Climate and Conflict:

A logistic multilevel analysis of the relationship between climate variability and violent conflict

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Abstract

In this thesis I investigate the link between climate variability and violent conflict. By applying an unconventional way of measuring conflict with regards to death toll based in contemporary climate-conflict literature, I investigate whether there exists a relationship between variations in climate measures and the occurrence of violent conflict. Building on contemporary theoretical assumptions where intermediate variables are seen as central, I build a theoretical argument where five categories of contextual variables are presented. These are *cultural*, *economic*, *institutional*, *geographical* and *demographic*. From these categories, I draw variables where I expect climate variability to have an intensifying effect on violent conflict. The hypotheses created from these theoretical categories are tested within a logistic multilevel regression-framework, and later by a mediation analysis. I utilize a detailed and nuanced sort of data from four different sources to test my theoretical claims. The datasets contain data on 49 African and Latin-American countries (*N*=15678), allowing for a broad analytical scope.

Based on the analysis performed in this thesis, little support is provided for the supposed relationship. Using multiple alternative variables to measure variability in climate the results stay more or less the same. Few consistent links are found. However, one cannot yet confidently discard the existence of a relationship; It might be the case that statistical analyses struggle to identify the complex mechanisms and processes at play. Both geographic and temporal complexity is present. More detailed qualitative analyses should be performed in order to more concisely create specific theories. By exploring cases where the relationship is thought to be present one can perform in-debt analyses of the mechanisms and processes at play.

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1 Introduction

Does climate variability have an effect on the occurrence of violent conflict? Scholars have since the days of reverend, economist and social scientist Thomas Malthus argued that environmental factors could influence violence. Since the days of Malthus, who put demographic growth at the forefront of his argument, these arguments have been polished as the knowledge of social and environmental phenomena has increased. In the late 1980s, environmental scientists discovered that the earth would struggle to tackle the human-induced changes to it. Researchers found various evidence for this, among these the Antarctic ozone hole (Homer-Dixon 1991). Such findings had far-reaching effects on the way scholars understood the environmental system. Following this, scholars began to wonder whether there exists a relationship between climate change- and variation, and violent conflict. In later years, climate variation and -changes have been cited among the reasons for extensive use of violence. Both Barack Obama and the UN Secretary General Antonio Guterres have publicly stated that the drought which preceded the onset of the Syrian Civil War, as well as the Syrian governments inadequate response to it, was among the reasons for fighting beginning when it did. Scholars are not agreeing on this particular case, as with most others (Gleick 2014; Ide 2018). Former UN Secretary General Ban Ki-Moon is also among those who have argued for the existence of a link between the two phenomena (Koubi 2019, 344). The climate-conflict-literature has yet to reach a consensus on whether or not climate variability or -change has an effect on violent conflict. In the case of Syria, a key argument of sceptics has been that while many studies have researched the preceding drought in Syria, they have largely ignored the same drought which occurred in neighbouring countries where violence did not happen. Politicians and the media often cite climate change-induced conflict as an increasing threat to human security. This thesis wants to make a contribution on the field and attempt to explore whether these claims are trustworthy. Using high quality dis-aggregated data, it will employ a multilevel logistical analysis in an effort to answer some of the questions within the climate-conflict-conundrum. The principal research question is the following:

Does climate change have an effect (direct or in-direct) on violent conflict?

The thesis seeks to contribute to ongoing research through predominantly two unique elements; First, it includes a broad scope of cases – 15678 grid-cells located in 49 Latin-American and African countries are included in the analysis. The usage of grid-cells allows for a detailed disaggregated investigation into the relationship through a unique type of analytical unit in social sciences. These grid-cells are insensitive to political boundaries and thus allows one to use disaggregated, non-political units in accurate analysis. Being non-political also means that they are independent to violent conflict. The cross-regional scope will allow for rigorous generalization compared to using only one region. By including that many countries in the analysis, I can examine how country-level factors impacts otherwise similar grid-cells with regards to the consequences of climate variability. Second, it will exercise a non-traditional way of measuring violent conflict. Whereas most measures apply a 25-deaths per year threshold for an event being registered as a violent conflict, this thesis will lower the death-threshold significantly. This decision is based on theoretical arguments which have surfaced the later years. It is argued in general that climate variability first and foremost affect conflicts that are recognized by a relatively low death toll and should be understood more in a local context (Meierding 2013; Deligiannis 2012). Both positive and negative cases are included in the analysis. Positive cases refer to instances where violent conflict as per my conceptualization did happen, while negative cases applies to incidents that did not reach the threshold set for what constitutes a violent conflict. This threshold will be discussed more comprehensively in Chapter 2. Importantly, case selection is not done on the dependent variable. This will give a more nuanced picture of the relationship.

1.1 Contribution

Adams et al. (2018) argue that there exists sampling bias in the climate-conflict-literature. So far, most of the scientific focus has been put on Africa. There are multiple reasons for this bias. One of these regards data availability. Adams et al. (2018, 202) find a positive and significant correlation between countries that previously have been British colonies and being selected as cases. They argue that there exists a streetlight effect wherein researchers chose cases based on accessibility rather than fit for the explanation. There is also a tendency to pick positive cases. Countries with more than 1000 battle-related deaths per calendar year are mentioned triple the times of other countries in the literature (Adams et al. 2018, 200). This is problematic for several reasons. First, it might bias the results in the literature. For instance, picking only positive cases might lead the results into being mistakenly convincing in one direction. Second, a bias towards certain countries and regions mean that other places are understudied. These places might be specially exposed to climate variability and could potentially provide important information on the relationship. Third, overrepresenting certain regions and/or countries can create an undeserved impression of these places being more violent than others. As Africa is the most used region in the literature, it can create an image of Africa being especially violent compared to other areas.

Another tendency that is found not only in the climate-conflict literature, but also in the conflict literature generally, concerns the concept of conflict. Violent conflict is typically understood as a violent event in which there has been at least 25 battle-related deaths per calendar year (Högbladh 2019; Sundberg, Eck, and Kreutz 2012). However, theoretical advancements from scholars in the climate-conflict camp hold that climate-related conflicts are likely to be low in scale (Meierding 2013). Because of this, I want to explore if lowering the threshold for an event being characterized as violent alters the results. This approach will give insight into the solidity of the theoretical claims that will be presented in Chapter 2.

Climate-change and -variability is not concentrated to a few regions. By conducting a cross-regional analysis on the effect of climate variability, among other theoretically based variables, I will be able to see whether there are any effects, and if so, what do these effects suggest? As this is a relatively young literature, non-findings ought to be considered equally important as findings. This thesis combines a wide array of cases, over two continents, with a unique way of understanding violent conflict as a concept. Doing this will lead to stronger insight into the relationship between climate variability and violent conflict. Specifically, it will lead to a better understanding of how climate variability affects low-level violent conflict.

1.2 Structure

The rest of the thesis will be structured as the following: Chapter 2 introduces the theoretical aspects which the analysis will build on. It starts with a conceptualization of the terms climate variability and violent conflict. A theoretically driven explanation for why I have chosen the conceptualization I have will be given here. Then, a review of the theoretical arguments from the climate-conflict literature will be carried out. Beginning with Homer-Dixon's pioneering work, it will start by looking at early work on the subject, before moving over to more contemporary literature. Here I build my theoretical model, integrating multiple factors in the equation. Important to note is that the theory on the field is loosely formulated, with few specified models. Within the theoretical discussion, I will also discuss previous findings where the theoretical category has been central. What lessons are to be learned? In Chapter 3 I will introduce the data which will be used in the analysis. I will explain and explore relevant elements of the datasets and the variables that will be used in the analysis. Next, the analytical method will be discussed and explained. I will explain the reasoning for using exactly the method I do, and the analytical implications this has. In Chapter 4 the analysis will be carried out. I will build the model gradually, adding variables at steps until the full model is reached. Chapter 5 is devoted to running alternative models and a mediation analysis where I examine in-direct relationships. On the basis on the analysis and hypotheses produced, I will then conclude in Chapter 6.

2 Theory

This chapter begins with a review and discussion of the two key concepts in this thesis; climate variability and violent conflict. When conducting social science research, one of the goals should be to leave as little conceptual doubt behind as possible (Gerring 2012; Goertz 2006, 4). Social phenomena are largely artificial – we cannot touch any physical phenomena that is violent conflict. We can, however, recognize violent conflict when we see it based on some common understanding and, conceptualization of the concept. We can also agree on some common features of a given concept that allows us to categorize these. This is essentially what conceptualization aims to do. One can, for example, create typologies of almost similar phenomena which are based on many commonalities, with some distinctions which makes this typology necessary. This way concepts are created both by positive elements, i.e. what a concept contains, and in negative terms, i.e. what the concept is *not*. Low level violent conflict is different from civil war in some way. Climate variability and climate change are two different terms, implying some differences. These differences require us to clearly and concisely explain what is meant with the concepts. Following the conceptual discussion, a review of my theoretical model is conducted. Here, I synthesize theoretical arguments from five different categories. These are cultural, economic, institutional, geographic and demographic factors.

2.1 Climate Change

There is a difference between climate and the weather. Weather refers to "the conditions of the atmosphere at a certain place and time with reference to temperature, pressure, humidity, wind, and other key parameters…" (Cubasch et al. 2013, 123). The climate, conversely, is defined as "the average weather" statistically over a longer period of time, typically over 30 years (World Meteorological Organization 2019; Cubasch et al. 2013, 126). Following this logical trail, climate change occurs when the statistical levels of the climate indicators vary significantly (in the statistical meaning of the word) over longer time-periods. While the WMO[1] operate with a 30-year threshold, Field et al. (2014) prefer to use "decades or longer". There are also disagreements over what sort of activities climate change can occur from. World Meteorological Organization (2019) hold that the climate can change both from anthropogenic

[1] World Meteorological Organization

emissions[2] and from natural causes. United Nations (1992) and Field et al. (2014) do not agree with this view. Both argue that changes in the climate are only related to anthropogenic activity. However, whether climate change is only induced by humans or not, the main takeaway is that climate change is regarded with long-term changes in climate parameters, while the weather is a snapshot of these climate parameters at a certain place and point in time.

Another important distinction is between climate *change* and climate *variability*. The difference lays in the temporal scale of the concepts. Climate change is, as previously mentioned, experienced only over long periods. Climate variability on the other hand, can take place over shorter timespans. If extreme climate events happen more frequently one or two years, the temporal scale is not sufficient for it to be categorized as climate *change*. For that, the change must 1) take place over at least a decade, preferably longer, and 2) be statistically significant, to ensure it is not simply deviations from the norm, but rather that the norm has changed. Climate variability can be years where a place experiences more precipitation than previous years, or a rain-season not occurring. There are several ways one can observe such changes to the climate. One way is to simply measure and observe changes in climatologic parameters over time. If changes in these parameters are significant over sufficient years, it could be labelled as climate change. Another way is by inspecting the level of greenhouse gases in the atmosphere, which has increased considerably since the industrial revolution (Cubasch et al. 2013, 129).

Within the climate-conflict sphere, the goal is typically to investigate whether deviations in climatological variables increase the risk for violent conflict occurring. From research on climate change, we have an idea of which climatic parameters will change, and in which direction. Using this knowledge allows one to choose the same climate parameters in climate-conflict research and review the effect these have on conflict. Typically, the expressed goal is to measure whether climate *change* has an effect, however challenges with data often makes this a hard task. Rather, climate variables are parts of regression analyses, investigating whether variations have an effect on the conflict-variable of interest. This often means that one does not necessarily measure climate *change*, but shorter-term climate *variations*. There is also a related strand of research which focuses on the effects of climate crises and extreme climatic event's

[2] Human-induced climate emissions

effect on violent conflict. Neither this is a direct measure of climate *change*. Rather, it is often an attempt to investigate events that are assumed to become more regular if climate change proceeds as predicted.

The climate is also highly dynamic and spatially varied. Mexico has a vastly different climate than DR Congo or Algeria. Because of the dynamism of the climate, climate change is expected to take different forms in both different regions and countries. Geo-physical, un-changeable factors determined by nature partly determine this. Based on this it is reasonable to expect different climatic parameters to impact conflict differently in different areas, making it difficult to come up with generalizable claims of how climate change and variability will influence violent conflict in the future. Considering the limited amount of climate parameters, there is quite the variation in which climate variables are used in the climate-conflict field. Some researchers have used precipitation (Butler and Gates 2012; Hendrix and Salehyan 2012; Adano et al. 2012), while others have measured drought (von Uexkull et al. 2016; Theisen, Holtermann, and Buhaug 2012; Rustad, Rosvold, and Buhaug Forthcoming; Gleick 2014; Ide 2018), temperature (O'Loughlin et al. 2012; Godber and Wall 2014), or internationally shared water resources (Toset, Gleditsch, and Hegre 2000; Gizelis and Wooden 2010). The geographical scope of a given analysis is important. As climate change takes on different forms in different parts of the world, different parameters are likely to vary in effects geographically. This will receive a more rigorous analysis in the upcoming part of this chapter.

2.2 Conflict

The second key concept in this thesis is violent conflict. This is a concept that, in contrast to climate change, has received a lot of attention in social and political science. Naturally, people have been conscious of violent events much longer than climate change. At the same time, there is not the consensus revolving the concept as with climate change. Different criteria are upheld, and often slightly different terms are used to define the concept. Necessarily there exists a difference between low-level violent conflicts, which this thesis seeks to explore, and for example civil conflict or inter-state conflict. Differences might lay in the temporal scale of the conflict, the actors involved or the severity of it. Temporality concerning the relationship between climate and conflict also matters. Selby (2014, 837) argues that positivist research on the subject struggles to adapt to an appropriate temporal scale from when climate change- or -variability happens, and when conflict happens. He also critiques the calendar-year norm of measuring conflict for being arbitrary.

