regina Below, and Sylvain Ponserre. 2011. “Annual Disaster Statistical Review 2011: The Numbers and Trends.” Brussels: Center for Research on the Epidemiology of Disaster. Accessed July 31, 2012. http://www.emdat.be/publications.

———. 2012. “Annual Disaster Statistical Review 2011: The Numbers and Trends.” Brussels: Center for Research on the Epidemiology of Disasters. Accessed July 31, 2012. http://www.emdat.be/publications.

Harbom, Lotta, and Peter Wallensteen. 2010. “Armed Conflicts, 1946–2009.” *Journal of Peace Research* 47 (4): 501–509.

Hegre, Havard, and Nicholas Sambanis. 2006. “Sensitivity Analysis of Empirical Results on Civil War Onset.” *Journal of Conflict Resolution* 50 (4): 508–535.

Hendrix, Cullen S. 2010. "Measuring State Capacity: Theoretical and Empirical Implications for the Study of Civil Conflict." *Journal of Peace Research* 47: 273–285.

Hendrix, Cullen S. and Idean Salehyan. 2012. "Climate Change, Rainfall, and Social Conflict in Africa." *Journal of Peace Research* 49 (1): 35–50.

Heston, Alan, Robert Summers, and Bettina Aten. 2011. "Penn World Table Version 7." University of Pennsylvania: Center for International Comparisons of Production, Income and Prices. Accessed July 31, 2012. http://pwt.econ.upenn.edu/php_site/pwt_index.php.

Hidalgo, F Daniel, Suresh Naidu, Simeon Nichter, and Neal Richardson. 2010. "Economic Determinants of Land Invasions." *Review of Economics and Statistics* 92 (3) 505–523.

Holtermann, Hegre. 2012. "Explaining the Development-Civil War Relationship." *Conflict Management and Peace Science* 29 (1) 56–78.

Homer-Dixon, Thomas. 1999. *Environment, Scarcity, and Violence.* Princeton: Princeton University Press.

Humphreys, Mccarten. 2005. "Natural Resources, Conflict, and Conflict Resolution: Uncovering the Mechanisms." *The Journal of Conflict Resolution* 49 (4): 508–537.

Humphreys, Mccarten, and Jeremy M. Weinstein. 2008. “Who Fights? The Determinants of Participation in Civil War.” *American Journal of Political Science* 52 (2): 436–455.

IPCC. 2007. “IPCC Fourth Assessment Report. Climate Change 2007: Synthesis Report.” edited by R.K Pachauri and A. Reisinger. Geneva: Intergovernmental Panel on Climate Change. Accessed May 6, 2013. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

Kahn, M IIyas. 2010. “Pakistan’s Efforts to Rebuild Thwarted by Natural Disasters.” *British Broadcast Corporation (BBC),* November 28. Accessed July 31, 2012. http://www.bbc.co.uk/news/world-south-asia-11812934.

King, Gary, Michael Tomz, and Jason Wittenberg. 2000. “Making the Most of Statistical Analyses: Improving Interpretation and Presentation.” *American Journal of Political Science* 44(2): 347–361.

Kugler, Jacek, and Marina Arbetman. 1997. “Relative Political Capacity: Political Extraction and Political Research.” In *Political Capacity and Economic Behavior*. edited by Marina Arbetman and Jacek Kugler, 11–46. Boulder, CO: Westview.

Le Billion, Philippe. 2001. “The Political Ecology of War: Natural Resources and Armed Conflict.” *Political Geography* 20 (5): 561–584.

Lujala, Paivi. 2010. “The Spoils of Nature: Armed Civil Conflict and Rebel Access to Natural Resources.” *Journal of Peace Research* 47 (1): 15–28.

Magaloni, Beatriz. 2006. *Voting for Autocracy: Hegemonic Party Survival and its Demise in Mexico.* Cambridge: Cambridge University Press.

Miguel, Edward, Shanker Satyanath, and Ernest Sergenti. 2004. “Economic Shocks and Civil Conflict: An Instrumental Variables Approach.” *The Journal of Political Economy* 112 (4): 725–753.

Miguel, Edward, and Shanker Satyanath. 2011. “Re-Examining Economic Shocks and Civil Conflict.” *American Economic Journal: Applied Economics* 3 (4): 228–32.

Morrison, Kevin M. 2009. “Oil, Nontax Revenue, and the Redistributional Foundations of Regime Stability.” 63: 107–138.

Moyo, Dambisa. 2009. *Dead Aid: Why Aid is Not Working and How There is a Better Way for Africa.* New York: Farrar, Straus, and Giroux.

National Weather Service. 2013. “National Hurricane Center.” Accessed May 7, 2013. http://www.nhc.noaa.gov/.

Nanto, Dick K, William H. Cooper, and J. Michael Donnelly. 2011. "Japan's 2011 Earthquake and Tsunami: Economic Effects and Implications for United States." Washington D.C.:CRS Report for Congress, March 25. Accessed July 31, 2012. http://fpc.state.gov/documents/organization/159785.pdf.

NBC News. 2013. "Frustration Rises from Rubble Following China's Deadly Quake. *NBC News* April 22. Accessed April 22, 2013. http://worldnews.nbcnews.com/_news/2013/04/22/17859394-frustration-rises-from-rubble-following-chinas-deadly-quake?lite.

Nel, Philip, and Marjolein Righarts. 2008. "Natural Disasters and the Risk of Violent Civil Conflict." *International Studies Quarterly* 52: 159–185.

Oh, Chang Hoon, and Rafael Reuveny. 2010. "Climatic Natural Disasters, Political Risk, and International Trade." *Global Environmental Change* 20: 243–245.

Organski, A.F.K., and Jacek Kugler. 1980. *The War Ledger*. Chicago: University of Chicago Press.

Pinstrup-Andersen, Per, and Satoru Shimokawa. 2008. "Do Poverty and Poor Health and Nutrition Increase the Risk of Armed Conflict Onset?" *Food Policy* 33: 513–520.

Ross, Michael L. 2001. "Does Oil Hinder Democracy?" *World Politics* 53 (3): 325–361.

———. "What Do We Know About Natural Resources and Civil War?" *Journal of Peace Research* 47 (1): 337–356.

———. 2012. *The Oil Curse: How Petroleum Wealth Shapes the Development of Nations.* Princeton: Princeton University Press

———. 2001. *Triangulating Peace: Democracy, Interdependence, and International Organizations.* New York, NY: Norton.

Salehyan, Idean. 2008. "From Climate to Conflict? No Consensus Yet." *Journal of Peace Research* 45 (3): 315–326.

Salehyan, Idean, Cullen S. Hendrix, Jesse Hamner, Christina Case, Christopher Linebarger, Emily Stull, and Jennifer Williams. 2012. "Social Conflict in Africa: A New Database" *International Interactions* 38 (4): 503–511.

Sen, Amartya. 1999. *Development as Freedom.* New York: Alfred A. Knopf, Inc.

Slettebak, Rune T. 2012. "Don't Blame the Weather! Climate-Related Natural Disasters and Civil Conflict." *The Journal of Peace Research* 49 (1): 163–176.

Smith, Benjamin. 2004. “Oil Wealth and Regime Survival in the Developing World, 1960–1999.” *American Journal of Political Science* 48 (2): 232–246.

Smith, Elliot Blair. 2005. “Katrina Cripples 95% of Gulf Oil Production.” *USA Today,* August 30. Accessed July 31, 2012. http://www.usatoday.com/money/industries/energy/2005-08-30-katrina2-refinery-usat_x.htm.

———. 2010. “Masters of Their Domains: The Role of State Capacity in Civil Wars.” *Journal of Peace Research* 47 (3): 267–271.

Sobek, David, and Charles Boehmer. “If They Only Had Cake: The Effects of Food Supply on Civil War Onset, 1960–1999.” Unpublished Manuscript. Accessed May 6, 2013. http://digitalcommons.utep.edu/cgi/viewcontent.cgi?article=1001&context=charles_boehmer.

Steinberg, David Joel. 2000. *The Philippines, 4th Edition.* Boulder: Westview Press.

Thies, Cameron. 2010. “Of Rulers, Rebels, and Revenue: State Capacity, Civil War Onset and Primary Commodities.” *Journal of Peace Research* 47 (3): 321–332.

Tomz, Michael, Wittenberg, Jason, and King, Gary. 2003. “CLARIFY: Software for Interpreting and Presenting Statistical Results.” *Journal of Statistical Software* 8 (1).

Van de Walle, Nicolas. 2001. *African Economies and the Politics of Permanent Crisis, 1979–1999.* Cambridge: Cambridge University Press.

Vreeland, James, Raymond. 2008. “The Effect of Political Regime on Civil War: Unpacking Anocracy.” *Journal of Conflict Resolution* 53 (2): 401–425.

Ward, Michael D., Brian D. Greenhill, and Kristin M. Bakke. 2010. “The Perils of Policy by P-Value: Predicting Civil Conflicts.” *Journal of Peace Research* 47 (4): 363–375.

World Bank. 2012a. “World Development Indicators: Oil Rents as % of GDP.” *World Bank.* Accessed July 31, 2012. http://data.worldbank.org/indicator/NY.GDP.PETR.RT.ZS.

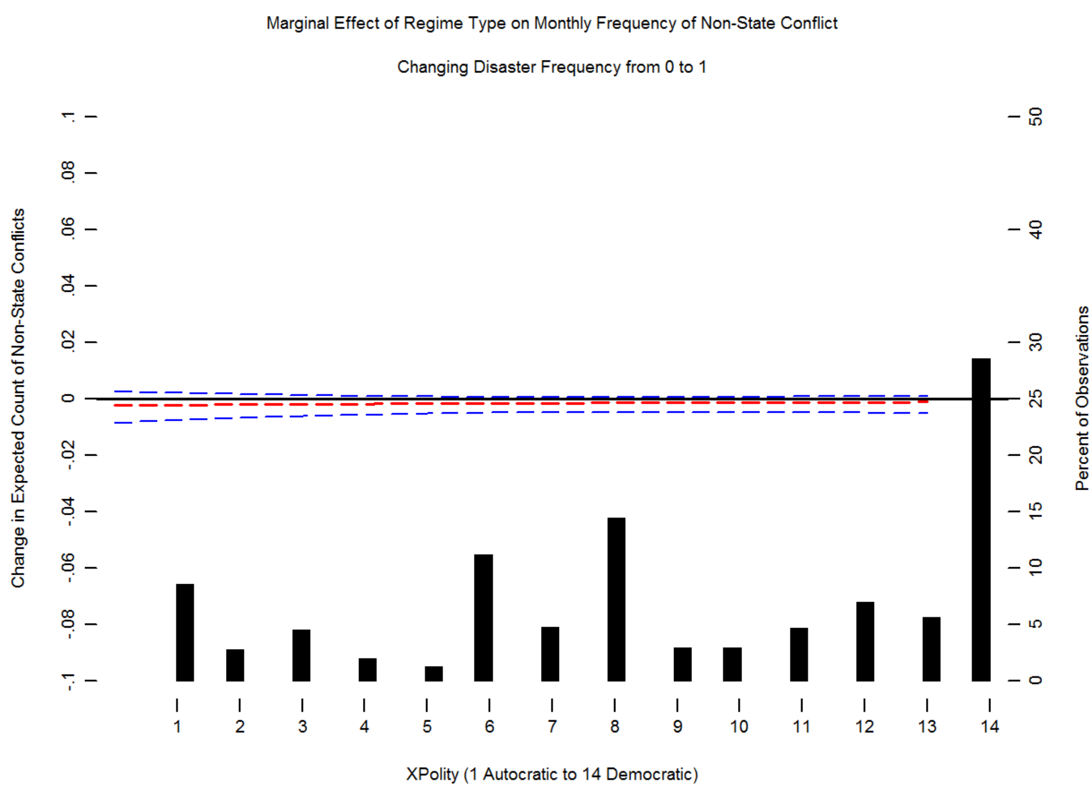
World Bank. 2012b. “World Development Indicators.” *World Bank.* Accessed July 31, 2012. http://data.worldbank.org.