Battle-related deaths per calendar-year is a typical way to define conflicts. This measures the amount of people who have lost their lives in violent battles that can be related to a given conflict. If the analysis wants to explain civil wars or inter-state conflicts, the battle-related deaths-threshold is often put to 1,000. Between civil wars and inter-state conflicts, actors make up a big difference. Inter-state conflicts occur between independent sovereign national states, while civil conflicts often occur between groups in the same state. Intra-state conflicts tend to apply a battle-related deaths-threshold of 25 (Sundberg, Eck, and Kreutz 2012; Högbladh 2019, 5). By using such an operationalization of violent conflict, conflicts where fewer people lose their lives are excluded. This could lead to the results being affected, as it leaves out a certain sort of conflict. Simultaneously, at some point there needs to be set a line. I wish to investigate what happens when the line is lowered.

Following contemporary theoretical claims, I will lower the threshold for violent conflict to 5 battle-related deaths per event. This does not come without consequences. Quick attacks with fewer deaths could be included for instance. I run the risk of including events where intra-personal violent events are measured as violent conflict. Random altercations between people might also be included as a violent conflict. At such a low threshold, determining intentions behind violent actions becomes harder. While at a certain number one can more securely infer that actions have been done with a level of consciousness, at such few battle-related deaths, this becomes harder. However, SCADs coding procedure mitigates this risk. The data is gathered by experts who have examined each event, cross-referenced with local sources and created the data in a comprehensive way.

Agency is another factor on this subject. Who the actors are, and what they seek to accomplish with violent acts could be important information for an analysis. Violent religious groups could use violence in an attempt to create a political entity in the image of their religion. Pastoralists, for instance, conduct combat for other reasons (Butler and Gates 2012). It is obviously hard to measure agency in statistical terms, however membership to certain groups can give an idea of what motivations lie behind violent actions. As argued by Seter (2016, 1), the relationship between actors, agency, stimulus, response and event happening is a vast simplification of an immensely complex social interaction. For this thesis, agency does not play a part. My goal is to investigate whether or not a consistent statistical relationship can be found between the existence of climate variability and the occurrence of violent conflict in a broad sense. Who performs the violence is not of importance, but rather if a link between climate variability and violent conflict exists.

It should also be noted that while conflict does not affect the weather or climate directly, it can have an effect on the measurement of it. Conflict can be one reason for weather stations being destroyed, or simply that readings cannot be done (Schultz and Mankin 2019, 723). A states' steering and bureaucratic ability can also impact its ability to maintain weather stations to a sufficient degree (Schultz and Mankin 2019, 723). Countries more exposed to violent conflicts might also be systematically less able to run weather stations. Assuming that is true, there can also be present a systemic lack of climate data in places where violent conflict occurs more often. However, some climate indicators are collected through satellite data which to an extent alleviate those concerns.

2.3 Climate change and conflict – The underlying logic

Theoretical advancements in the climate-conflict-nexus have been few. The literature is largely dominated by loosely formulated expectations rather than precise and clear theories with explicit mechanisms. There is however a consensus about the in-direct nature of the proposed relationship. Salehyan (2014, 1) argues that this might be because the field of climate change and violent conflict still is in its formative years. He further argues that there is a relationship present, and that "…the discussion is no longer about whether or not the climate influences conflict, but about when and how it does so" (2014, 1). He goes on to state that while empirical tests and data quality in the field is generally high, there has been a lack of theoretical attention, and that it is primarily here the literature is lacking (2014, 2). Koubi (2019, 356) implies a similar concern, stating that theoretical expectations should be more explicitly formulated and explained. Buhaug (2015, 269, 270) argues that the quantitative climate-conflict literature[3] struggles to develop strong theories. One explanation for this is the complexity of causal frameworks presented. Even though data quality has come a long way on the field, empirical methods still struggle to explain intricate relationships which might last over many years and geographic regions (2015, 270). Context is also thought to be highly important (Buhaug 2015, 271; Koubi 2019, 356; Salehyan 2014, 4). Climate variability is seen as an intensifying factor in this puzzle rather than a direct causal factor in itself. Contextual factors are thought to be necessary in order for climate variability to lead to violent conflict. Why is it that some countries or regions, experience a positive relationship between climate variability and violence, while others do not? What is it that may determine whether or not climate change or variability leads to violence?

Two groups are regarded as pioneers in the literature; the Toronto group, led by Thomas Homer-Dixon, and Günther Baechler and his Environmental Conflict Project (ENCOP). The groups share a neo-Malthusian theoretical position, which has been subject to criticism over the years. It should perhaps not be surprising as they were some of the first scholars to dip their feet into the largely un-studied field of climate change and conflict. Already here the models were complex. Homer-Dixon (1991, 77) focused on both national and international acute conflicts. Baechler (1998, 25) also believed that environmentally induced conflicts could erupt both within and between states. Homer-Dixon (1994, 18) found little empirical evidence for environmentally based inter-state conflicts. Later findings have been ambiguous. Gizelis and Wooden (2010) and Tir and Stinnett (2012), for instance, provide some evidence that intra-state water conflicts can lead to conflict between states. Relationships between shared rivers and war are weaker (Toset, Gleditsch, and Hegre 2000). Generally, the focus has moved downwards, to intrastate conflicts of various sorts. For the purpose of this thesis, I will carry a similar emphasis on low-level factors.

Scholars belonging to the neo-Malthusian tradition have often received criticism for holding an overly deterministic understanding of the relationship between climate factors and violent

[3] Differences between quantitative and qualitative studies will be more thoroughly discussed in the methods chapter later in the thesis.

conflict. Such criticisms are unreasonable, according to Homer-Dixon (1991, 100). Both Homer-Dixon, Boutwell, and Rathjens (1993, 31, 32) and Baechler (1998, 35, 36) employ theoretical models which include political and economic factors. These models' complexity has been another source of criticism (Gleditsch 1998, 390, 391; Meierding 2013, 188). Because the speed of climate change has accelerated since the industrial revolution, societies will have less time to adapt than previously. Populations have also grown considerably, and become more dependent on large amounts of resources (Homer-Dixon 1991, 100, 101; Salehyan 2008, 7). Opponents of neo-Malthusianism tend to aim criticism towards its pessimistic outlook on human ingenuity and lack of belief in technological advancements (Gleditsch 1998, 383).

Within the climate-conflict literature, one separates between renewable and non-renewable resources. Oil, minerals and rocks are typical examples of non-renewable resources. Renewable resources include fresh water, fish, agricultural land and forests. These resources can, with the correct usage[4], stay in a renewable circuit. Climate change can alter these circuits. By changing the climatic conditions of an area, a renewable circuit might become dependent on different treatment by humans. If so, it is crucial that humans are able to adapt to those changes in order to keep the renewable resource in a sustainable way. Another way to damage renewable circuits is by over-using a resource. Over-usage can be spurred by accelerated population growth, forcing the population to increase the intensity by which a resource is used. All these processes can lead to scarcer resources. As argued by Homer-Dixon (1991, 100) both population pressure and climate changes has increased rapidly since the industrial revolution, accelerating such processes at a speed not yet experienced by humankind.

Three elements of resource scarcity are central. One of these is environmental change, with the two other being population growth and unequal distribution of resources (Homer-Dixon 1994, 8). Interaction between these three lead to two main causal processes, according to Homer-Dixon (1994, 10). These two processes exemplify how climate factors are dependent on certain contextual factors being present. The two main mechanisms proposed are named *resource capture* and *ecological marginalization*. Resource capture happens when political, economic or

[4] One could distinguish between contingent renewable resources and non-contingent renewable resources. Here, the term renewable resource is used for those resources which can be harvested and renewed by nature given the correct conditions.

cultural elites take control over valuable renewable resources. Thus, the share of a given resource left becomes smaller. The resource-cake becomes smaller for the rest of the population, who has less to share. Scarcer resources create increased pressure in the society. Such pressure is thought to potentially boil over and lead to violent conflicts. Ecological marginalization occurs when a renewable resource's circuit becomes harder to sustain. That sort of challenge can occur from multiple directions related to climate change. Climate change might alter the local climatic dynamics. A changed climate can alter the needs of a crop or type of agricultural land for it to be sustainable (Homer-Dixon 1994, 10, 11; Theisen 2008, 803). Without proper knowledge of and resources to conduct sustainable cultivation, this can be detrimental. Climate change can also force people to move from one area to another because living a stable life is not possible in the first area. These people might not be acquainted with the new area's conditions, and how to use the area in an environmentally sustainable way. Drop in productivity and sustainability of an agricultural area can have large consequences for whole societies. Migration could be a product of several factors, environmentally related or not.

The temporal scale is believed to be important. Long-term changes in the climate, like a gradually weakened ozone layer are thought to be less important in this context. Instead, short- and medium-term changes that people are likely to be exposed to during a lifetime are thought to be more relevant (Homer-Dixon 1994). Higher average temperatures, changes in precipitation patterns or soil that become more infertile are theorized to be more important forms of climate parameters which influence violent conflict. Direct and in-direct effects like drought, sudden decreases in food production or increased economic hardships as a consequence of climatic factors are seen as important.

The rest of the theory chapter will be devoted to discussing the different proposed mechanisms through which climate change is thought to have an effect of violent conflict. I will present these arguments thematically, beginning with cultural factors. Here, migration, ethnic cleavages and effects of migration are seen as the most important mechanisms. Then, economic factors will be proposed, where food-price shocks and interpersonal inequalities are seen as central. Institutional aspects are next, which focus on legitimacy and democratic-ness of institutions and local-level conflict-solving arenas are fundamental. Geographic factors are discussed next, before I finish with demographic factors. Hypotheses will be presented simultaneously. While theoretical assertions are presented, I will simultaneously be presenting existing literature on the relevant factors.

2.3.1 Cultural Factors

There is an extensive complexity connected to the way climate change and -variability affects conflict through cultural aspects. Most central is ethnic fractionalization and migration. Ensuring that 1) climate change had an effect on migration, and 2) being certain that this migration in some, probably in-direct, way led to a conflict is a demanding task. One challenge could be how members of a group perceive the reason(s) of migration. While climatic factors may be an important push-factor, people could express different reasons. Because climate change is thought to play such an underlying role, it could be assumed that environmental migrants are not conscious of it themselves because they are not necessarily aware of climate change or -variability's role. It is imperative to note that this is likely to vary. A farmer whose crop yields have deteriorated by higher temperatures, drought or changes in humidity probably connects the dots.

Migration is one avenue which can alter local dynamics. The push-factor for migration could be climate change or non-climatic factors (Homer-Dixon 1991, 108). Bernauer, Böhmelt, and Koubi (2012, 6) view migration as a coping-mechanism for groups who are harshly affected by climate change. Migration can have multiple effects; It can increase tensions between groups in the receiving area (Baechler 1998, 26; Burrows and Kinney 2016, 8), boost competition over limited resources in the receiving area (Bernauer, Böhmelt, and Koubi 2012, 6), and heighten the pressure on local institutions. Migration can clearly be induced from climatic conditions (Abel et al. 2019, 239). Migration could also be spurred by violent conflicts. Thus, a potential circular relationship appears. Climate change leads to migration in some way, which leads to conflict, which again forces people to flee from the violence.

As an area receives migrants, existing dynamics in that area will be altered. More people suddenly live in a place. Without enough time to adjust, this can have a big impact on the area, its social, economic, cultural and political dynamics. It is possible that the receiving area already has weak institutions, low trust and a poor economy, exacerbating the situation. Those groups who originally inhibited the area might feel a sense of losing the rightful ownership over the land and its resources (Homer-Dixon 1991, 108, 109; Burrows and Kinney 2016, 8). Such a reaction could be related to a fear of losing one's cultural identity. People belonging to certain groups could feel angered by migrants being given land to live on. For these people, migrants receiving some sort of benefits can feel like they have lost benefits which are rightfully theirs because of their sense of rightful belonging to the destination area.

Another factor related to migration and ethnic fragmentation is competition over resources. As new people arrive, the amount of people who need and want resources increases. This can fuel competition over limited resources. If a group perceives the access to a resource as unbalanced, they might see it as reasonable to take up arms in order to gain access to that resource. Such inequalities might be based on ethnic and cultural groups. Thus, inequalities relating to the access to renewable resource is one way that can spur violent conflict (Baechler 1998, 26). Culturally hinged grievances can dig deep in a society. That kind of grievances are related to relative deprivation theory, which argues that individuals who see their material situation as worse off than it used to be are more likely to feel angered with a weak material situation. Fearon and Laitin (2003) do not find robust evidence for the idea that ethnicity explains civil wars. Schleussner et al. (2016, 9218) discover findings which indicate that climate-related disasters plays a role in armed conflicts erupting in ethnically fragmented societies. Buhaug, Cederman, and Gleditsch (2014, 421, 422) argue that horizontal grievances based on cultural or ethnic groups make a society more prone to violent conflict. Through a series of regression analyses, results show that these variables explain civil wars better than previous measures of inequality (Buhaug, Cederman, and Gleditsch 2014, 429). Culturally hostile rhetoric can help fuel aggressiveness between groups. Groups who find themselves as the targets of malicious rhetoric might also be politically and socially isolated groups. These are thought to be less likely to receive necessary aid in times of need from exclusionary governments. Inclusionary governments which provide necessary aid should thus be likely to mitigate the danger of conflict.

Migration could also prove to be a big challenge for the local government and its institutions. Situations where a lot of people arrive at an area quickly means that the local institutions suddenly have a lot of work to do, which they might not be equipped to. Especially in states with already weak bureaucracies, frail institutions and a fragile economy, such events could prove problematic. Some find evidence for climate-induced migration as a reason for conflict spurring in Syria. Using data on asylum seeking flows, Abel et al. (2019, 246) argue that local conditions were necessary for events to develop the way they did.

Cultural explanations for why conflicts happen are common in the conflict-literature. Within the framework of this thesis climate variability can be a factor both for the occurrence of migration and for intensifying tensions in a destination area. Groups could be forced to migrate from one area to another which can impact the social, cultural and economic situation in the destination area. Competition over resources can arise when large amounts of people suddenly arrive. This competition can itself be a product of climate variability, and the things people compete over can be affected by climate factors. Such competition might create hostile attitudes towards other groups, which can be based on cultural, ethnic, religious or linguistic differences. Groups might be excluded from society because of this, which aggravates an already tough situation. This can make the choice of taking up arms easier.

> ***H1****: At the grid-cell level, as more ethnic groups are excluded, the likelihood of violent conflict happening increases.*
>
> ***H2****: Countries which share political power between social groups (ethnic, linguistic, religious etc) are less likely to experience violent conflict.*
>
> ***H3****: Countries that ensure equal access to public services across social groups (ethnic, linguistic, religious etc) are less likely to experience violent conflict.*

2.3.2 Economic Factors

Another way climate variability can alter the likelihood of violent conflict is by affecting the economy. Both the country- and local level economy is thought to matter. Peoples' perception of the economy, both their personal economy and the country's is regarded as important factors. Economic performance at the country level can affect the occurrence of violent conflict, measured as economic growth (Bergholt and Lujala 2012, 149) or socioeconomic development (Hegre et al. 2016, 2). At the local level, relative-deprivation theory argues that individuals who see their own material and/or immaterial situation as worse off compared to other members of society can be more likely to perform violent acts in order to amend their situation (Homer-Dixon 1991, 109; Buhaug, Cederman, and Gleditsch 2014, 421). Food insecurity also matters at the local level, especially in contexts where people are dependent on their own production (Koren and Bagozzi 2016, 1000; Godber and Wall 2014, 3092, 3093). A break-off point is thought to exist where people think that taking up arms is the best choice for improving their situation. Homer-Dixon (1991, 109) also argues that climate variability can change the opportunity structure of a society into a favourable one for violent organizations. By making conflict-mitigating institutions less effective in their work, or the state apparatus less efficient, alternative options such as joining violent groups becomes a more viable option (Barnett and Adger 2007, 644; Homer-Dixon 1991, 109, 110). This way, the state can be understood as both the solution to and root of a conflict (Barnett and Adger 2007, 646).

The economic situation of the individual, group and state are all considered to be important in the conflict literature (Hegre et al. 2016, 2; Buhaug, Cederman, and Gleditsch 2014, 419, 420; Barnett and Adger 2007, 645). Fearon and Laitin (2003, 80) argue that young men are the most likely to be recruited to insurgent action when the economic alternatives are worse. Simultaneously, the poorest countries on earth tend to be those who are also the most exposed to the effect of climate variability, change and disasters (Scheffran et al. 2012, 7). It is also usually the poorest countries in the world which experience the greatest population growth. Adding poor economic performance to a growing population might very well serve as a pressure-cooker for which violent conflict could be the results (Hegre et al. 2016, 1; Barnett and Adger 2007, 644). Food insecurity is for example found to be correlated with a worse life evaluation by Arab youth (Asfahani, Kadiyala, and Ghattas 2019, 73).

One study finds proof for local income shocks affecting civil conflict (Buhaug et al. 2020). The effect is strongest for ethnic groups who have experienced political deprecation of their own status (Buhaug et al. 2020, 24, 25). This is especially true for groups who live in agriculturally dependent countries. von Uexkull et al. (2016) perform an analysis which reveals that specific conditions must be met for drought to affect conflict. Very poor countries where there exists politically excluded groups who are agriculturally dependent are more likely to experience drought-induced conflicts (von Uexkull et al. 2016, 12393). Koubi et al. (2012, 114) analyse the in-direct effect climate takes through economic factors, in this case through growth. Their analyses find no robust evidence for the mechanism. Bergholt and Lujala (2012) perform a similar analysis in which they find corresponding results. Climate related natural disaster are shown to impact economic growth. However, this effect does not translate over to conflict onset (Bergholt and Lujala 2012, 160). Buhaug, Cederman, and Gleditsch (2014, 421) contend that studies attempting to catch the relationship between economic inequalities and civil war have failed to investigate what they believe might be the most important factor, group-level inequalities and grievances. They are critical of scholars dismissing potential links on the basis of analyses where Gini-coefficients are applied as measures of inequality. Instead, they argue that measures of horizontal inequalities, i.e. inequalities between groups in a society should be preferred over measures of individual inequalities (Buhaug, Cederman, and Gleditsch 2014, 422).

Barnett and Adger (2007, 643) contend that spatial differentiation also plays a role in how climate events' impacts violence and human security. Some areas within a country can be more exposed to climatic events than others. Thus, "Climate change may directly increase absolute, relative, and transient poverty by undermining access to natural capital." (Barnett and Adger 2007, 643). Agricultural areas can experience situations where changes in the climate makes production of goods less effective. Food could be one type of goods. Increased food prices are thought to lead to an increase in conflicts (Smith 2014, 682). It must however be noted that conflict can in itself be a significant source of food insecurity. Buhaug et al. (2020, 3) make the assumption that income shocks that are biased toward specific societal groups makes collective action issues easier to overcome, making violent conflict more likely. Buhaug et al. (2015) test the relationship between food production shocks and violent conflict in Africa south of Sahara. Their results yields no robust results with regards to food production shocks' effect on conflict

(Buhaug et al. 2015, 1, 6, 8). In contrast, Smith (2014) finds that rapid food price increases leads to higher likelihood of social conflict.

On the country level, growth is often seen as an important explanatory factor of violent events. Devitt and Tol (2012, 130) hold the argument that national level economic growth reduces the chance of conflict. Important to note in this regard is the potential circular effects. Growth can alleviate the likelihood of violent conflict, while conflict is likely to reduce growth. Conflict tends to be considered as the opposite of development. Devitt and Tol (2012, 131, 132) visualize climate change's effect on growth to be slender but present. Countries vary with regards to their dependence on sectors which are affected by climate factors (Adano et al. 2012, 66). African countries' economies tend to more exposed to climate change and/or variability. Hendrix and Salehyan (2012, 38) argue that climate change, in their case measured as rainfall shocks, can affect economic productivity by people being displaced, crop failures and losses of essentialities. Devitt and Tol (2012, 131) present that because of biophysical reasons and temperatures increasing, productivity might sink as a consequence of climate change.

A states' services can also be damaged by climate change, predominately by a loss of income. Low productivity in agriculture can mean that the state does not receive sufficient income from taxation and fees. States with economies which are reliant on agriculture should be especially exposed to this. With less income, a states' services and institutions could be weakened and more easily overworked. Provision of aid and welfare services could be one such avenue where the state is weakened (Barnett and Adger 2007, 644). It is thought that welfare services can mitigate the intensifying effect of weakened state institutions and capacity to provide necessary services.

Climate change can work through economic factors in order to make conflict occur at multiple analytical levels. At the group-level, horizontal inequalities between societal groups can help those groups overcome collective action problems, increasing the likelihood of violent conflict. If some group is systematically worse off than other groups, grievances are likely to emerge. Sentiments like that can, especially for groups with an obvious collective identity, help organize violent action. Food price shocks can also make violent conflict more likely. If people cannot afford the food they need, they might very well take to the streets. For the state, challenges lie primarily where tax revenues become lowered. Less tax income means a state that will struggle more to perform its tasks. These tasks include provision of aid and welfare for those exposed to hardships brought on by climate variability, as well as conflict solving.

***H4:** Richer grid-cells are less likely to experience violent conflict*

***H5:** Countries with economic growth are less likely to experience violent conflict*

2.3.3 Institutional Factors

A third outlet where climate variability can lead to conflict is through institutional factors. As previously mentioned, changes or variability in climate can alter the income of the state, causing lower tax income. This can weaken the state and its ability to provide services that can be conflict mitigating. One example of such a service is education. Education is seen as one of the most important factors for people being able to better their lives. Not having the opportunity to gain an education means that people significantly decrease the possibility to experience social mobility, wage increases and employment. Individuals who see a lack of opportunities are found to be more likely to join armed organizations (Barnett and Adger 2007, 645). Not only educational institutions matter. Both Butler and Gates (2012) and Baechler (1998) argue that property rights are important. Owning ones' own property can mean that one foresee a more stable and predictable future than those who do not own their own land (Baechler 1998, 34). Butler and Gates (2012, 24, 26) argue that the organization of property and property rights can have a distributing effect on a society. This claim is tested by looking at pastoralist fighting in Eastern Africa. They find evidence for a relationship wherein the climate variable is contingent on outside factors for it to affect conflict (Butler and Gates 2012, 23, 32). Results support the idea that property rights matters, and decisively biased property rights matter for conflict dynamics between pastoralist groups in East Africa (Butler and Gates 2012).

Effective and democratic institutions are also thought to be significant. In high pressure situations, such institutions can help mitigate the dangers posed as threats of violence (Bernauer, Böhmelt, and Koubi 2012, 5). Some countries are better equipped to tackle challenging situations induced by climate factors because of their institutional framework. In the case of migration, an effective institutional infrastructure lets the provision of necessary aid, guidance and facilitation of adaptation flow easier (Koubi 2019, 348; Burrows and Kinney 2016, 12). Brzoska and Fröhlich (2015, 203, 204) point to three types of receiving regions that are thought to be especially conflict prone. The three types are 1) Regions with extreme scarcity, 2) Regions with high level of conflict, and 3) Regions with exclusive identities. Exclusive identities are here regarded as in- and out-group ideas with competitive interests and identities (Brzoska and Fröhlich 2015, 201). These types of receiving areas are seen as areas where in-migration is thought to have a potentially intensifying effect on the likelihood of conflict. The issue of identity and diverging interests is thought to be the primary driver (Brzoska and Fröhlich 2015, 200). Areas with low adaptive capacity and high vulnerability to climate change are viewed as more exposed to climate-driven conflicts spurred by migration (Brzoska and Fröhlich 2015, 197). The causation between provision of aid and services, and legitimacy might be circular; If a state is unable to provide citizens with the necessary assistance, a loss of legitimacy could follow (Barnett and Adger 2007, 647). Access to important securities like welfare services and economic safety-nets can also play a role in increasing human security (Barnett and Adger 2007, 646). Hutchison and Johnson (2011) find that higher levels of institutional capacity in African countries are correlated with higher levels of legitimacy for the citizens. This impacts conflicts, because "…Trust is associated with peaceful conflict resolution, both internationally and domestically" (Hutchison and Johnson 2011, 738). Hegre et al. (2016, 6) hold that institutions that perform conflict mediating roles are dependent on certain levels of trust and legitimacy in order to accomplish their goals sufficiently.

Political pluralism and the possibility of having an impact on the political dynamics of a country is regarded as another important mitigating factor. Barnett and Adger (2007, 647) argue that democracies reduces individuals need to act in violent ways. Arenas like these create platforms in which groups can present and fight their case against a sitting regime. Civil societies can also play a similar role (Baechler 1998, 33). A free civil society can also perform tasks that a lacking state cannot cover itself. Kahl (2006, 28, 29) believes that two components of a state are key; the groupness of the state, and its institutional inclusivity.

Local institutions can play a relieving role as well. In some cases, a state's ability to reach outward to the whole country might be low. Meierding (2013) insists on the need of shifting the analytical focus from the state-level to a more local level. She further argues that institutional factors can play mitigating roles in the causal process before climate change leads to violent conflict (Meierding 2013, 188). Linke et al. (2017) investigate whether the local institutional context matters for support for violence in Kenya. Their findings suggest that the local institutional context does matter for how people perceive violence (Linke et al. 2017, 1567, 1568). According to Meierding (2013, 195), these local institutions can both take the form of formal and informal institutions. Such institutions might have higher local trust and legitimacy than state-level institutions.

> ***H6:*** *Countries with stronger protection of property rights reduces the risk of violent conflict*
>
> ***H7:*** *More egalitarian democratic countries are less prone to violent conflict*
>
> ***H8:*** *Countries with equal access to basic education reduces the likelihood of violent conflict*

2.3.4 Geographic Factors

While a state can provide necessary aid in central areas where it exerts strong control, distant areas can be less likely to acquire such aid. This could be because of multiple reasons. Regional belonging can be one sort of identity which is prevalent in a country (Østby, Nordås, and Rød 2009, 302). Their study finds that regions with low educational levels, significant intra-regional inequalities and relative deprivation are more prone to violent conflict (Østby, Nordås, and Rød 2009, 316, 317). Buhaug, Cederman, and Rød (2008, 533, 534) propose that strong and excluded ethnic groups located in a country's periphery increase the chance of civil war in weak states. This chance, they theorize, increases as the distance between the excluded group and a country's capital increases. Their analysis reveals that both the proportion of mountainous area in an excluded groups area with and that areas' distance to country capital is positively related to violent conflict (Buhaug, Cederman, and Rød 2008, 549).

Terrain is viewed as important factor. For instance, Fearon and Laitin (2003, 80) insist that, among other factors, rough terrain increases the risk of civil war because it presents a favorable environment for rebels to fight in. Similar arguments are presented in Hendrix (2011) and Fearon and Laitin (1999). The main argument is that terrain with low accessibility and tactical advantages for insurgents makes such areas tactically favorable. Hendrix (2011, 346) also argues that remote areas and low state capacity increase the likelihood of rebellion. Results from the subsequent analysis are ambiguous; While mountainous terrain and far-away areas are related to lower state capacity, the relationship with conflict is less clear (Hendrix 2011, 356).

Distance from the center can affect a country's ability to perform key tasks and provide necessary services for all inhabitants. Aas Rustad et al. (2011, 28) argues that geographic location matters with regards to a states' ability to monitor and conduct their expected tasks. One study finds that as the distance from a country's capital increases, the likelihood of violent conflict follows (Buhaug and Rød 2006). Remote populations in a country might be more loosely connected to the central government (Hendrix 2011, 349). Rough terrain and low accessibility is also thought to be negatively correlated with state capacity (Hendrix 2011, 349, 350). Jimenez-Ayora and Ulubaşoğlu (2015) present rough topography as an explanation for why some states have weaker apparatuses than others. They argue that mountainous terrain increases the transaction costs in creating a legitimate working state (Jimenez-Ayora and Ulubaşoğlu 2015, 170). Agricultural production is less effective in steep mountainous areas (Nunn and Puga 2012, 21). Transport and infrastructure costs also increase in tougher terrains (Jimenez-Ayora and Ulubaşoğlu 2015, 170; Nunn and Puga 2012, 21). Tough terrains can be an influential factor with regards to a state's ability to perform and provide central state tasks. As discussed previously, such tasks are seen as important factors for mitigating conflict. Thus, tough terrain and distance to capital is assumed to be positively linked with the occurrence of violent conflict.