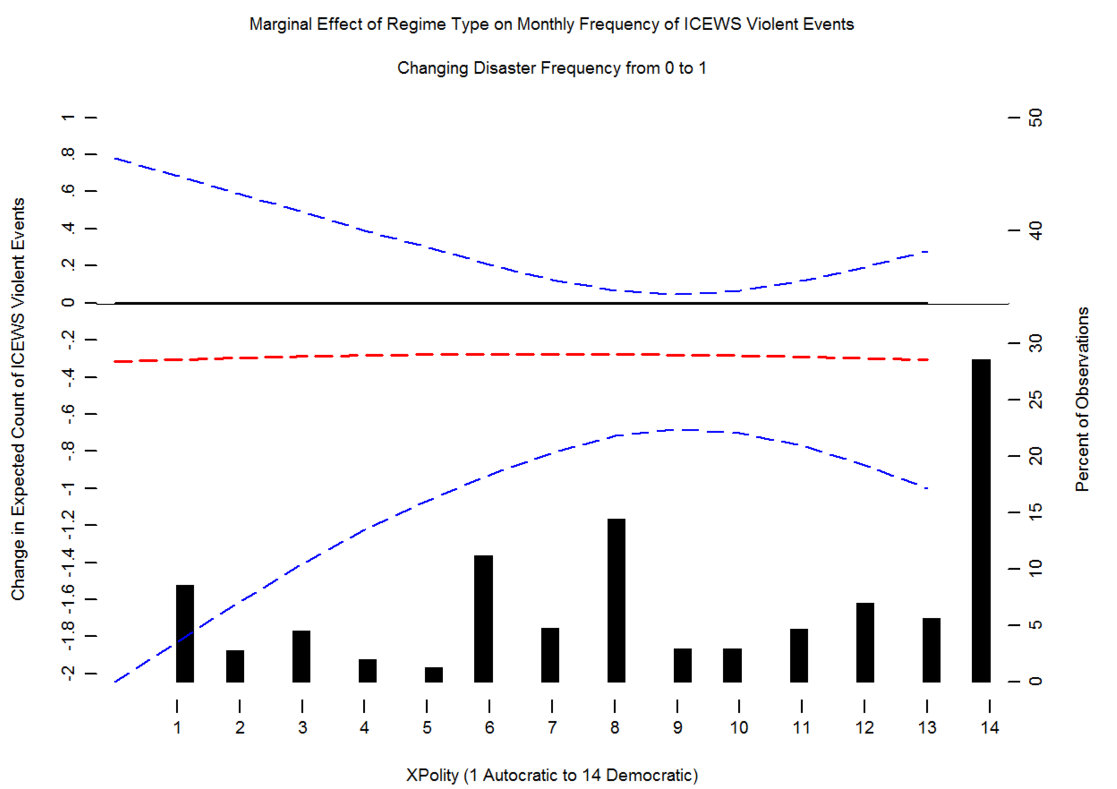
Xinhua. 2012. “Industrial Precaution Urged in China’s Flood Season.” *Xinhua (English),* April 28. Accessed May 7, 2013. http://news.xinhuanet.com/english/china/2012-04/28/c_131558799.htm.

4. 8 Appendix

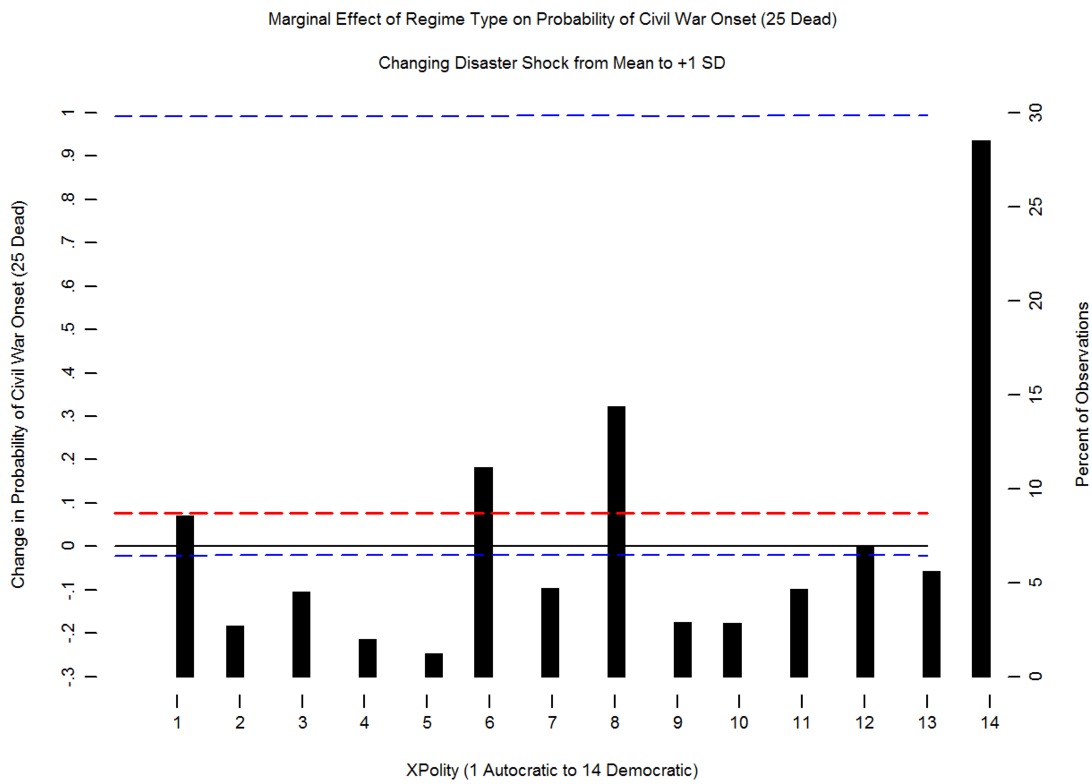
The following contains additional graphs of insignificant multiplicative interaction for all Hypotheses 2–4. Note: that in Hypothesis 3(b) Model 5 is truncated due for graphical modeling purposes due to extremely large confidence intervals at high values of *Resource Rents as % GDP (lag).* For Hypothesis 2 (d) and Hypothesis 3(d) Models 5, 7, and 9 are truncated at varying values of *Xpolity (lag)* and *Resource Rents as % GDP (lag)* for similar reasons.

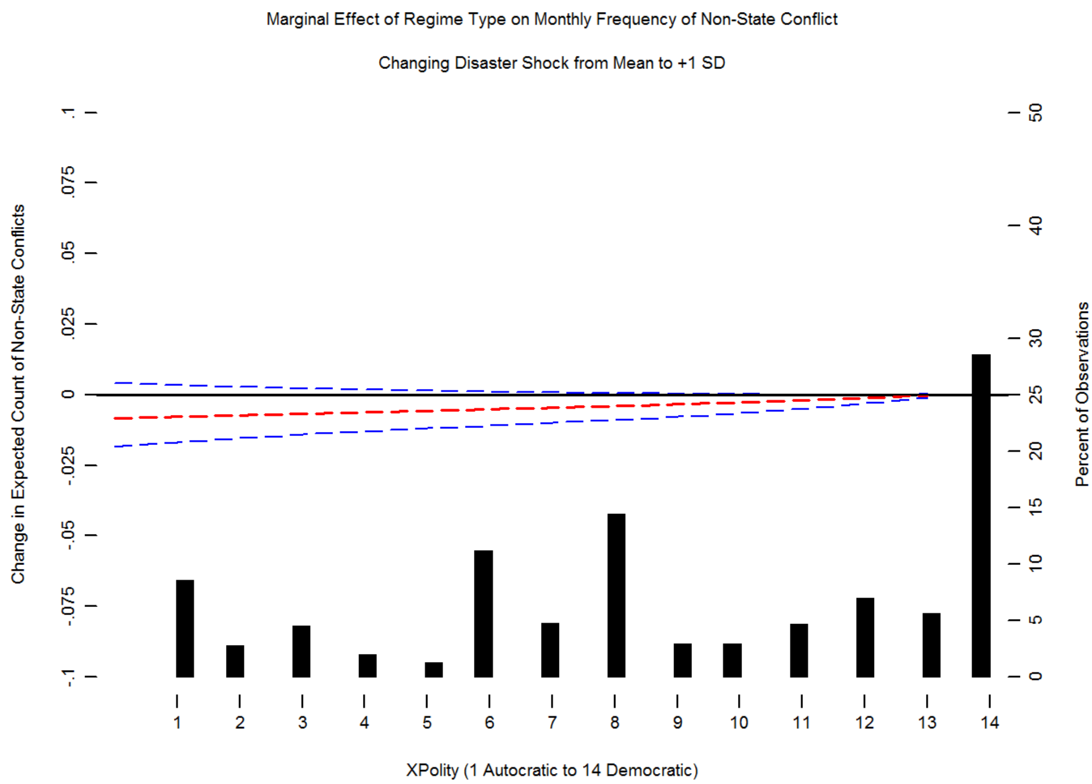
Hypothesis 2(a) and 2(b):