H9: *More mountainous grid-cells will be more likely to experience violent conflict*

H10: *Distance to capital is positively correlated with violent conflict at the grid-cell level*

H11: *Access to public services in distant areas is negatively correlated with violent conflict at the country level*

2.3.5 Demographic Factors

Population size and growth has previously been presented as a central part of Malthusian theory. It is for instance an important element of Homer-Dixon (1991); Homer-Dixon, Boutwell, and Rathjens (1993). Increased population growth is often deemed as one way where climate change- and variability can in-directly lead to violent conflict. Population growth is thought to lead to demand-induced scarcity. In these instances, the amount of resources is constant, while the number of people who have to share the resources increases (Urdal 2016, 420). Increased pressure and competition over resources can, as discussed earlier, lead to violence. Unequal distribution of resources can also ignite violence. Areas that are environmentally fragile can be harmed by increased population, which increases resource-pressures for the inhabitants. Urdal (2016) finds little evidence for these claims. Homer-Dixon (1994) finds evidence for both population movement (1994, 20) and population growth (1994, 29). Replicating a previous study, Theisen (2008) finds population size to be positively related to the onset of violent conflict. Hypothesizing that both population growth and density increase the risk of violence, Raleigh and Urdal (2007) find strong evidence for population density as a consistent predictor of violent conflict. Population growth is believed to be one reason for livelihoods being worsened although not a primary reason for it (Barnett and Adger 2007, 644).

H12: *Grid-cells with higher populations are more exposed to violent conflict.*

Figure 2.1 summarizes the theoretical linkages between climate variability and violent conflict. It illustrates how climatic factors and their consequences work through necessary contextual factors, which have been presented in the theory chapter. Note also that climate variability does not impact geographical factors in itself, however geographical factors can serve as contextual factors that increase the likelihood of violent conflict.

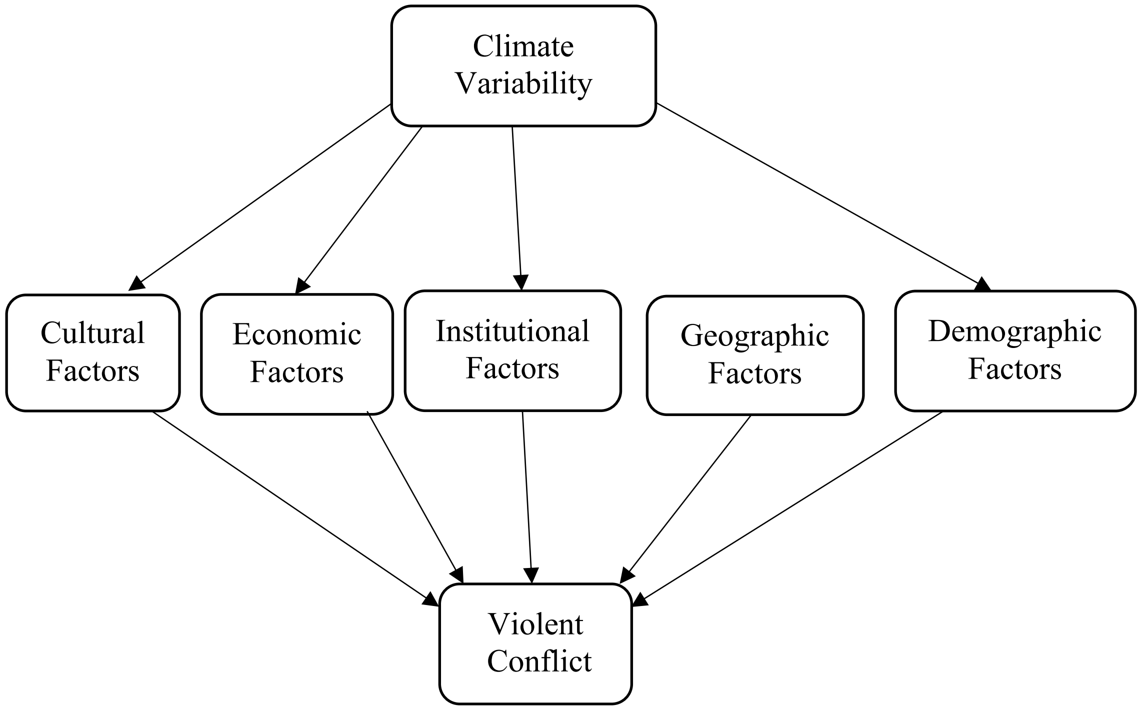

Fig 2.1 Summary of the theoretical linkages between violent climate variability and violent conflict.

3 Data and Methods

This chapter will introduce the data applied in the analysis, as well as the analytical method chosen in order to investigate the theoretical arguments presented earlier. Two main sources of data will be used, while some variables are brought in from two other sources. These data sources are discussed first, before I delve into further detail of the relevant variables of the analysis. Lastly, I review the analytical approaches I utilize and the statistical assumptions that follow.

3.1 Data

The two main data-sources are PRIO-GRID, a dataset which is created by the Peace Research Institute Oslo (PRIO), and the second is Social Conflict Analysis Database (SCAD) (Tollefsen, Strand, and Buhaug 2012, 2016; Salehyan and Hendrix 2017; Salehyan et al. 2012). Because SCAD began collecting data from 1990, the temporal scope begins that year. V-Dem and World Bank data make up the two last sources of data (Coppedge et al. 2019b; World Bank 2019). One primary motivation lies behind the choice of using the PRIO-GRID dataset; PRIO-GRID is structured in a way that allows for dis-aggregated analysis of the relationship between climate variability and violent conflict. Doing this follows recommendations found in contemporary literature on the subject (Meierding 2013, 195; Deligiannis 2012). Because intra-state variation in important variables that touches on climatic, cultural, economic, institutional, geographic and demographic factors are thought to be of importance, being able to investigate and include the intra-state variation is an analytical advantage in this study. Whereas aggregated variables would miss out important variance and nuances, this data keeps those nuances.

3.1.1 PRIO-GRID

PRIO-GRID's analytical units are termed grid-cells. These are quadratic figures which in total cover the whole face of earth. Whereas most datasets use either countries, regions or communes as the analytical units, PRIO-GRID create their own units. The grid-cells are made at a 0,5 by 0,5 resolution, which translates to 55km by 55km at the equator. The size of the grid-cells is illustrated in Figure 3.1. Because of earths curvature, their size varies somewhat based on the latitude they are placed in (Tollefsen, Strand, and Buhaug 2016, 3). The grid-cells are insensitive to political boundaries. This make the grid-cells exogenous to factors such as civil war outbreak, geographic natural borders, spatial distribution of wealth or changes in a country's boundaries (Tollefsen, Strand, and Buhaug 2012, 363). Grid-cells cannot possibly be altered because of outbreaks of violence, while administrative borders can very well change because of conflict. The total number of grid-cells in the PRIO-GRID is 259.200. When only looking at terrestrial grid-cells, i.e. grid-cells which cover landmass, the number is 64.818. Each grid-cell contains coordinate information regarding its location on earth. This information is used to ensure that SCAD-events are placed correct geographically, i.e. within its corresponding grid-cell. Geographically, the scope of the analysis is limited to Africa and Latin America. The finished dataframe contains 15678 grid-cell observations over 54 countries ranging from 1990 to 2014. Because of missing values these numbers drop somewhat in the models. This gives the analysis a wide geographic scope, as well as temporal. With a broad scope over two regions I can investigate grid-cells which are similar geographically and with regards to how they are influenced by climate factors. Simultaneously, with the wide variation in countries, I can examine how different political contexts impact the grid-cells experiences. Latin-America is a region which has not been studied as intensely as Africa. Including this region into the analysis as well can lead to new insights into the relationship between climate variability and violent conflict. I also avoid biased sampling by including all countries, not leaving some out because of the dependent variable. It also means high variation in the contextual factors.

The grid-cells contain a wide array of information. First, because the grid-cells themselves are insensitive to political boundaries, some grid-cells contain areas from multiple countries. This is solved by assigning the cell to the country which has the most land area in the cell. If there are legal changes as to who owns area, that change will take effect in the dataset from the upcoming January 1st (Tollefsen, Strand, and Buhaug 2012, 368). Most of the data that the grid-cells contain is not original PRIO material. Rather, most of the data is taken from outside sources, and compiled into the structural framework of PRIO-GRID which allows for detailed analysis (Tollefsen, Strand, and Buhaug 2016, ii). Using a grid-cell framework ensures that the analytical units are not affected by the phenomena of interest, i.e. violent conflict. Thus, challenges with exogeneity with regards to the units and outcome variable should not be an issue.

3.1.2 SCAD

Because the analysis wants to test the theoretical claims with an un-conventional measure of conflict, making use of a dataset that focuses on lower level conflicts, even non-violent ones such as demonstrations, is fitting. It contains data on a variety of social conflict in 12 Latin-American countries and 49 African countries over the temporal scope of 1990 – 2017. The creators set one requirement for a country being included in the database; A country had to have over one million inhabitants in year 1990 to be allowed to be a part of the database (Salehyan and Hendrix 2017, 1).

SCAD finds their conflict information from two main sources; *Associated Press* (AP) and *Agence France Presse* (AFP). A thorough walk-through of the process which makes the process reproducible is found in the codebook (Salehyan and Hendrix 2017, 2, 3). A research staff does the work of finding and coding the information into the dataset.

An advantageous element of this dataset is the fact that it does not apply any threshold regarding death tolls in order to be included. Thus, one can easily apply one's own death threshold. SCAD also includes a variable(s) that state what the assumed reason behind an event was. These variables include economic and environmental reasons among others. A weakness with this indicator is that there often is a lack of information. There are more missing values than not in this variable. Including it into the analysis, the *N* of the analysis would reduce dramatically. Therefore, it is not utilized in the analysis. Another reason for choosing not to use the variable is that climate variability can influence other types of factors, like economic ones. SCAD also includes information about the relevant actors in events, and approximations regarding the location of an event. These coordinates are used to merge the two datasets together in a manner that is correct spatially. Because the certainty of the coordinates varies, there is also included information regarding the confidence of the location. Events in smaller towns, rural areas or villages tend to be less precisely stated than events in smaller cities (Salehyan and Hendrix 2017, 9).

3.1.3 V-Dem & World Bank

Country-level variables will be brought in from V-Dem and the World Bank (Coppedge et al. 2019a; Coppedge et al. 2019b; World Bank 2019). The Varieties of Democracy dataset is a project which primarily concerns itself with measuring democracy. Five different dimensions of democracy make up the central democracy concepts (Coppedge et al. 2019b). For this thesis, the egalitarian dimension of democracy will be utilized. The dataset also includes sub-indexes of the democracy measures, which allows for more in-debt analysis of specific parts of the democracy-dimension I employ. V-Dem uses country expert evaluations to obtain the values of their variables. Measurements errors and disagreement is considered in the calculation (Coppedge et al. 2019a, 29). Most variables have a scale from -5 to 5, although some range from 0 to 1.

World Bank is an international institution that works with economic issues, and primarily with the goal of ending extreme poverty (World Bank 2019). They also keep large amounts of data, primarily on economic variables. From the World Bank I will draw a variable which measures a country's GDP growth in percentages per year (World Bank 2019).

3.2 Variables

3.2.1 Dependent variable

The dependent variable is based on the "*ndeath*"-variable from the SCAD dataset. Ndeath measures the number of people who lost their life in a social conflict event (Salehyan and Hendrix 2017, 6). Based on this variable, I create a new dichotomous variable. This variable is created based on the previous discussion of death threshold. Events where 5 or more people lost their life in a violent event are coded as a 1, meaning a violent conflict took place. Events where less than 5 people lost their lives are coded as 0, which translates to a non-violent event. This includes events where there are no reported deaths. There are cases in SCAD where the number of deaths is uncertain. In some cases, SCAD can with confidence know whether the death tally was over or under 10. Where the death tally was either completely uncertain or certain to be under 10, the cases were removed. This choice was made because I could not be certain whether the death number was 3 or 8, which would impact the dependent variable. Cases where SCAD are confident that the number of deaths exceeds 10 are included as positive cases. In total there are 2976 cases where conflict has happened, according to my concept of violent conflict. Negative cases are 12702.

There also was a conscious choice to use a binary dependent variable. First, I do not wish to measure the intensity or scale of conflicts, but rather the occurrence of them. If I wanted to measure dynamics of conflicts on the basis of climate parameters, a continuous dependent variable could have been a more logical. This way I can rather investigate which factors impact the likelihood of violent conflict happening, which essentially is the goal of the thesis. If I rather wanted to understand how climatic factors, among others, impacted the intensity, i.e. by the number of deaths in conflicts, a continuous measure would be the way to go. By creating a clear cut-off point I also can keep negative cases. Ignoring negative cases is one area where the climate-conflict literature has gained criticism in the last years (Adams et al. 2018).

3.2.2 Independent Variables

This section will be dedicated to presenting the independent variables at the grid-cell level. I begin with the climate measures, before moving on to cultural parameters, then the economic variables, with institutional variables following. Geographic variables make up the penultimate category, with demographic, i.e. population size being the last.

3.2.3 Climate Variables

Three variables will be used as measures of climatic factors, with one being used the most. That variable is a measure of drought intensity of a year. The two other climatic measures, which I primarily use to check alternative climate variables and to test robustness, are measures of precipitation and temperature. All of these variables are included in the PRIO-GRID dataset, which have compiled them from various sources. I will also employ lagged types of the variables as another test of alternative measures of climate parameters.

Drought

The primary climate variable is a measure of drought (Guttman 1999; McKee, Doesken, and Kleist 1993). The variable is based on the *Standardized Precipitation Index* (SPI) (McKee, Doesken, and Kleist 1993). This variable indicates how long, in months, the longest streak of drought lasted in a given year. Its value indicates how big of a proportion of that year experienced drought. Although it is not synonymous with temperature and/or precipitation measures, those measures can affect drought.