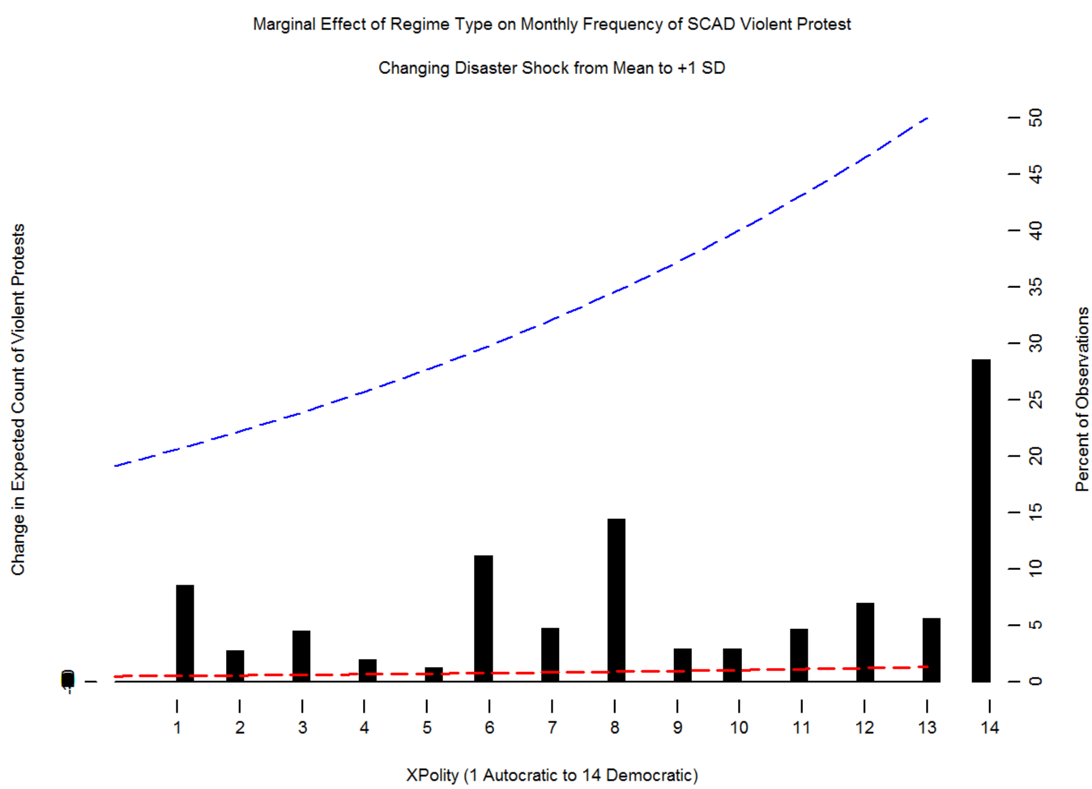




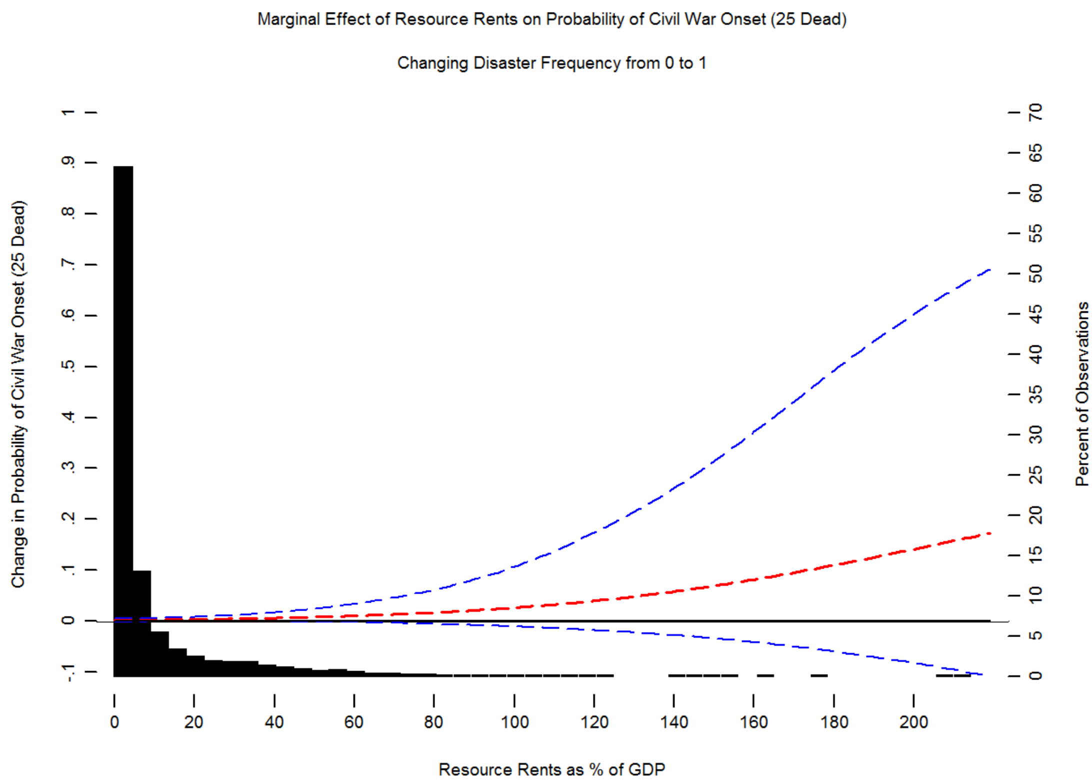
Hypothesis 2(c) and 2(d):

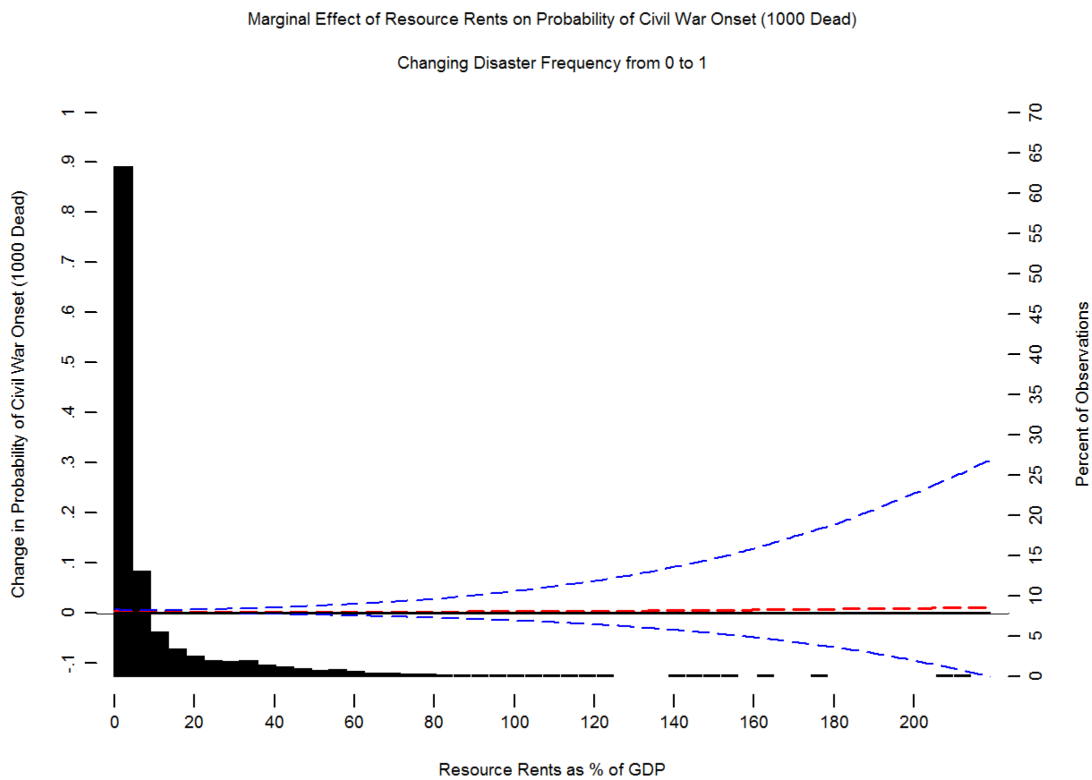

Marginal Effect of Regime Type on Probability of Civil War Onset (25 Dead)
Changing Disaster Shock from Mean to +1 SD
Change in Probability of Civil War Onset (25 Dead)
-.3
-.2
-.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
Percent of Observations
0
5
10
15
20
25
30
1
2
3
4
5
6
7
8
9
10
11
12
13
14
XPolity (1 Autocratic to 14 Democratic)

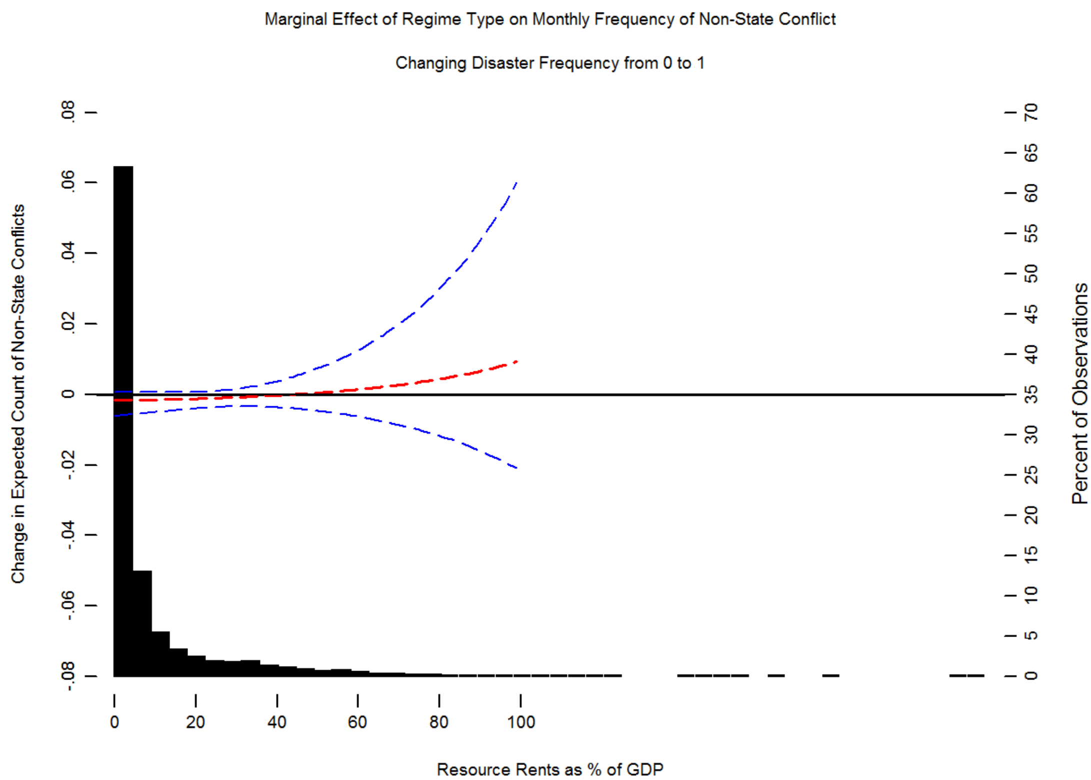

Marginal Effect of Regime Type on Monthly Frequency of Non-State Conflict
Changing Disaster Shock from Mean to +1 SD
Change in Expected Count of Non-State Conflicts
.1
.075
.05
.025
0
-.025
-.05
-.075
-.1
Percent of Observations
50
40
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
XPolity (1 Autocratic to 14 Democratic)



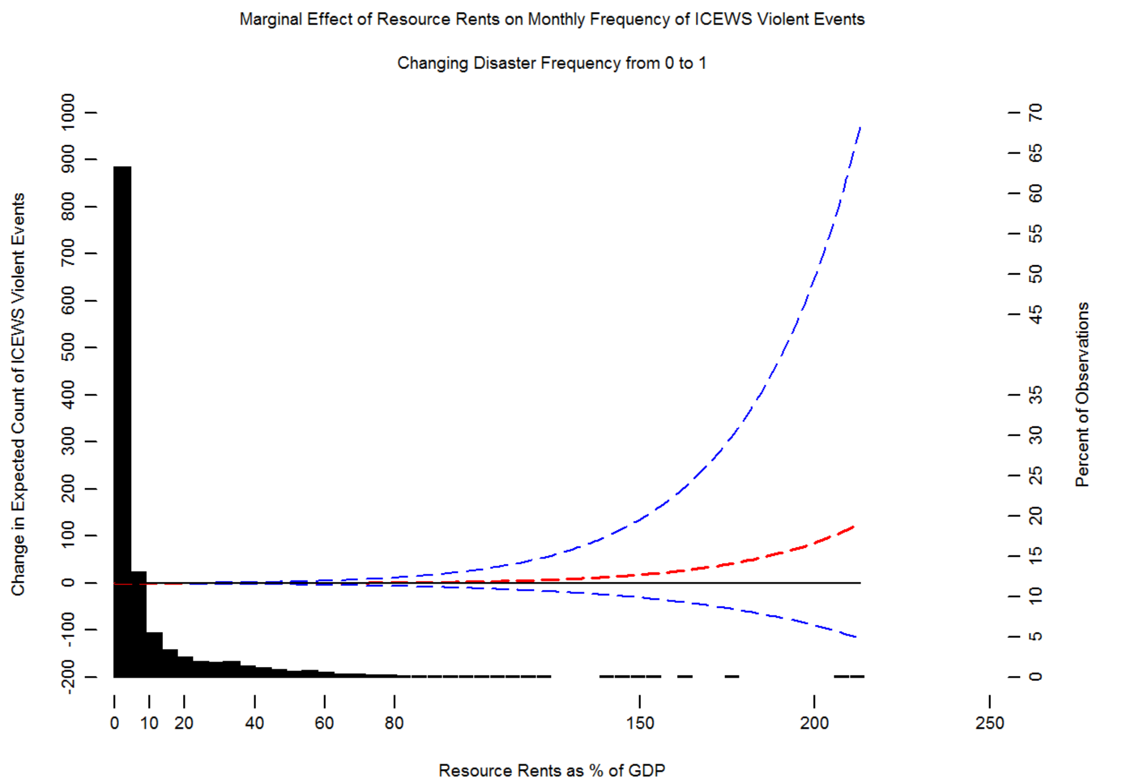
Hypothesis 3(a) and 3(b):


Marginal Effect of Resource Rents on Probability of Civil War Onset (25 Dead)
Changing Disaster Frequency from 0 to 1
Change in Probability of Civil War Onset (25 Dead)
-.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
Percent of Observations
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
0
20
40
60
80
100
120
140
160
180
200
Resource Rents as % of GDP

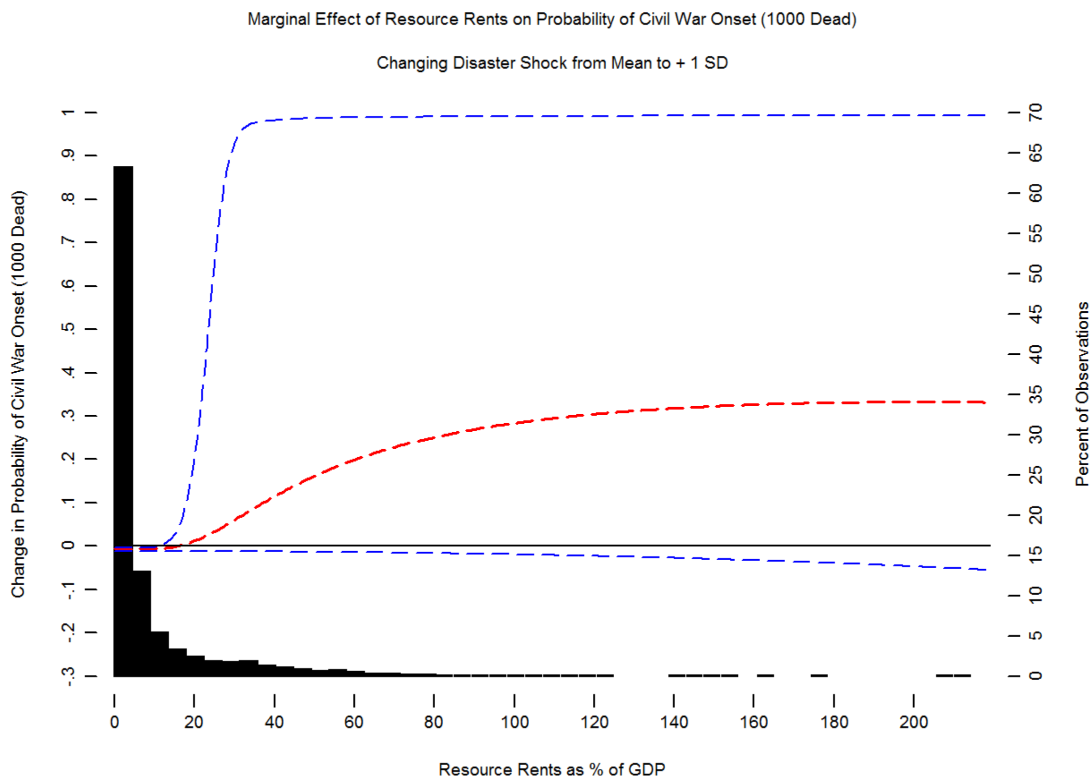

Marginal Effect of Resource Rents on Probability of Civil War Onset (1000 Dead)
Changing Disaster Frequency from 0 to 1
Change in Probability of Civil War Onset (1000 Dead)
Percent of Observations
Resource Rents as % of GDP
-.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
0
20
40
60
80
100
120
140
160
180
200