SPI's definition of drought is "… the difference of precipitation from the mean for a specified time period divided by the standard deviation where the mean and standard deviation are determined from the past records (McKee, Doesken, and Kleist 1993, 17, 18). The SPI index divides drought into four categories based on the values received; Mild drought 0 to -0,99; Moderate drought -1,00 to -1,49; Severe drought -1,50 to -1,99; and Extreme drought -2,00 and lower (McKee, Doesken, and Kleist 1993, 18). PRIO uses this index in order to create their variable. For a month to be considered to have experienced drought, it must experience a value of -1,50 or lower. That means that a drought streak is ended if a months' value goes over -1,50. A cell's value is then calculated by dividing the number of consecutive months with drought by 12, receiving the proportion of a year with drought (Tollefsen, Strand, and Buhaug 2016, 20). If one cell in a year experiences 5 consecutive months of drought as the longest streak of drought, the calculation becomes 5/12 = 0.41. The cell then receives the value 0.41 for that year. Theoretically, a cell could gain a value over 1, as drought can last longer than 12 months (Tollefsen, Strand, and Buhaug 2016, 20).

Fig 3.1 Plot of mean drought value per grid-cell, between 1990 – 2014. Darker colours indicate higher value.

Temperature

The temperature variable I utilize is gathered from the PRIO-GRID, which has compiled it from the *GPCP Version 2.2 Combined Precipitation Data Set* (Tollefsen, Strand, and Buhaug 2016, 19; Fan and van den Dool 2008). The variable measures the average temperature for each cell-year. I use this variable from 1990 up to 2014, although it contains data from 1948 (Fan and van den Dool 2008, 3, 4). Because there is a lack of one grand satellite data source which has gathered data from 1948 up to today, the temperature data is brought in from many different sources (Fan and van den Dool 2008, 5).

Precipitation

For a measure of precipitation, I use a variable PRIO-GRID has taken from the *Global Precipitation Climatology Project* (GPCP) dataset (Tollefsen, Strand, and Buhaug 2016, 19; Huffman, Bolvin, and Adler 2012). This variable indicates the total amount of precipitation for each cell-year, in millimetres. As with the previous variable, also this one uses satellite data in order to compile data. GPCP's temporal scale goes from 1979 – 2014 (Huffman, Bolvin, and Adler 2012, 4; Tollefsen, Strand, and Buhaug 2016, 19). Precipitation in this context does not only refer to rainfall, but also snow, hail and drizzle (Huffman, Bolvin, and Adler 2012, 10). PRIO calculates the yearly total of GPCP's monthly values of the variable (Tollefsen, Strand, and Buhaug 2016, 19).

3.2.4 Contextual Variables

In this section I will introduce the non-climate variables at the grid-cell level. I will start with the variables that concern the cultural aspects of the grid-cells, before moving over to variables that concern economic factors. Then, I will discuss indicators of institutional, geographic and demographic factors.

3.2.5 Cultural Variables

Excluded Ethnic Groups

The *Ethnic Power Relations Dataset Family* provides a variable which measures the number of excluded ethnic groups within an area (Tollefsen, Strand, and Buhaug 2016, 15; Vogt et al. 2015). Previous measures of ethnic fragmentation often used ethno-linguistic fractionalization as an avenue to measure the ethnic fragmentation in a society. Earlier datasets also rarely contained information about ethnic groups power relations to each other (Vogt et al. 2015, 3). This way of measuring ethnic fragmentation touches more on the political aspect; the focus is on groups being excluded forcefully from political life.

An ethnic groups access to power is measured through a three-part ordinal scale (Vogt et al. 2015, 6, 7). These three parts are again divided into sub-categories. The three parts of the ordinal scale are as follows: A group 1) controls power alone, 2) shares power with other ethnic groups, or 3) is excluded from executive state power (Vogt et al. 2015, 6). Below the three ordinal values, different sub-categories are found. The third ordinal category (is excluded from executive state power) has three sub-categories; *Powerless*, *discriminated*, or *self-exclusion*. PRIO-GRID includes ethnic groups which fall into the first two of the sub-categories. Thus, ethnic groups who are excluded by their own choice are not seen as excluded in the PRIO-GRID dataset (Tollefsen, Strand, and Buhaug 2016, 15).

Power Distribution by Social Groups

This is a measure of how the political power in a country is distributed between social groups[5]. Because social identities vary both in time and space, they are contextually defined. Identities can also cut across each other, making an individual or group cross-sectional in this regard (Coppedge et al. 2019a, 191). The variable is measured by aggregating country expert responses who score countries on a low (0) to high (4) scale, where higher scores are synonymous with more distributed power across groups. Lower values signal less distribution of power (Coppedge et al. 2019a, 191). The scale of the variable ranges from -5 to 5.

[5] V-Dem uses the term social group when talking about ethnic, religious, linguistic etc. groups.

Access to public services

Access to public services are two variables. One measures the access to public services based on social group membership, while the other concerns the difference between urban and rural populations (Coppedge et al. 2019a, 197, 199). Both are attained from the V-Dem dataset.

The first variable concerns itself with whether *social group membership* is an important rift which determines peoples' access to public services. Examples of public services can be, but are not limited to, clean water and healthcare, order and security and primary education (Coppedge et al. 2019a, 197). This variable requires that there are inequalities in the access that are based on social group membership. If societal groups do not make up a cleavage in access to public services, Coppedge et al. (2019a, 197) suggest that the value given should be 4 by the experts, which translates to equal access. The scale of the variable is a scale from low (-5) to high (5), where higher values indicates more equality, and lower values less equality. Country experts' assessments are aggregated

Access to public services distributed by urban-rural location measures whether there are differences in access based on where people live. V-Dem define urban areas as areas with a population density over 150 people per square kilometre, that there is a place with over 50,000 inhabitants within "some reasonable travel time, for example 60 minutes by road" (Coppedge et al. 2019a, 199). If where people live do not matter for their access to public services, the value 4 is assigned by country experts, which means that there is equal access across the whole country. The scale for this variable goes from low (-5) to high (5) (Coppedge et al. 2019a, 199, 200). The score of a country-year is also here based on multiple country expert assessments.

3.2.6 Economic Variables

Gross Cell Product

This variable is a measure of the gross cell product (GCP) for each grid-cell included in the analysis. The variable is acquired from the *G-Econ Dataset v4.0* (Tollefsen, Strand, and Buhaug 2016, 15; Nordhaus et al. 2006). This variable does not have observation for each year in the temporal scope of the analysis. Here, observations are measured in five-year intervals since 1990. I have chosen to fill in the missing values of the variable with the value of the last observation[6].

The currency the variable is measured in is US Dollars (Tollefsen, Strand, and Buhaug 2016, 16). Another option could have been to use a similar variable, which measures the relative purchasing power parity. However, this variable is preferred. There should be no reason for purchasing power parity having a larger influence on the outcome than the gross cell product. Having such an indicator at the grid-cell level is beneficiary because "The linkage between economic activity and geography is obvious to most people: populations cluster mainly on coasts and rarely on ice sheets" (Nordhaus 2006, 3510).

GCP is calculated in any given cell by the following formula (Nordhaus 2006, 3511):

GCP by grid cell = (population by grid-cell) X (per capita GCP by grid cell)

The quality and availability of economic data varies from country to country. Because of this, the way GCP is measured for different countries can vary. However, the above formula is the basic principle by which the variable is measured (Nordhaus 2006, 3511).

GDP Growth (%)

GDP growth (in percentage) is brought in from the World Bank (2019). The growth rate is based on constant 2010 US Dollars (World Bank 2019). World Bank's definition of GDP is "…the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products." (2019). The data is taken from the World Bank national accounts and OECD national account files (World Bank 2019).

[6] This is done with the "na.locf" function in R, from the Zoo package (Zeileis and Grothendieck 2005).

3.2.7 Institutional Variables

Egalitarian Democracy

From the V-Dem dataset I extract the *Egalitarian Democracy Index* (Coppedge et al. 2019a, 41). This variable builds on the more basic polyarchy index from the same dataset, but also measures egalitarian principles. Three points must be reached in order to gain the status of egalitarian democracy; 1) The protection of the rights and freedoms of all individuals, no matter social group affiliation, 2) An equal resource distribution across all social groups, and 3) An equal access to power across groups and individuals (Coppedge et al. 2019a, 41). The index is measured on an interval scale, from low (0) to high (1). It contains data from 1990 to 2014.

By using this measure instead of the traditional Polyarchy, or the Electoral democracy index, the analysis gains more insight into the distribution of resources and power (Coppedge et al. 2019a, 39). This way, the variable touches on the neo-Malthusian arguments presented earlier. A high score on the egalitarian democracy index should for example signify a fairly equal distribution of resources and power.

Educational Equality

From V-Dem *Educational Equality* is also utilized, which measures the degree to which basic education is ensured to all citizens in a way that makes them able to perform and exercise their basic rights (Coppedge et al. 2019a, 192). This variable also makes up a part of the egalitarian democracy index.

The variable is measured on a scale from low (-5) to high (5). Country experts provide the scoring that the value is determined by. At the lowest value, the attainment of education is highly unequal, with at least 75% of children not receiving sufficient education as per V-Dems understanding. At the highest value, equal access is provided and less than 5% of all children get an education that do not meet quality standards. Generally, basic education refers to the ages between 6 and 16, however this varies somewhat between countries (Coppedge et al. 2019a, 192).

Property Rights

V-Dem's Property rights indicates the degree to which citizens of a country possesses the right to private property. This includes not only the ownership, but acquirement, possession, sale and inheritance of private property. Land is also included as private property (Coppedge et al. 2019a, 270). Important to note is that this variable is not concerned with the ownership of property, but rather the *right* to it (Coppedge et al. 2019a, 270). Its scale goes from low (0) to high (1).

3.2.8 Geographic Variables

Proportion of Mountainous Terrain

From the PRIO-GRID I will also use a variable which indicates how much of each grid-cell is covered with mountainous terrain. This variable's measurement is based on data from the Mountain Watch report (Blyth et al. 2002; Tollefsen, Strand, and Buhaug 2016, 7).

Its indicator ranges from 0 to 1. Higher values indicate a higher proportion of a cell that is covered by mountainous terrain. Mountain Watch's definition of mountains is divided into seven different classes, which primarily are based on differences in elevation and slope of the mountains (Blyth et al. 2002, 74).

Distance to Capital

This variable measures' a grid-cell's distance to the capital of the country it is assigned to. The distance is measured in kilometres, from the centroid of the cell and to the national capital. The calculation is based on coordinates derived from the cShapes dataset (Tollefsen, Strand, and Buhaug 2016, 14; Weidmann, Kuse, and Gleditsch 2010).

Agricultural Area and Urban Area

Two indicators are measures of the percentage of each grid-cell which contains respectively agricultural and urban area, based on land-use-data from ISAM-HYDE (Tollefsen, Strand, and Buhaug 2016, 22; Meiyappan and Jain 2012). The dataset provides thorough estimates of historical measures of land use activity based on advanced techniques which accounts for uncertainties in estimates (Meiyappan and Jain 2012, 125). Whereas ISAM-HYDE includes two different categories of agricultural area, PRIO aggregate both of these, creating a common agricultural area-variable. Data is only available from 1990, 2000 and 2010 (Tollefsen, Strand, and Buhaug 2016, 22). Thus, I use the same process as with GCP to fill missing values between these years in order to have sufficient observations.

Urban area is similar to agricultural area. This variable indicates the amount of area in any cell that is covered by urban area in percentages. It is aggregated from the "urban"-category in ISAM-HYDE (Tollefsen, Strand, and Buhaug 2016, 22). I've also conducted a similar fill-in procedure with this variable, as with agricultural land.

Irrigation

Here, the measure calculates how much of the area of a grid-cell that is equipped for irrigation systems. Originally, the measure is stated in hectares, however I have chosen to convert it to square kilometres instead (Tollefsen, Strand, and Buhaug 2016, 22; Siebert et al. 2015). In PRIO-GRID, the variable is derived from the Historical Irrigation dataset v.1. More specifically, they use the AEI_EARTHSTAT_IR dataset in order to calculate the values of the indicator (Tollefsen, Strand, and Buhaug 2016, 22). As with the agricultural area variable, there are missing values. I employ the same method to fill in these missing values as earlier.

3.2.9 Demographic Variables

Population size

Lastly, a variable which measures the population size in each grid-cell is included. PRIO finds the variable at the *Gridded Population of the World version 3*. Similar to previously discussed variables, also this one lacks estimates for each year. Because of this, I've filled in the previous observed value where there are no observations. PRIO-GRID has four different versions of this variable. The one I have chosen to use denotes the number of people within each grid-cell. I have also translated the variable so that it denotes the population size in thousands for simplicity and easier to read data.

3.4 Methods

This part of the thesis will discuss the analytical approach I will use in order to test my hypotheses and ultimately whether climate variability does affect conflict. Choice of method matters, and it should be chosen because of theoretical and methodological reasons. Here, the choice falls on a multilevel logistic regression model. Within the climate-conflict sphere, there seems to be a lack of cross-communication between those who perform quantitative analyses and those who use qualitative methods. Often times results vary between the two camps. The two methodologies have their own strengths and weaknesses. Within the context of the climate-conflict realm, intensive qualitative case studies are more equipped for investigating complex mechanisms and many-faceted causalities (Kahl 2006, 59). Inductive studies are also something qualitative methods excel at. For the purposes of this study, where the goal is to test existing theory on the field, using a quantitative analysis with wide geographic and temporal scope is more fitting. Although detecting causal relationships is something statistical methods struggle with, examining correlations is still important in a field where there is yet to reach a consensus on the proposed relationships.

This part of the chapter begins with a walkthrough of logistic regression analysis and why it is chosen for this analysis. Next I discuss multilevel models and their theoretical and statistical prerequisites. Lastly, I consider mediation analysis, and why it is included in this thesis.

3.4.1 Logistic Regression Analysis

With a dichotomous dependent variable, the normal assumption of linearity does not hold. Because the distribution of the dependent variable is dichotomous, a logistic regression method is the obvious choice. Had I chosen to use the *ndeath*-variable instead of creating my own dependent variable, the choice would have been different because the *ndeath*-variable is continuous (Sommet and Morselli 2017).

In logistic regressions, the results one receives are different from the conventional OLS-estimates. Instead of producing regression coefficients, it deals out log odds. These values tell us something about the likelihood of the dependent outcome happening, based on log transformation which causes the estimated effect to fluctuate between 0 and 1. These log odds are transformed into the more interpretable odds-ratios, which essentially is the probability of the outcome happening divided on the probability of the outcome not happening. If this value becomes lower than 1, the variable has a mitigating effect on the dependent variable. If its value is higher than 1, it has a strengthening effect on the outcome variable.