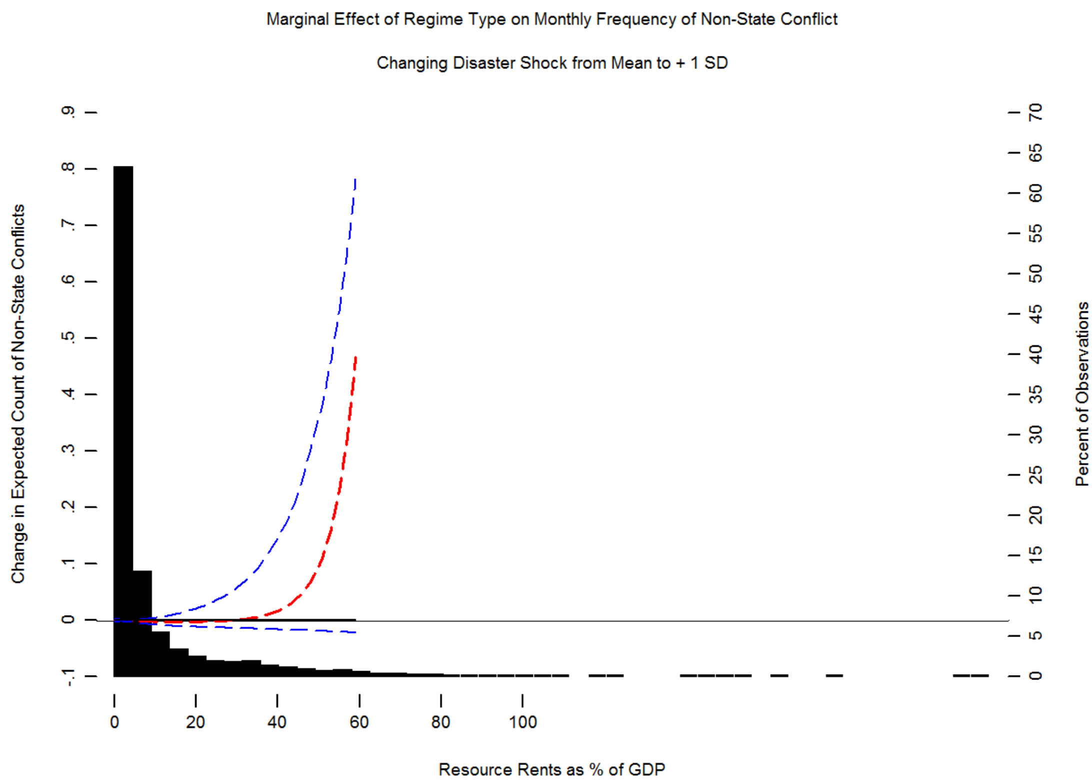


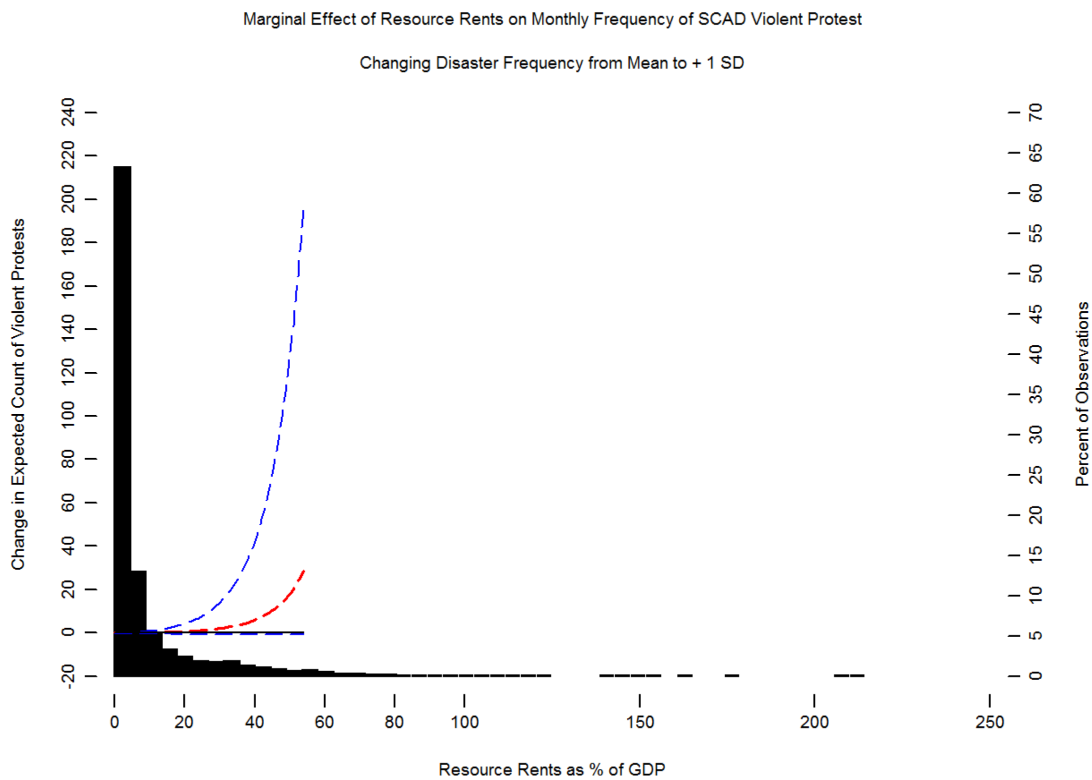
Marginal Effect of Regime Type on Monthly Frequency of Non-State Conflict
Changing Disaster Frequency from 0 to 1
Change in Expected Count of Non-State Conflicts
.08
.06
.04
.02
0
-.02
-.04
-.06
-.08
Percent of Observations
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
20
40
60
80
100
Resource Rents as % of GDP

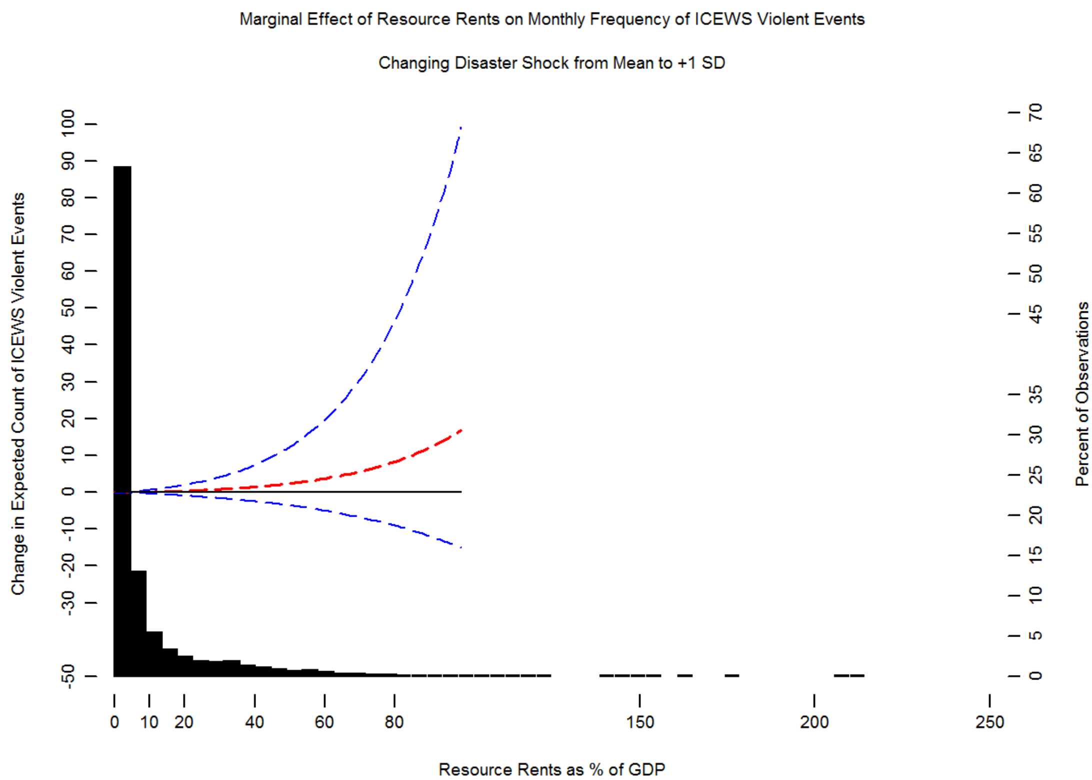


Hypothesis 3(c) and 3(d):

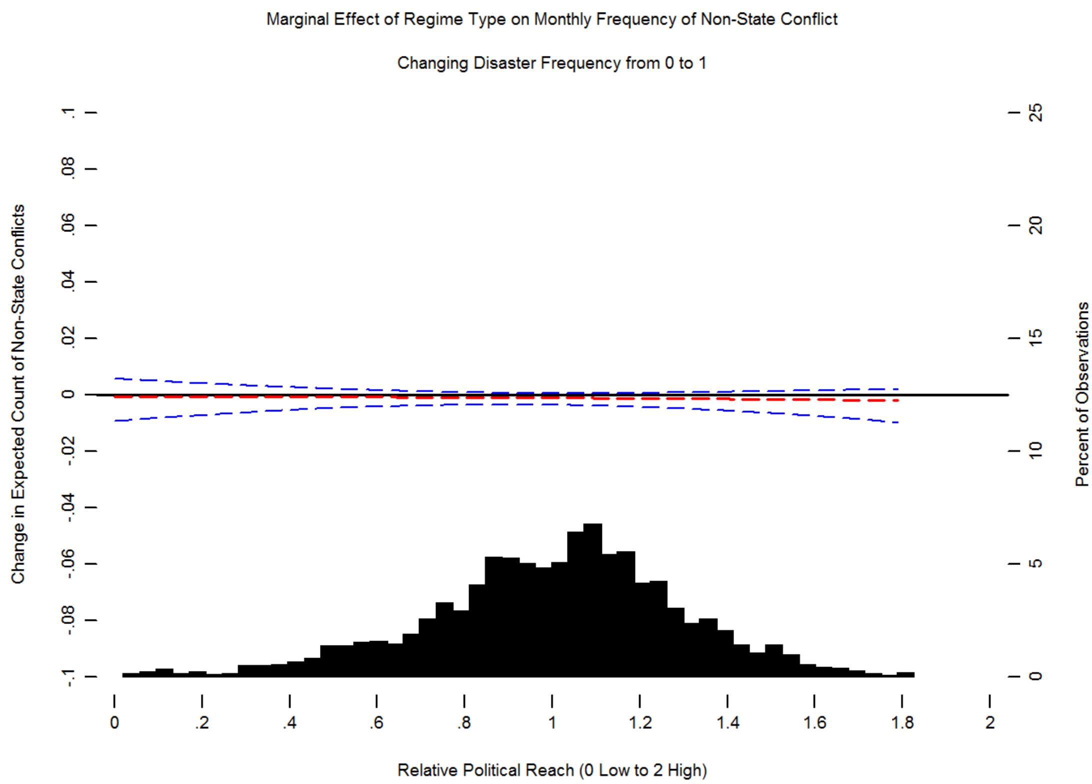

Marginal Effect of Resource Rents on Probability of Civil War Onset (1000 Dead)
Changing Disaster Shock from Mean to + 1 SD
Change in Probability of Civil War Onset (1000 Dead)
-.3
-.2
-.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
Percent of Observations
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
0
20
40
60
80
100
120
140
160
180
200
Resource Rents as % of GDP

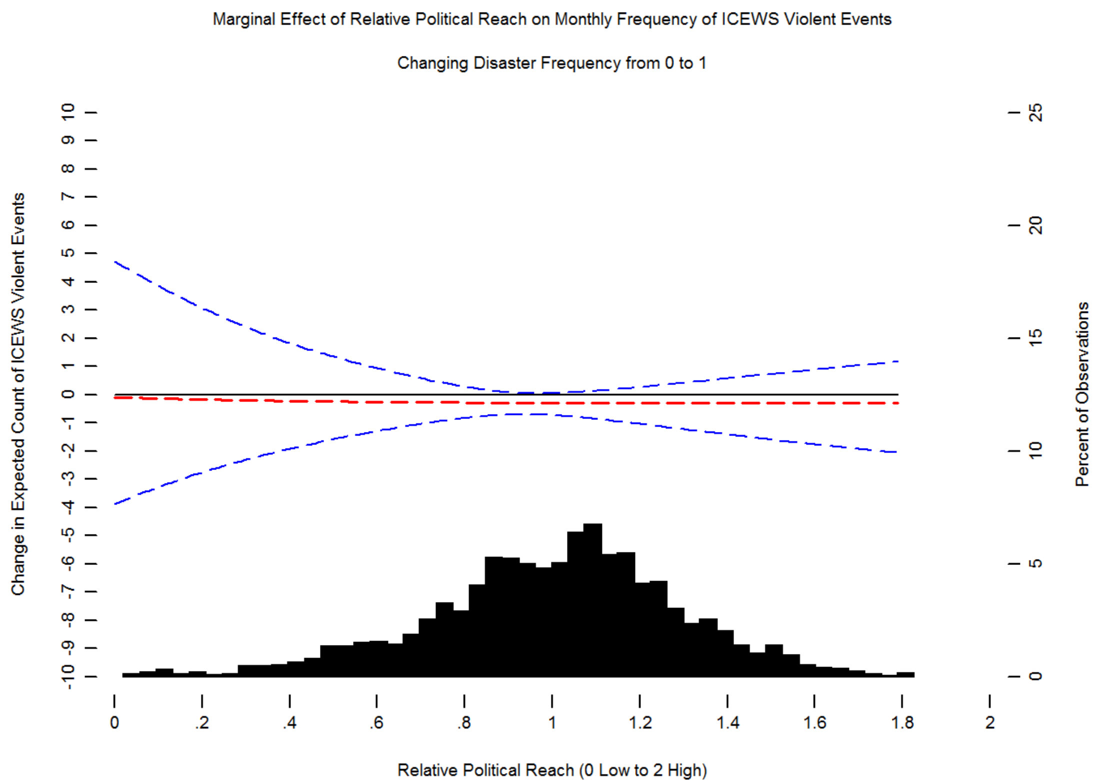

Marginal Effect of Regime Type on Monthly Frequency of Non-State Conflict
Changing Disaster Shock from Mean to + 1 SD
Change in Expected Count of Non-State Conflicts
-.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
Percent of Observations
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
0
20
40
60
80
100
Resource Rents as % of GDP


Marginal Effect of Resource Rents on Monthly Frequency of SCAD Violent Protest
Changing Disaster Frequency from Mean to + 1 SD
Change in Expected Count of Violent Protests
-20
0
20
40
60
80
100
120
140
160
180
200
220
240
Percent of Observations
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
0
20
40
60
80
100
150
200
250
Resource Rents as % of GDP

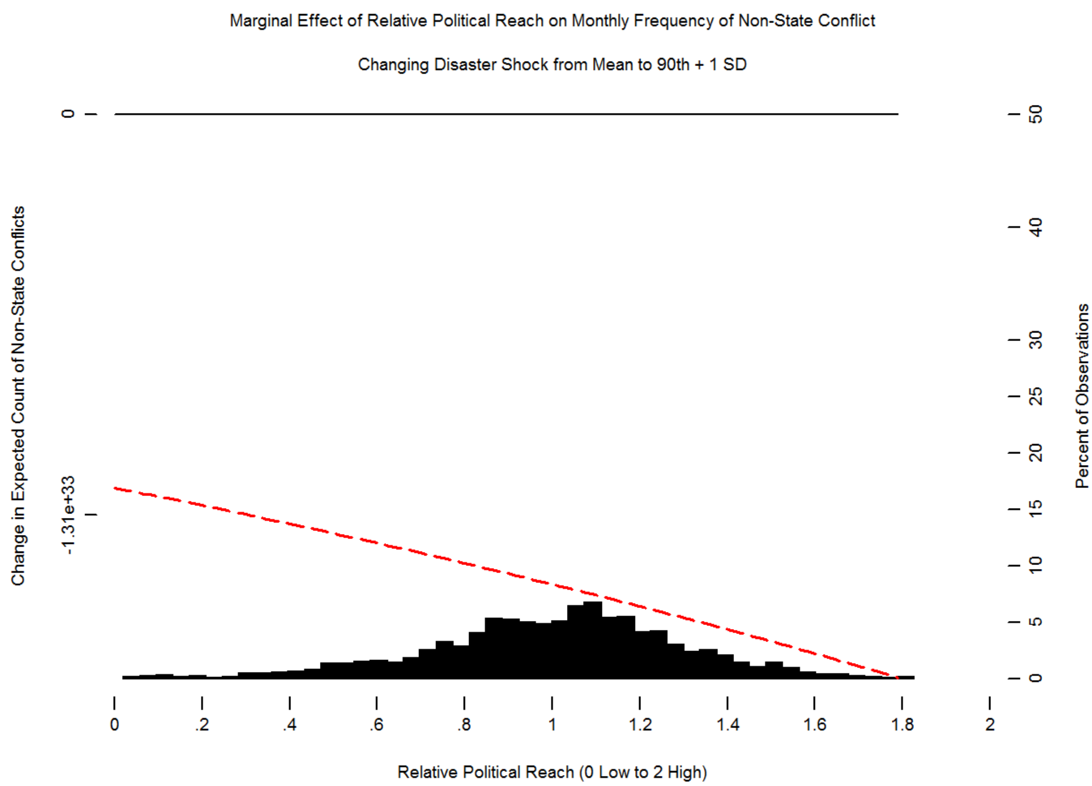


Hypothesis 4(a) and 4(b):

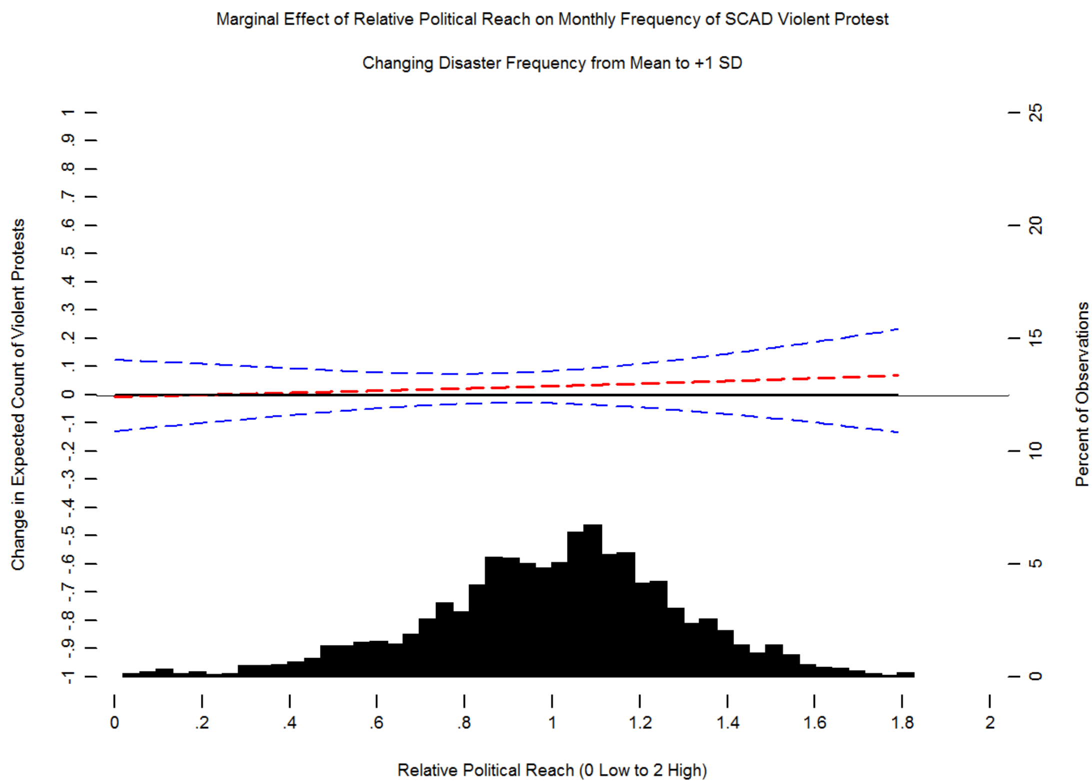

Marginal Effect of Regime Type on Monthly Frequency of Non-State Conflict
Changing Disaster Frequency from 0 to 1
Change in Expected Count of Non-State Conflicts
Percent of Observations
Relative Political Reach (0 Low to 2 High)
.1
.08
.06
.04
.02
0
-.02
-.04
-.06
-.08
-.1
25
20
15
10
5
0
0
.2
.4
.6
.8
1
1.2
1.4
1.6
1.8
2



Hypothesis 4(c) and 4(d):



Marginal Effect of Relative Political Reach on Monthly Frequency of Non-State Conflict
Changing Disaster Shock from Mean to 90th + 1 SD
Change in Expected Count of Non-State Conflicts
0
-1.31e+33
Percent of Observations
50
40
30
25
20
15
10
5
0
0
.2
.4
.6
.8
1
1.2
1.4
1.6
1.8
2
Relative Political Reach (0 Low to 2 High)


Marginal Effect of Relative Political Reach on Monthly Frequency of SCAD Violent Protest
Changing Disaster Frequency from Mean to +1 SD
Change in Expected Count of Violent Protests
-1 -.9 -.8 -.7 -.6 -.5 -.4 -.3 -.2 -.1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
0 5 10 15 20 25
Percent of Observations
0 .2 .4 .6 .8 1 1.2 1.4 1.6 1.8 2
Relative Political Reach (0 Low to 2 High)

Chapter 5

Conclusions

5.1 Alarmism or Evidence: A Summary of the Results

My research has demonstrated the theoretical and statistical utility of temporally disaggregating meteorological and physical data down from a yearly to a monthly unit of analysis. Doing so allowed me to test the three major divisions of the ecoviolence literature, searching for evidence of a relationship between environmental factors and the onset of various forms of violent conflict.

In Chapter 2, I first showed the advantages of using temporal disaggregation by presenting estimations of the relationship between temperature changes and the onset of violent conflict first at the yearly level and then at the monthly level. I demonstrated that the results only improved when using a country-month research design, validating the use of this method in subsequent chapters. Furthermore, I found evidence in support of the ecoviolence theory when examining the theoretical mechanism of 'Seasonality and Strategic Viability', which argues that the onset of violent conflict increases in months that are marked by predictable and favorable weather. Conversely, I found in testing various operationalizations of the general 'Eco Shock and Equilibrium Disruption' mechanism, that the risk of violent conflict declines in months marked by substantial deviations in the long-term temperature mean of meteorological patterns.

In Chapter 3, I delineated the advantages and disadvantages of existing studies that have investigated the relationship between environmental degradation and the onset of violent conflict. Next, I constructed new datasets based on sound meteorological data and found little support for a connection between these measures and the onset of violent conflict. In addition, I evaluated the famous Diamond (2006) hypothesis via principal component factoring. The analysis revealed that the dimensionality of his theory is constrained to three rather than eight factors; albeit, there remained approximately 38% unexplained variation among the proxy variables. When analyzing these three dimensions, I found mixed support for the theory, showing that the 'desertification' dimension is most strongly associated with the onset of violent conflict.

Finally, in Chapter 4, I tested the relationship between natural disasters and their association with the onset of violent conflict, conditional on three different dimensions of state capacity. The results indicated mixed support for both theoretical mechanisms, ultimately suggesting the effects of state capacity at mitigating the onset of violent conflict in the event of a natural disaster are overstated, despite the widely held belief in existing literature that they have an attenuating influence.

5.2 Future Steps & Improvements: Spatial Disaggregation

As emphasized previously, the major contribution of this research has been to use temporal disaggregation of various meteorological and physical measures for generating strong theoretical mechanisms that may plausibly explain the commonly held belief that changing environmental factors are associated with the onset of violent conflict. As shown throughout this dissertation, the evidence is unsystematic, but the findings suggest that the causal pathways to conflict are more likely tied to the 'Seasonality and Strategic

Viability" mechanism. With regard to improving upon this work, I believe that there exist several avenues worthy of pursuit.

The advantages of temporal disaggregation would stand to benefit by a complementary use of spatial disaggregation. One of the drawbacks of using country-aggregated data is that it both overstates and understands the degree of variation observed in a host of theoretically interesting types of information such as population density, income distribution, ethnic settlements, and other development measures (for further discussion see Hegre, Ostby, and Raleigh 2009). For instance, the findings of Chapter 4 were largely inconclusive. The results suggested that natural disasters showed only a weak conditional marginal effect with various measures of state capacity. As the data currently exist, it is unclear whether these findings are the actually true or whether they are suffering from a severe case of ecological fallacy that is creating a series of null findings. Because the social consequences of environmental changes are often most strongly felt at a local level rather than countrywide, it makes theoretical sense to spatially disaggregate these measures as well. Unfortunately, local measures of state capacity are notably absent from most political science conflict literature, yet the theoretical justification for their use is strong. Patterns of development differ not only cross-nationally, but within country as well. One only needs to look at a nighttime satellite image of the world to see that electricity grids are spatially clustered. This trend is replicable also with: roads, rivers, railways, airports, population density, ethnic groups, meteorological, and physical factors as well. Local measures of state capacity via spatial disaggregation would have allowed for more meaningful tests of my theoretical arguments discussed at length in Chapter 4.