In the sample in this analysis, there are 2976 positive cases, i.e. cases where conflict has happened, and 12702 cases where conflict did not occur. The spread is uneven as there are more negative than positive cases. The ideal situation for logistic regressions is that the spread is as close to 50/50 as possible. Simultaneously, the sample represents events that have happened. Violent conflicts are less likely than non-violent events to occur as shown in the sample. In this case, the probability of conflict happening is 18,9%. For it not happening, the percentage is 81%. Based on this, the odds of violent conflict are 18,9/81,0 = 0,23. Along with the odds-ratios, I will also report the predicted probabilities of variables on the outcome variable. This makes the results somewhat easier and more intuitive to understand.

3.4.2 Multilevel Analysis

Social sciences are dynamic. People are influenced by several different elements in the social and political world (Goldstein 2011, 1; Bickel 2007, 3). Climate and conflict are no different. Both local-level (grid-cells) and country-level explanations are presented as important reasons as to why conflict does or does not happen. To ensure a concentrated and rigorous analysis, one should test factors at multiple levels. Multilevel analysis allows us to do this. It makes it possible to separate the effects of grid-cell variables and country-level factors (Sommet and Morselli 2017). Another advantage concerns the clustering of observations within specific countries. One can allow variables' effects to vary between countries. This makes it possible to examine how the effect of drought varies between different countries (Sommet and Morselli 2017). Besides this, multilevel models are similar to typical OLS regressions. The output coefficients are the effects of that one variable with the other variables held constant.

One important thing to avoid when performing multilevel analyses is what Goldstein (2011, 10) calls *ecological fallacies*. If we imagine there is a correlation between the likelihood of conflict and economic performance of a country, one cannot infer that grid-cells with good economic performance on average are less likely to experience conflict (Diez Roux 2002, 589; Mathisen 2018, 41). This is because country- and grid-cell-level variables are mathematically independent of each other (Bickel 2007, 185; Goldstein 2011, 11).

3.4.3 Mediation Analysis

In order to test in-direct effects of climate variables, I will also perform a mediation analysis. Doing this allows me to test how climate variables affect violent conflict. Because of the complex mechanisms proposed in contemporary theory, such an analysis could help strengthen the understanding of the relationship.

Mediation analyses allows us to test not just simple X – Y-relationship, but more complex relationships where the explanatory variable is thought to affect an intermediate, or mediating variable, which in turn effects the outcome variable (Mathisen 2018, 44). For instance, I can test how drought impacts gross cell product, which again impacts violent conflict.

Practically, I employ the R-package named *mediation* in order to perform the analysis in R-Studio (Tingley et al. 2014). Whereas earlier mediation-methods have not been able to tackle non-linear models, this package allows me to use it in the setting of a non-linear model (Imai, Tingley, and Keele 2010, 44, 45; Tingley et al. 2014; Mathisen 2018). This means that it is possible to apply this method on a binary dependent variable, which I utilize in this analysis.

3.5 Statistical Assumptions

All statistical methods require some assumptions about the data, the spread of the dependent variable and so on. Independence of observations is one that is applied in normal regression models, but which does not translate into multilevel methods. Assumptions regarding heteroscedasticity does not hold. Because the variance in the dependent variable is limited to 0 and 1, one cannot assume the spread to be neither heteroscedastic nor independent of each other.

Disagreements exists with regard to how many level-2 units must be present in a multilevel analysis as a minimum. Some argue that 50 units should be the lowest amount to ensure precise results (Sommet and Morselli 2017, 206), some find at least 20 to be a requirement (Stegmueller 2013, 758), while other are less concerned with the number of groups, and maintain that as long as there are theoretical reasons to perform a multilevel analysis, one should do it (Gelman and Hill 2007, 275; Luke 2004, 22). The full model (model 5) in this analysis contains 48 country units.

Some tests are necessary to perform. Although many statistical assumptions from regular regression models do not translate to this analysis, the assumption that the independent variables are not correlated with each other does (Finch, Bolin, and Kelley 2014, 9). This is tested by estimating what is called *variance inflation factors* (VIF). Typically, the threshold for

VIF-values is above 10. Even so, if scores in the regressions seem unnatural or simply impossible, the alarm lamps ought to go off. None of the variables in the full model of the analysis reach over the threshold-score when performing a VIF-test. However, when including egalitarian democracy and educational equality or equal access to power by social group in the same model, egalitarian democracy's odds-ratio becomes inflated. Therefore, I do not have any models with those variables together.

A second test that was carried out before conducting the multiple regressions was an ICC-test. ICC stands for Intra-Class Correlation Coefficient (Finch, Bolin, and Kelley 2014, 24). This coefficient tells us to what degree there are correlation of observations between clusters of groups, i.e. countries, in the data. Correlation-clusters should signal that there is noteworthy variation between countries. An ICC-test was performed on an empty model, with satisfying results regarding proceeding with the analysis. It will be discussed in greater detail in the next chapter.

4 Results

So far, I have introduced the theoretical model with subsequent hypotheses of cultural, economic, institutional and geographic characters. These hypotheses will be tested within an analytical framework which focuses on low-level conflict thought to be prevalent in smaller, local communities. I then presented the variables that will be used to test my hypotheses, which are brought in from four different data sources. The variables are found at two analytical levels; grid-cell-level and country-level. Lastly, I presented my analytical strategy, wherein I presented the reason for choices made with regards to methods.

The following section will be structured as follows; I start by going through how I will compare models, where two measures are presented; AIC and ICC. Then, a brief discussion of specification of random slopes is conducted. After this, I begin the analysis by examining bivariate relationships between the dependent variable and some of the explanatory variables in order to illustrate some of the effects. Then, I build my model. I begin with mainly geographic grid-cell level (level 1) variables, before introducing the rest of the level 1 variables in the next model. Further, I incrementally add country-level (level 2) variables to the model until I reach the full model (model 5). Lastly, I employ a model (model 6) with some different country-level variables in order to test H2 and H8.

4.1 Explained Variation

No consensus exists with regards to the issue of indicating explained variation when using multilevel analysis. Whereas OLS regressions can use the R^2 to infer the explained variation of a model, it is not as clear for multilevel models. Two methods will be used; AIC (Akaike's Information Criterion) and ICC.

AIC is used in order to measure a models' fit to the data by adding the deviance of a model *d* and the number of variables in the model, and then multiplying it by 2 (Mathisen 2018, 42):

$$\text{AIC} = d + 2q$$

This has two consequences; First, smaller models will by nature have lower AIC than bigger ones, as they have fewer variables. Second, if deviation revolving the data goes down, the AIC value will get lowered. If two models based on the same dataset receive two different AIC-values, the model with the lowest value is preferred. There is no clear cut-off point which tells us when one model becomes notably better than another. Some advice exists; a reduction in AIC between to models within the 2-10-range is often seen as giving cautious support to the lowest value, whereas a drop in value over 10 is generally seen as strong support (Hox, Moerbeek, and van de Schoot 2018, 38, 39).

Another way to interpret model precision is through the ICC-value. Important to note is that the ICC only measures the explained variance for the level 2 (country-level) variables. However, if a country-level variable that is assumed to explained some of the between-country variation in the occurrence of conflict is introduced to a model, one should expect the ICC value to be lower than in the previous model.

4.2 Random Slopes

Allowing low-level variables to vary across countries is a method to get around the oft-mentioned quantitative issue of causal heterogeneity. Different countries are likely to give different explanations to social phenomena. Instead of looking at the mean values from between all countries, one can receive the mean values for every single country for themselves. This allows for an inferential complexity which combats previous criticism towards the quantitative approach. I can, for example, estimate the effect of excluded ethnic groups within each single country. This way, I can examine correlations in each country in the analysis instead of relying on the average effects of the whole sample of countries.

4.3 Bivariate Relationships, Grid-Cell Level

I begin the analysis by looking at single variables' effect on violent conflict. This way I can single out the effects and see how these result change as the model progresses. It is also a way to illustrate baseline relationships.

4.3.1 Drought

The climatic variable that receives the most attention in this thesis is the drought variable. Before I move on to the multivariate models and their results, I want to illustrate some bivariate relationships. The bivariate relationship between drought and violent conflict could be understood as illustrative of the broader relationship and the assumed mechanisms between the two.

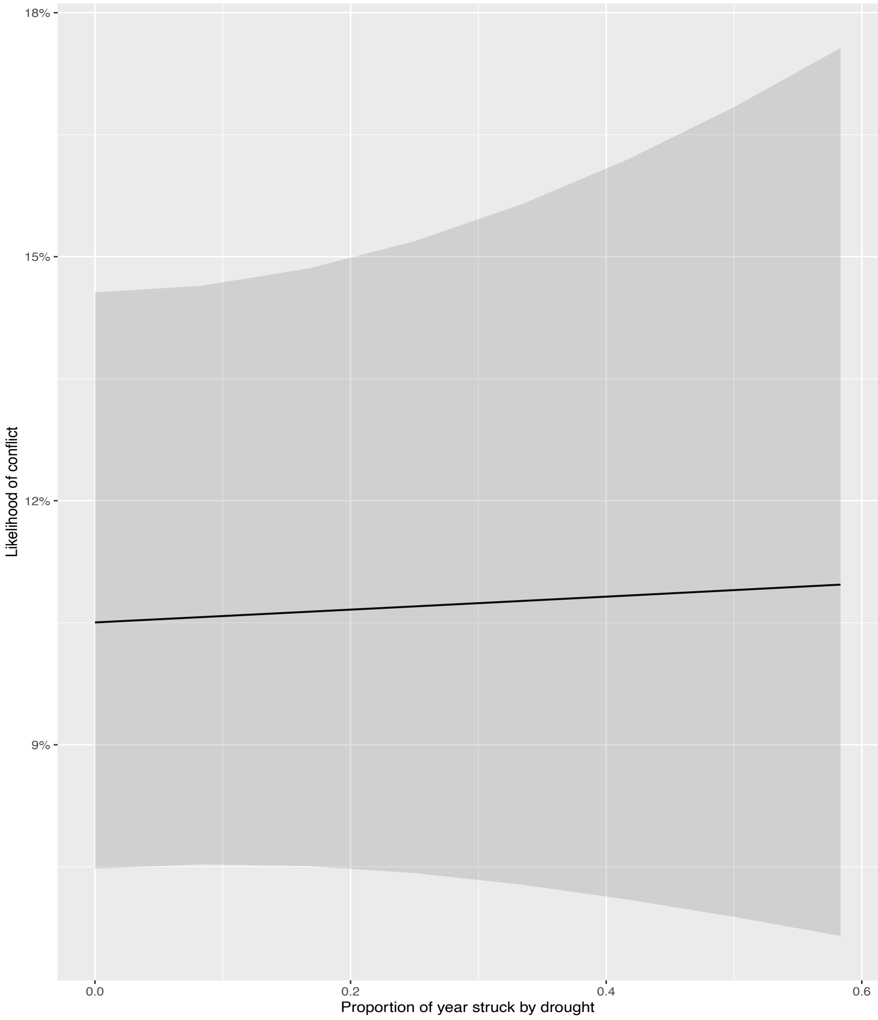

Fig 4.1 Predicted probabilities of drought on violent conflict, bivariate relationship. Grey areas are standard errors.

Figure 4.1 illustrate the relationship between the proportion of a year which has endured drought and the likelihood of violent conflict. The relationship is not statistically significant, and the odds-ratio of the variable is 1,086. Drought's effect on violent conflict on its own is weak and non-significant. If I specify the model so that the effect of drought varies between countries, the effect declines. While not significant, the odds-ratio falls to 0,741. Figure 4.2 illustrate the differences between the results with and without drought as a random slope. Predicted probabilities of the model echo the fact that the effect of drought is seemingly minimal. The values of predicted probabilities of drought stay within the 11%-range through all values of drought.

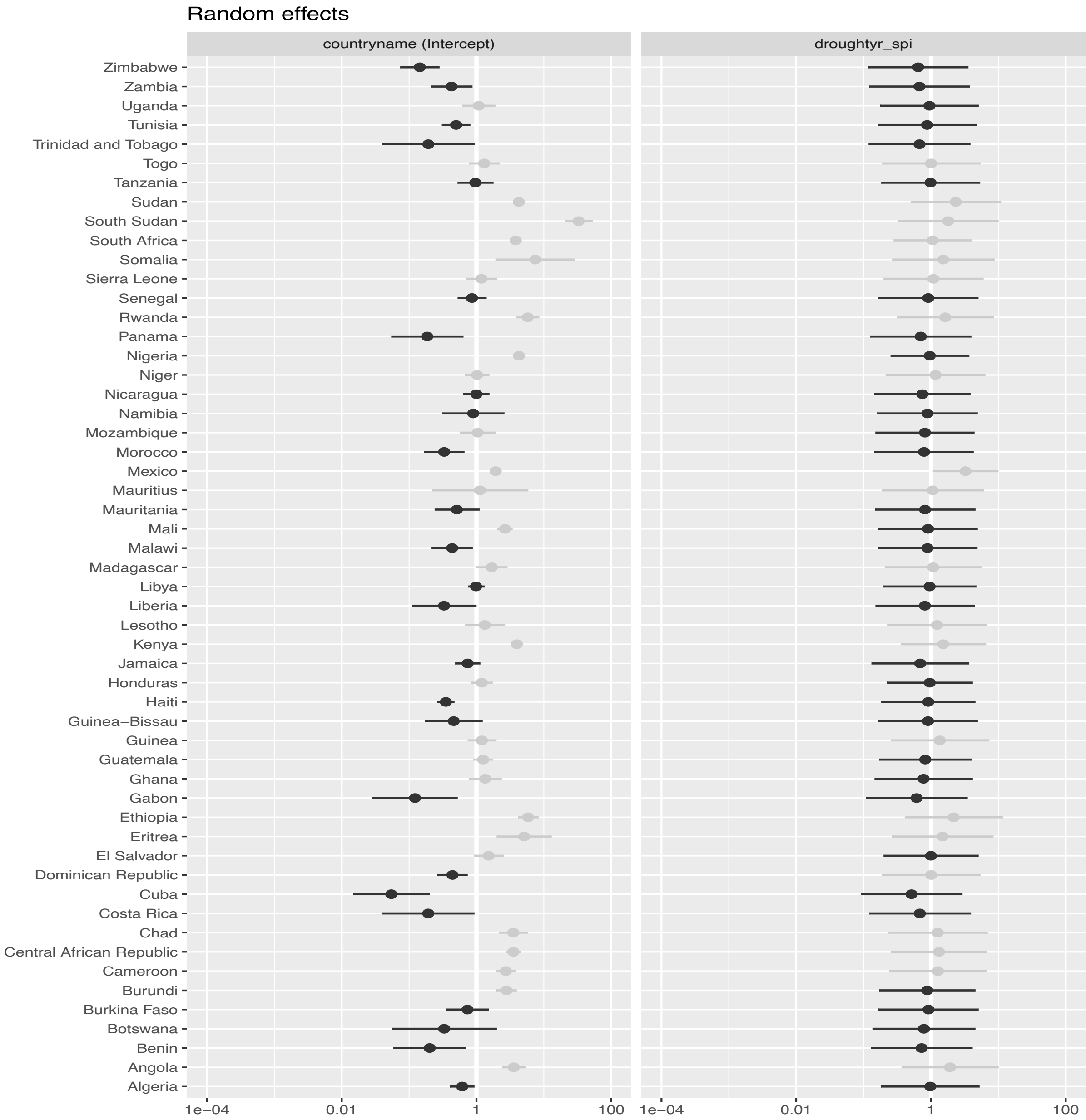

Fig 4.2 Between-country variation and random slope of drought on violent conflict.