A richer research design would also have included a temporal disaggregation of *all* the measures and not just the meteorological and physical used in my analyses *and* a corresponding spatial disaggregation for all of these measures. In construction of the various meteorological and physical datasets that were used in this dissertation, I was forced to transform these data from their geo-located points to country-level datasets in order to make these measures applicable with existing political science datasets. This approach drastically limited the potential of this otherwise rich universe of data.

5.21 Differentiation of Existing Theoretical Mechanisms

A major finding of this research was increases in the onset of conflict was most often associated with the ‘Seasonality and Strategic Viability’ mechanism rather than the more often-discussed ‘Eco Shock and Equilibrium Disruption’ mechanism. What remains to be answered are: ‘Why?’ and ‘What does seasonality imply for the onset of violent conflict?’ The large implication of my findings is that seasons are a heuristic tool that actors use to judge when the onset of conflict is strategically most favorable. However, it is conceivable that notion of seasonality acts differently for different forms of conflict. For instance, for civil wars such as the current one in Afghanistan, it is often characterized by a ‘fighting season’ during the spring and summer. In this instance, seasonality seems tied to this notion of strategic viability because the melting of the mountain snows allows for the increased movement of troops and supplies throughout the country for rebels forces and ISAF troops alike (King and Yaqubi 2012; Partlow 2011). Yet, an alternative explanation could be used to describe seasonality because of its association with growing seasons for various types of agricultural goods. In the case of social protests and other violent events, it may be that prevalence or lack thereof of food is responsible for eliciting violent outbreaks. Therefore, seasonality may be able to explain both strategic motivations and the more traditional argument of resource scarcity within the ecoviolence literature. Ultimately, what is required is an investigation of these concepts on a local scale by spatially mapping the onset of conflict to truly judge whether onsets occur in or within geographic areas and environmental conditions supportive of strategy or ones marked by a prevalence or lack of natural resources.

5.22 Testing of Currently Untestable Theoretical Mechanisms

A further benefit of spatial disaggregation is that it allows for the testing of currently untested ecoviolence theoretical mechanisms. Of a particular interest is the diffusion of environmentally displaced refugees. An often-discussed mechanism within the civil war literature is how migration may generate violent conflict via refugee flows into places that subsequently destabilize host communities, change ethnic compositions, and exacerbate resource competition (Salehyan and Gleditsch 2006). Martin (2005) finds some evidence to suggest that resource management between refugee and host communities have important effects on the onset of violent conflict between them; while Reuveny (2007) finds an increase in the frequency of conflict in areas that receive refugees due to environmental problems. Among other issues, one major issue with testing this displacement mechanism is that there are few datasets that provide reliable spatial mapping of the flow of environmental refugees. Research does not adequately explain why, when, or for how long people leave in response to environmental issues. This is in large part because ecoviolence theory is silent on the difference in implications between forced environmental migration and seasonal migration. For instance, the implications of Oliver-Smith (2011) suggest that involuntary migration, such as moving in response to a natural disaster or sea level rise, may produce a different type of refugee and set of interactions with their new host community because of the permanence of their movement. Contrast this form of migration with the seasonal migration, related to changing environmental conditions for agricultural employment: Gray (2011) finds temporary migration is tied to changing agricultural conditions in Africa; while Ellis (2000, 58) argues that "in sub-Saharan Africa, labour markets are poorly developed in rural areas so that migration is a more common response to cyclical changes in farm labor needs than wage work secured locally." Therefore, seasonality may simultaneously drive different forms of migration for different reasons. These differences have implications for the onset of conflict because host communities may be more tolerant of seasonal labor migration than a permanent influx of environmental refugees, which may radically alter local political and social contexts.

Location is another factor that is not well understood in the context of environmental migration. The question of how far people move and where they move in response to various environmental problems only appears to be documented and understood at an anecdotal level (see Findlay and Geddes 2011). Spatial disaggregation would allow researchers to map the direction, distance, and time from which environmental migration occurs. Doing so would provide some theoretical currency for understanding under what conditions we should expect migration in response to environmental issues and then tailor a policy response appropriately in order to avoid issues like the onset of violent conflict, resource competition, and host-refugee disagreements.

A second area of interest that would benefit from spatial disaggregation is in studying growing trend within energy markets in response to climate change has been a shift toward 'green' industries such as production of energy from solar, wind, and biofuels. The commonly held view is that this trend is positive for mankind because it helps reduce the world's emission of greenhouse gases, which are responsible for climate change and may even lift the rural poor out of poverty (Hazell 2006). However, the social consequences of this move toward these new forms of energy, particularly biofuels are poorly understood—plagued with a variety of ethical questions and subject of intense debate (Gleditsch 2012; Gomiero, Paoletti, and Pimentel 2009; Oxfam 2007). Of particular concern is how the shift towards large argo-industries influences proximate agricultural communities' employment prospects and social attitudes.

A consequence of this shift may manifest itself into a 'race to the bottom' in regions characterized by these budding industries, which drive local producers out of the market and/or pay them wages below market value. A second concern is that the pursuit of these industries may increase the price of food as large amounts of arable land are used for energy production rather than food production (Gomiero, Paoletti, and Pimentel 2009). A third concern is that overtime these industries may come to be another form of government rents, which may create a 'green resource curse' akin to the arguments of Ross (1999; 2001a; 2001b). A final concern is that the shift to these new forms of energy will inflame a 'global land rush' where competition for the land needed for biofuel productions leads parities into conflict with those who need that same land for food production (Scheidel and Sorman 2012). Together these consequences may interact to increase local political grievances, disrupt established local employment patterns, and increase the frequency of riots and other forms of violent conflict in response. Spatial disaggregation would contribute to testing these mechanisms because it would allow us to investigate the effects of these industries on the communities in which they are located and the role to which they inflame resource competition (for further discussion see Gleditsch 2012; Neville and Dauvergne 2012). Unfortunately, the ecoviolence literature remains silent on the role of biofuels for conflict and development.

Finally, a third area of interest that would benefit from spatial disaggregation is in studying how the practice of crop substitution may be associated with the onset of violent conflict. The IPCC (2007), and others (Mendelshon, Dinar, and Williams 2006), maintain that the effects of climate change will be exacerbated in poor, agricultural areas of the world. These areas of the world are often situated in climates that are productive for both legal and illegal agricultural products (i.e. coffee vs. coca or poppy). Scholars are beginning to recognize the possibility of climate change forcing farmers to cultivate drug crops as an alternative because of their constitution in the face of increasing climate variability (Dube and Vargas 2012). These effects have not been shown to increase the risk of violent conflict in Colombia (Dube and Vargas 2012), however results from large-n empirical testing remain unknown. It may be that an increase in the supply of drugs, brought about indirectly via agricultural responses to climate change, undercuts the premium that rebel groups and cartels receive and leads to the long-term demise of the drug trade. Alternatively, it could increase the rate of drug use and crime at an appalling level among the poor and disenfranchised. The truth remains to be seen, but spatial disaggregation would allow for the testing of this mechanism by mapping shifts and trends in agricultural patterns and then correlating their changes in response to local environmental factors to determine their social impacts.

5.23 Issues with Spatial Disaggregation: "Missing the Forest for the Trees"

For all its potential benefits, spatial disaggregation is not a panacea. The use of GIS in political science is a relatively new phenomenon and some of the implications of its modeling decisions are not well understood. For instance, the choice of grid cell size when using spatial disaggregation is extremely important. Using too small a grid cell and one risks focusing on details so small that they are irrelevant unless considered in a broader context. Using too large a grid cell and one risks making an ecological fallacy (with most research a 'country' is effectively the only grid cell). Despite the recent popularity of PRIO-GRID (Tollefsen et al. 2012), there lacks a firm consensus on the proper size of a grid cell for modeling various political science phenomena. In the context of ecoviolence research, this problem is compounded because environmental factors do not respect the arbitrary imposition of a grid cell. In this sense, grid cells are not always independent of one another—particularly so when one considers meteorological measures. As Tollefsen et al (2012, 369) admit, "the assumption of independent and identically distributed observations made in inferential statistics often does not hold when working with geographic data. And although there are methods for dealing with this problem, the fact remains that the 'starting and stopping' of various physical and meteorological factors are imprecisely captured by the use of a grid-cell; and the choice of their size is important particularly when considering the differences between climate and weather.”

A second issue with grid cells as a unit of analysis is that they are a-theoretical, which means that they are fixed in time and space, but the ideas a researcher uses them to understand may not be (i.e. environmental conditions, conflict, economic development, ethnic distributions, migration, and political boundaries) (Tollefsen et al. 2012, 365). The consequence of this is that the grid design is inflexible to many concepts of interest, making its overall utility somewhat limited.

A related issue is the question of grid connectivity. GIS specialists often refer to this concept as the ‘least cost path’ because of the degree of effort used to connect one grid to another. In some instances, this may be irrelevant, but when considering issues of troop movements, refugee flows, and state capacity (i.e. issues of interest to this dissertation), the choice of grid connectivity is important. Should researchers measure connectivity as a single concept, such as a shared road? Or should they measure connectivity as a multiple dimensional concept such as a shared ethnicity community, a shared electricity grid, and/or a shared climate? In places like sub-Saharan Africa, the question of grid connectivity is extremely important because economic development is quite inconsistent (see Moyo 2009). With regards to this inconsistency, a railway may matter less than a dirt road, and a dirt road may matter more than a river way. Ultimately, the choice of connectivity influences how we measure many important issues like the onset of violent conflict and conflict diffusion.

Dataset size is also a concern when using a grid cell research design. Given the emphasis throughout this dissertation on the importance of seasonality, and the concerns regarding grid cell size and connectivity, researchers could easily find themselves with a dataset consisting of tens of millions of observations. Datasets of this size call into question issues of overall utility and feasibility. Millions of observations also require a massive amount of computing power, which in some cases may be infeasible given budgetary concerns and time constraints.

Finally, there is an overarching tradeoff that sometimes must be made between theory and space. Researchers have shown that conflicts cluster in space (Buhaug and Lujala 2005) and Tofflesen et al. (2012) argue that "most civil wars are highly local events and many have little impact on the society at large" (372). Although this may often be true, it is not always a valid argument for preferring a smaller grid cell to the country as the most desirable unit of analysis. Because the 'state' is considered a crucial actor in the coding of a civil war (Gledtisch et al. 2002), and its government is theoretically considered the agent of the entirety of the state (Hobbes 1963; Locke 1963; Rousseau 1963), it may be inappropriate to prefer a grid cell to the country at large when studying the onset of violent conflict. In addition, just because conflicts may be located within specific areas of a country it does not mean that their economic and social effects are contained there. One would be hard pressed to adequately refute that the economic and social costs of the American Civil War had 'little impact' on other areas of the country that did not actually experience combat.