Figure 4.2 show the random effects of countries and drought on the dependent variable, violent conflict. First, it shows that there is noteworthy variation on the dependent variable between countries. Second, one can infer from this that there are no outliers in the dataset which ought to be removed based on extreme values. Third, it shows how the drought variable gives less between-country variation. We can see, for example, that Cuba is a lot less exposed to violent conflict than South Sudan, for example. The bivariate model's ICC-value is .346, and its AIC is 13520,9. It contains 15678 observations over 54 countries.

4.3.2 Mountainous Area

The next bivariate relationship to be evaluated is between mountainous area and violent conflict. Figure 4.3 depicts the relationship. Here, the effect of proportion of a cell covered in mountainous area is significant, with a positive odds-ratio (OR = 1,03). The figure shows how as the proportion of a cell covered by mountainous area increases the probability of conflict increases as well. The likelihood moves steadily upward the whole way. This models' AIC-value is 13493,0, which translates to a drop in AIC of 27,9 from the previous bivariate relationship. It's ICC is .385, which is .039 higher than the ICC of the relationship between drought and conflict. Such a result could suggest that landscape plays an important role in where violent conflict takes place.

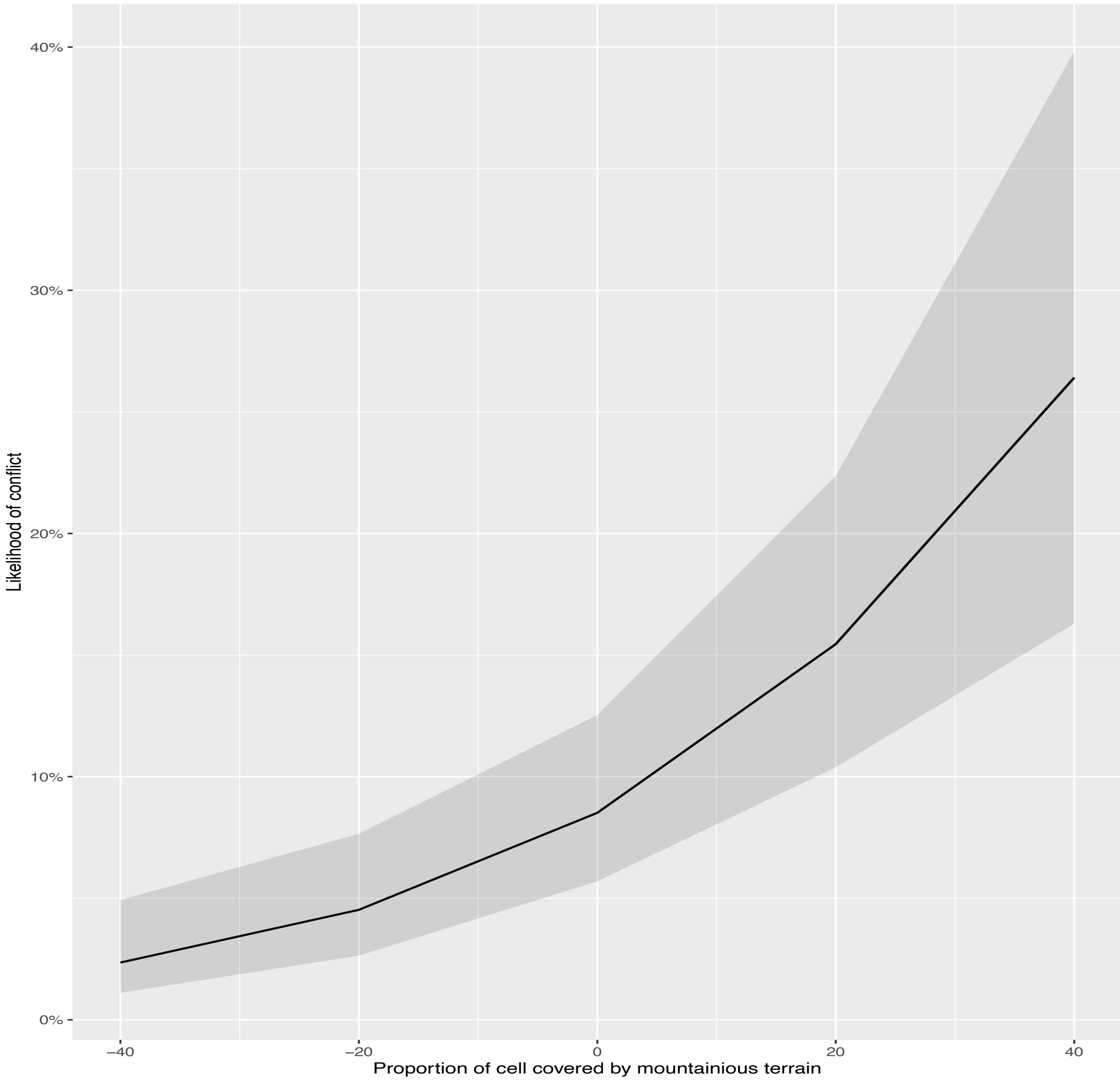

Fig 4.3 Relationship between proportion of grid-cell covered in mountainous area and violent conflict, in predicted probabilities. Standard errors are grey areas.

4.3.3 Distance to capital

Another variable that concerns the geophysical and location of the grid-cell is distance to capital. This variable indicates how far it is to the country's capital from the centre point in any given grid-cell[7]. This relationship is also significant at the 1% level, with a slightly positive odds-ratio of 1,000. Figure 4.4 highlights the effect of the variable. Similar to mountainous

[7] This is discussed in more detail in the previous Data section.

area, this variable steadily rises. As one gets further away from the capital, the risk of violent conflict increases substantially. The ICC of the model is .332, and its AIC is 13442,2 with the same amount of observations as the previous models. This is the lowest AIC of the bivariate relationships so far, suggesting that this is the best fitted model so far (AIC drops by 50,8). Specifying the variable as a random slope leads to an even lower AIC (Drops by 329,1). From this one should take that the effect of the variable varies between countries.

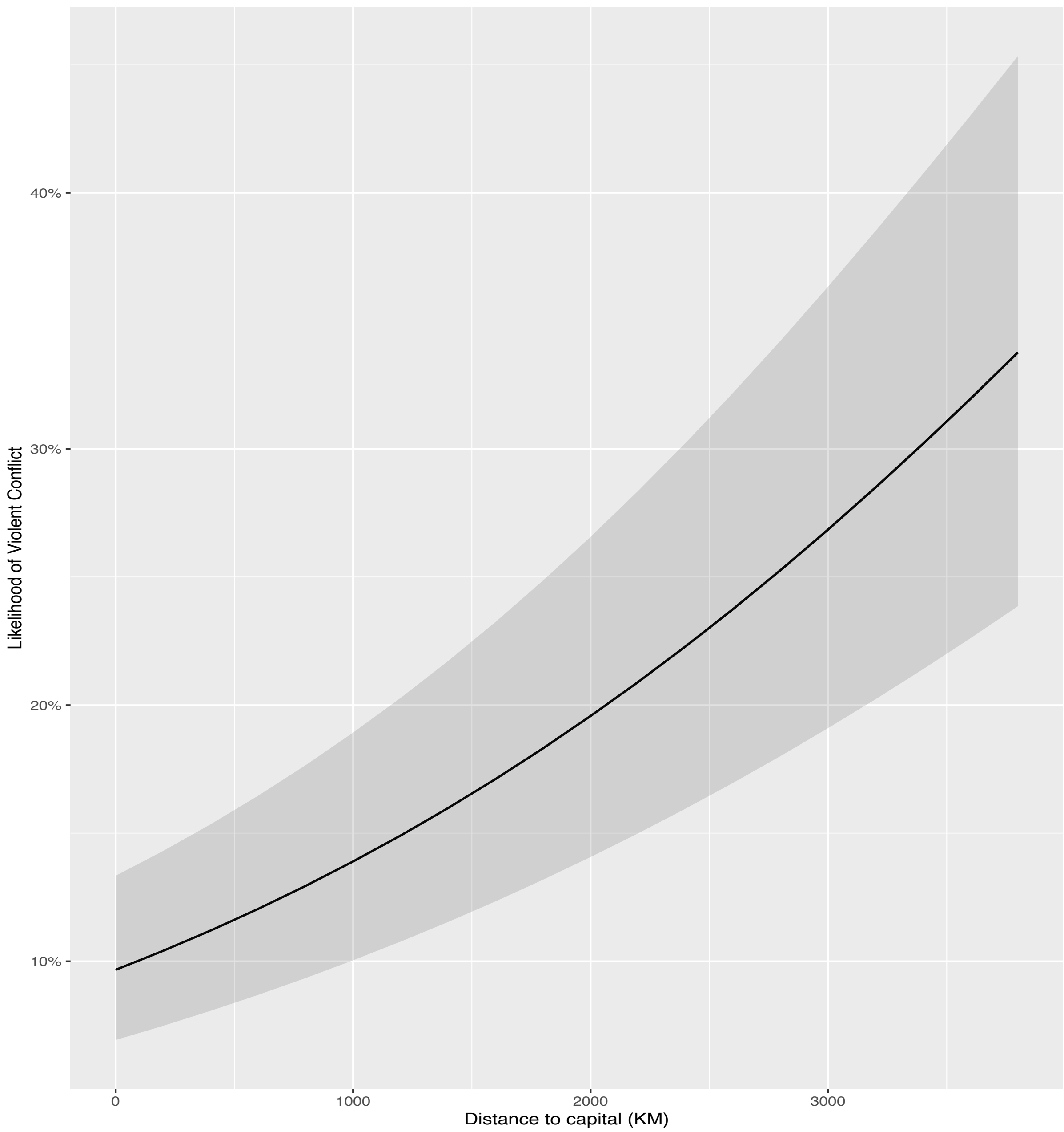

Fig 4.4 Relationship between distance to capital (in KMs) and violent conflict, in predicted probabilities. Grey areas are standard errors.

4.3.4 Egalitarian Democracy

The last variable I inspect at a bivariate level is egalitarian democracy. Egalitarian democracy is significant at the 1 percent level, with a clear descending slope. Figure 4.6 illustrates the effect of the variable. One can clearly see how the closer a country gets to the ideal of egalitarian democracy, the lower the likelihood of conflict happening. This model clearly suggests that egalitarian democracy has a mitigating effect on violent conflict. Its AIC-value is 13253,8, and ICC is .235. The ICC is higher than the previous models. Important to note is that this is the only bivariate model which uses a country-level variable. Drop in AIC indicates that this model is to be preferred over the previous ones (AIC drops by 188,4).