Even on a theoretical level, the actors we study may not respond to political issues based on a grid cell research design. Rather, it is conceivable that people are more likely to respond, prioritize, and identify problems through social or political hierarchies like local governments, administrative districts, cities, ethnic communities or the state at large rather than through grid cells. Thus, using grid cells as the method for measuring political science phenomena may not adequately match the reality of human behavior. Overall, the somewhat less accurate research design demands that come with a good theory may trump the nuances provided by a grid cell research design, if the research question demands that such a choice be made.

5.3 Testing of Other Interesting Dependent Variables

The primary focus of this dissertation has been on investigating the links between environmental change and the onset of violent conflict. This focus reflects the general interest of the ecoviolence literature and the public at larger; however, there are other interesting dependent variables which have yet to garner the attention of ecoviolence scholars. To my knowledge, there are no published studies explaining how environmental factors influence the duration and diffusion of conflict once it begins. If seasonality is important for the onset of violet conflict then it does not take a stretch of the imagination to conclude that it is equally important for its duration or its pervasiveness as inclement weather conditions may bring fighting to a standstill during certain months of the year or change the strategic locations of rebel bases and conflict zones.

Conflict resolution may be another dependent variable of interest as it relates to environmental factors. The unpredictability of climate change and the growing scarcity of certain natural resources may influence the bargaining strength and commitment of actors seeking to negotiate ends to violent events. For instance, the increasing salinization of Gaza's aquifers may eventually serve to diminish the strength of demands for Palestinian statehood to such a degree that any offer by Israel will be accepted (Feitelson, Tamimi, and Rosenthal 2012). Worsening environmental conditions can be seen as discount factors in game theory bargaining literature, altering payoffs and exacerbating commitment problems for warring parties. Overall, limiting the dependent variable to only onsets of violent conflict may miss important theoretical mechanisms, and therefore future research should seek to explore these other areas of interest.

5.4 Final Thoughts

For several decades, attempts at establishing a connection between environmental factors and the onset of violent conflict remained elusive, being both confounded by poor data and weak theoretical connections. My analyses show that the elusiveness of this relationship is fading. Through the use of temporal disaggregation, and a careful consideration of the theoretical mechanisms behind seasonality, I have shown that there is indeed an association between environmental changes and the onset of violent conflict. Although this association is not systematic across various forms of violent conflict, and occasionally in directions opposite of environmental alarmism, readers should not take this as a lack of evidence. These relationships are complex. It is up to future generations to determine how best to solve the social complexities that environmental changes will continue to inevitably produce by relying on cooperative peaceful solutions for the betterment of all.

5.5 References

Buhaug, Halvard and Paivi Lujala. 2005. “Accounting or Scale: Measuring Geography in Quantitative Studies of Civil War.” *Political Geography* 24 (4): 399–418.

Dube, Oeindrila and Juan Vargas. 2012. “Commodity Price Shocks and Civil Conflict: Evidence from Colombia.” *Review of Economic Studies* (forthcoming).

Ellis, Frank. 2000. *Rural Livelihoods and Diversity in Developing Countries.* New York: Oxford University Press.

Feitelson, Abdelrahman Tamimi, and Gad Rosenthal. 2012. “Climate Change and Security in the Israeli-Palestinian Context.” *Journal of Peace Research* 49 (1): 241–257.

Findlay, Allan and Alistair Geddes. 2011. “Critical Views on the Relationship Between Climate Change and Migration: Some Insights from the Experience of Bangladesh.” In *Migration and Climate Change* edited by Etienne Piguet, Antoine Pecoud, and Paul De Guchteneire, pp. 138–159. Cambridge: Cambridge University Press.

Gleditsch, Nils Petter. 2012. “Whither the Weather? Climate Change and Conflict.” *Journal of Peace Research* 49 (1): 3–9.

Gleditsch, Nils Petter, Peter Wallensteen, Mikael Erikson, Margareta Sollenberg, and Havard Strand. 2002. “Armed Conflict 1946–2001: A New Dataset.” *Journal of Peace Research* 39 (5): 615–637.

Gomiero, Tiziano, Paoletti G., Maurizio, and David Piementel. 2010. “Biofuels: Efficiency, Ethics, and Limits to Human Appropriation of Ecosystem Services.” *Journal of Environmental Ethics* 23: 403–434.

Gray, Clark L. 2011. “Soil Quality and Human Migration in Kenya and Uganda.” *Global Environmental Change* 21: 421–430.

Hazell, Peter. 2006. “Developing Bioenergy: A Win-Win Approach That Can Serve the Poor and the Environment” In *Bioenergy and Agriculture: Promises and Challenges* edited by Peter Hazell and R.K. Pachuari. International Food Policy Research Institute. Accessed January 7, 2013. http://www.ifpri.org/sites/default/files/publications/focus14.pdf.

Hegre, Havard, Gundrun Ostby, and Clionadh Raleigh. 2009. “Poverty and Civil War Events: A Disaggregated Study of Liberia.” *Journal of Conflict Resolution* 43 (4): 598–623.

Hobbes, Thomas. 1963. “Leviathan.” In *Social and Political Philosophy*, edited by John Somerville and Ronald E. Santoni, pp. 139–168. New York: Anchor Books.

IPCC. 2007. “IPCC Fourth Assessment Report. Climate Change 2007: Synthesis Report.” edited by R.K Pachauri and A. Reisinger. Geneva: Intergovernmental Panel on Climate Change. Accessed May 6, 2013. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

King, Laura and Amial Yaqubi. 2012. “18 killed across Afghanistan; Violence Tends to Increase Seasonally.” *Los Angeles Times,* April 26. Accessed May 6, 2013. http://latimesblogs.latimes.com/world_now/2012/04/afghanistan-violence-kills-18-seasonal-increase.html.

Locke, John. 1963. “The Second Treatise on Government.” In *Social and Political Philosophy*, edited by John Somerville and Ronald E. Santoni, pp. 169–204. New York: Anchor Books.

Martin, Adrian. 2005. “Environmental Conflict between Refugee and Host Communities.” *Journal of Peace Research* 42 (3): 329–346.

Mendelsohn, Robert, Dinar, Ariel, and Larry Williams. 2006. “The Distributional Impact of Climate Change on Rich and Poor Countries.” *Environment and Development Economics* 11: 159–178.

Neville, Kate J. and Peter Dauvergne. 2012. “Biofuels and the Politics of Mapmaking.” *Political Geography* 31: 279–289.

Oliver-Smith, Anthony. 2011. "Sea Level Rise, Local Vulnerability and Involuntary Migration." In *Migration and Climate Change* edited by Etienne Piguet, Antoine Pecoud, and Paul De Guchteneire, pp. 160–187. Cambridge, MA: Cambridge University Press.

Oxfam. 2007. "Biofueling Poverty—EU Plans Could be Disastrous for Poor People." Last modified October 29. Accessed January 8, 2013. http://www.oxfam.org/en/node/217.

Partlow, Joshua. 2011. "In Afghanistan, Uptick in Violence This Winter Coincides with Less Snow." *The Washington Post*, January 15. Accessed May 6, 2013. http://www.washingtonpost.com/wp-dyn/content/article/2011/01/14/AR2011011404695.html.

Reuveny, Rafael. 2007. "Climate Change-Induced Migration and Violent Conflict." *Political Geography* 26: 656–673.

Ross, Michael L. 1999. "The Political Economy of the Resource Curse." *World Politics* 51: 297–322.

———.2001a. "Does Oil Hinder Democracy." *World Politics* 53: 325–61.

———.2001b. *Timber Booms and Institutional Breakdown in Southeast Asia.* Cambridge: Cambridge University Press.

Rousseau, Jean-Jacques. 1963. “The Social Contract.” In *Social and Political Philosophy,* edited by John Somerville and Ronald E. Santoni, pp. 205–238. New York: Anchor Books.

Salehyan, Idean and Kristian Skrede Gleditsch. 2006. “Refugees and the Spread of Civil War. *International Organization* 60 (2): 335–366.

Scheidel, Arnim and Alevgul H. Sorman. 2012. “Energy Transitions and the Global Land Rush: Ultimate Drivers and Persistent Consequences.” *Global Environmental Change* 22: 588–595.

Tollefsen, Andreas Foro, Havard Strand and Halvard Buhaug. 2012. “PRIO-GRID: A Unified Spatial Data Structure.” *Journal of Peace Research* 49 (2): 363–374.

VITA

Steven T. Landis

224 Pond Laboratory
Department of Political Science
Pennsylvania State University
University Park, PA 16802

landis.steven@gmail.com
www.steventlandis.weebly.com

Education

Ph.D. in Political Science, 2013 (expected)
The Pennsylvania State University, University Park, PA
Dissertation: "The Seasonal Influence of Meteorological and Physical Factors on the Onset of Violent Conflict"

Interuniversity Consortium for Political and Social Research, 2010
University of Michigan, Ann Arbor, MI
Training: "Introduction to Bayesian Modeling for the Social Sciences; R Statistical Computing; Regression III: Advanced Methods"

M.A. in Political Science, 2010
The Pennsylvania State University, University Park, PA
Thesis: "Crude Interests: OECD Foreign Aid Allocation to Oil Producing Post Civil War Countries, 1980–2006."

B.A. Political Science, 2008
Eastern Michigan University, Ypsilanti, MI

Research Experience

Research and Graduate Studies Office Dissertation Research Semester, January 2012-August 2012
The National Center for Atmospheric Research, Boulder, CO

Graduate student visitor at the National Center for Atmospheric Research's Research Applications Laboratory. I spent nine months collecting meteorological data required for my dissertation research.

Militarized Interstate Dispute Project Research Assistant, 2008-2011
The Pennsylvania State University, University Park, PA

Senior coder of a National Science Foundation funded research project that collects data on international conflicts events, short of war, between two or more states.

Teaching Experience

Co-Instructor & Teaching Assistant for Government and Politics of East Asia PL SC 458, Spring 2013
The Pennsylvania State University, University Park, PA

Served as co-instructor and teaching assistant for Dr. Gretchen Casper. This course is an upper-level undergraduate course that examines the political institutions, the democratic revolutions, the differences in political leadership and political processes of the major states of East Asia.

Instructor for International Relations Theory PL SC 418, Fall 2012
The Pennsylvania State University, University Park, PA

Instructor for an upper-level undergraduate course in international relations theory. This course is designed as a survey course of the primary debates about conflict, trade, and development within the field of international relations.