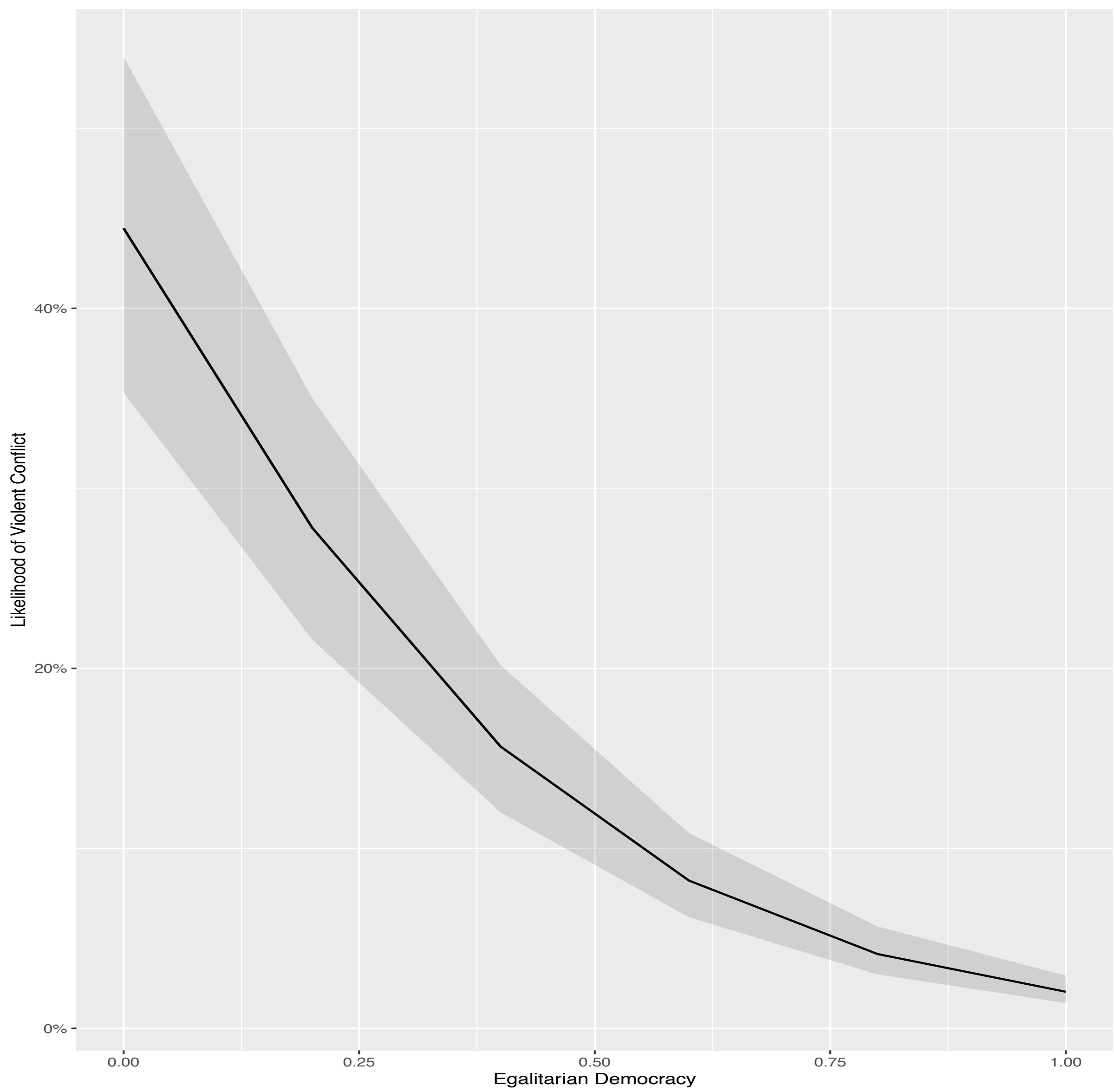

Fig 4.5 Relationship between degree of egalitarian democracy and violent conflict, in predicted probabilities. Grey areas are standard errors.

4.4 Model Diagnostics

As a last note before going into the models, it is important to take hold of model diagnostics. The full model yields un-reliable results on the variable *egalitarian democracy*. When specifying *egalitarian democracy* as an inter-country effect in these models, the results become more realistic, however it is hard to trust these results when the original results were as extreme as they were. Although the relationship is not significant, the result is still noteworthy. VIF-tests and subsequent incremental changes to models proved that multicollinearity was the reason for the obscure results. Thus, changes ought to be made with regards to which variables are included in different models (Finch, Bolin, and Kelley 2014, 9).

4.5 Empty Model

When performing a multilevel analysis, the first model one wants to inspect is an empty model. The ICC value is the most interesting value to look at, as it tells us how much of the variation in the dependent variable that is based at the country level. Here, the empty model receives an ICC-value of .346. An ICC-value of .346 translates to a between-country variation of 34,6%, with the remaining variation is within countries. Such a result is rather high. At the same time, one should not be to surprised. Some countries experience a lot of conflicts, whereas others are less exposed to the phenomenon. At the same time, most of the variation is found within countries, which could lend itself to the theory that intra-state low-level conflict relies on local level factors, among others climatic factors.

	Model 0 Empty Model		
	Odds Ratio		SE
Constant	-2.138***		0.189
Var(Cons.[country])	1.742		1.32
ICC		.346	
AIC		13516.2	
BIC		13531.6	
N (Grid-Cell-Events)		15678	
N (Countries)		54	

** $p < 0.05$, **$p < 0.01$, ***$p < 0.001$*

Table 4.1 Empty model with Conflict Dummy and the random effects of accounting for inter-variation. Sources: PRIO (2016) & SCAD (2017).

4.6 Model 1

Model 1 includes the drought variable as well as variables which contain information regarding the geographic properties of each grid-cell. In this model, conflict-occurrence is modelled as a function of these elements. Thus, we can gather from this model how the physical and demographic characteristics of an area can influence the risk of violent conflict. From this we can also infer if factors such as irrigation systems have a mitigating effect on drought.

First and foremost, drought is not significant in model 1. The odds-ratio of drought is slightly positive (OR = 1.006), which indicate that it has a weak increasing effect on violent conflict. The predicted values of drought within model 1 express that the effect is stable even while the number of months where drought is experienced increases. Droughts predicted probabilities stay at 10% all over, also when the value is 0, which indicates no drought experienced. The odds-ratio of drought suggests that as the drought variable increases, the chance of violent conflict increases ever so slightly.

Urban area is significant at the 99% threshold, with a negative odds-ratio. As the amount of a cell's area which contains urban areas increases, violent conflict becomes less likely. The predicted probabilities allow us to go further in debt of this result; at cases where there are no urban areas in a grid-cell, the chance of violent conflict happening is at 12%. Where 20% of a cell is made up of urban areas, the risk becomes 4%. This drops to 1% at the highest value, 35%. This result contrasts the Malthusian argument of demographic growth being detrimental, although just partly. Urban areas seem not to be the areas which are most exposed to violent conflict. However, given the necessary circumstances, urban areas could prove to be stages of disaster. Such events would however be contingent on complex mechanisms which statistical methods would struggle to measure.

Irrigated areas have a slightly negating effect on violent conflict (OR = 0.999) and is significant at the five percent level. This suggests that the proportion of a cell that is equipped for irrigation systems is negatively correlated with violent conflict. In the cases where the cell has no area equipped for irrigation, the predicted probability of violent conflict occurring is 11%, which goes down to 3% at the highest value. Capital distance is another variable that is significant at a satisfactory level, with a positive odds-ratio (OR = 1.000). By using predicted probabilities, we explore this further. It becomes clear that as a cell's distance to the country's capital increases, the predicted probability increases, an effect that stays consistent. Cells which value is 0, i.e. are in the same cell as the capital, the predicted probability is 9%. For cells that are 1800km away from the capital, the probability rises to 16%. At the highest value, the risk increases to 26%.

These results, together with the result of urban area suggests so far that the risk of violent conflict is highest in rural areas, far away from a country's capital. This supports hypothesis 10, which argues that areas farther away from a country's capital are more at risk of experiencing violent conflict. Coupling these two variables together with predicted probabilities emphasizes this; Where a cell has the lowest values of urban area and is farthest away from the capital, the predicted probability becomes 33%. The opposite case, with high urban area values and zero distance to the capital, the effect drops to 7%.

Mountainous area is also positive and significant (OR = 1.026). Predicted probabilities reiterate the results – Where there is the lowest amount of mountainous terrain in a cell, the predicted probability of violent conflict is at 3%. This increases to 21% at the highest value. The terrain and physical layout of a grid-cell seems to matter for the chance of violence spurring. I take this as a testament to existing literature which argue that areas that are characterized by advantageous terrain, be it mountainous or covered by shrubs and/or mountains, are preferred by rebels (Fearon and Laitin 2003; Buhaug, Cederman, and Rød 2008). Hypothesis 9 and 10 are supported by these results. Following this logic, it might be a matter of conscious choice by those committing violence; Choosing to act in areas that provides a tactical advantage to them is preferred.

Another way to gain insight into the strength and precision of the model is by looking at and comparing the AIC and ICC-values. This must necessarily be based on a comparable starting point. Since this is the first multivariate model, there is no other model to compare it to yet. Comparability with future models will to a certain degree be dependent on the sample size of grid-cells and countries included in the model. In the forthcoming models, observations will fall off because of missing values. I will however be able to more thoroughly compare coming models with each other.

The ICC-value of model 1 is at .355. As ICC measures the explained variance for country-level variables, I ought not to give it to much interest in the first models as they contain no country-level variables. It will, however, be more important as country-level variables are introduced. I expect the ICC-value to drop when country-level variables are introduced because I expect those to explain more of the country-level variation experienced. Model 1's AIC-value is 13313.3. When I can compare the value to the coming models, it will give us an idea of the explanatory power of the models.

	Model 1		*Model 2*		*Model 3*	
	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE
Grid-Cell Variables						
Drought	1.006	*0.386*	1.291	*0.424*	1.119	*0.427*
Agricultural Area	1.001	*0.001*	1.003*	*0.001*	1.000	*0.001*
Urban Area	0.937***	*0.006*	1.003	*0.010*	0.972***	*0.010*
Irrigated Area	0.999*	*0.000*	0.999	*0.000*	0.999	*0.000*
Distance to Capital	1.000***	*0.000*	1.000***	*0.000*	1.000*	*0.000*
Mountainous Area	1.026***	*0.007*	1.023**	*0.007*	1.007	*0.007*
Excluded Ethnic Groups			1.665***	*0.047*	1.243***	*0.052*
Gross Cell Product			1.013	*0.007*	1.012	*0.007*
Population			0.999***	*0.000*	0.999***	*0.000*
Country Level Variables						
Egalitarian Democracy					0.035***	*0.264*
Educational Equality						
Access to public services, urban/rural						
Access to public services, social groups						
Property Rights						

Excluded Social Groups			
Power Distribution by Social Groups			
Model Stats			
ICC	.355	.303	.202
AIC	13313.3	10389.7	10225.9
BIC	13375.1	10470.8	10314.4
N (Grid-cell-events)	15678	11777	11777
N (Countries)	54	49	49

^ $p < 0.06$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.2 Model 1-3: Models with climatic and geographical variables, political, economic and social variables at the grid-cell level and with one country-level variable. Source: PRIO-GRID (2019); SCAD (2017); author's calculation.

4.7 Model 2

Model 2 introduces the rest of the grid-cell level variables; Excluded Ethnic Groups, Gross Cell Product and Population (in 1000s). Important to note is the drop of observations in this model compared to model 1. Whereas model 1 has N = 15678, model 2 is significantly lower at N = 11777. This has consequences for the comparability between the two when it comes to AIC-value.

Drought's odds-ratio increases a little bit from model 1 to model 2 (From OR = 1.006 to 1.291). Still, drought is not significant. Agricultural area also increases minimally, by 0.002. Urban area rises to 1.003 from 0.937. This means that between model 1 and model 2, the effect of proportion of cell covered by urban areas goes from having a slight mitigating effect to a slender intensifying effect. Irrigated area receives the same value as in model 1, at 0.999. It is however not significant in model 2. Distance to capital keeps its results and is still significant with an odds-ratio of 1.000. Mountainous area's odds-ratio drops by 0.003 while it is still significant.

Of most importance and interest in this model are the new variables. Excluded ethnic groups is significant, with an odds-ratio of 1.665. This is the strongest effect in model 2, and hints that as there are excluded ethnic groups in a given grid-cell, the risk of violence increases. This lends support to the argument that the existence of involuntary excluded ethnic groups increases the risk of violent conflict, which was presented in hypothesis 1. Predicted probabilities illustrate this clearly; When there are zero excluded ethnic groups present, the predicted probability of conflict is at 8%. With one group, this increases to 13%. For cases with two excluded ethnic groups, the percent is 20%, and 29% for circumstances with 3 excluded ethnic groups.

Does drought affect the predicted probabilities of excluded ethnic groups? By looking at the predicted probabilities of excluded ethnic groups where drought has different values, we can investigate this. If an area has experienced 3 months of drought and has three excluded ethnic groups present, the predicted probability lands at 31%. That is an increase of 2 percentage points. Cases with 7 months of continuous drought and 3 excluded ethnic groups has a 32% percentage likelihood of violent conflicts happening. This suggests that drought has a slim, intensifying effect on violent conflict in areas where there are politically excluded ethnic groups.

Gross cell product also gets a positive odds-ratio (OR = 1.013), although not as strong as excluded ethnic groups. The variable is not significant. Population, measured in 1000s, is significant, with an odds-ratio of 0.999. Although the effect is slender, grid-cells with lower populations are more likely to experience violent conflicts. At the lowest value of the variable, the predicted probability is 11%, which drops to 0% in the most populous areas. It is interesting to note how the population variable receives a significant negative odds-ratio, as this opposes conventional Malthusian theory, and thus hypothesis 12, which holds high populations as one central aspect of the climate – conflict relationship.

The ICC-value of model 1 has decreased, which signals that this model explains for 14,6%[8] more of the explained country level variation, i.e. the introduced variables adds these 14,6%. The AIC-value of the model is also significantly lower. This should not be given much weight however, as the *N* of model 2 is a lot lower than model 1. Model 2 has 3901 less observations at the grid-cell-level than model 1, rendering comparison of the two's AIC fruitless.

4.8 Model 3

One country level variable is introduced in model 3, which is Egalitarian Democracy. It's odds-ratio is at 0.035, which is a very strong effect. As discussed before, variables which receive a value below 1 has a mitigating effect on the dependent variable. The farther from 1 a variable is, the stronger is the effect[9]. Egalitarian democracy's slope is thus steep, similar to the plot of the bivariate relationship presented earlier.

Overall, there are few changes with regards to estimates of variables. Drought drops to an odds-ratio of 1.119, while staying non-significant. Urban area drops to below 1 (OR = 0,972) while staying significant. Distance to capital keeps its odds-ratio (1,000) and significance-level, though not as strongly as before. Mountainous area stays above 1 (OR = 1.007) but becomes non-significant. Excluded ethnic groups and population stay significant at the same level. Excluded ethnic groups drop in odds-ratio by 0,422 (OR = 1.243). Other than urban area's change in direction, there are few notable changes in the results besides the new variable.

Model diagnostics allow us to examine model 3's performance compared to model 2. Both models have grid-cell *N* = 11777 and country *N* = 49. Because of these similarities, we can use the AIC-values with confidence to determine which model is preferred. Model 3's AIC-value is 10225,9. This translates to a drop of AIC by 163,8[10]. On the background of what constitutes meaningful differences in AIC-values, a drop by 163,8 is large. Thus, model 3 should be preferred to model 2 on the basis of model fit.

[8] Calculation: (0.355 – 0.303)/0.355*100.
[9] This is true both for intensifying and mitigating variables.
[10] Calculation: 10389,7-10225,9 = 163,8.

ICC must also be considered. Model 3 has introduced the first country-level variable. One could reasonably expect this to explain for quite a bit of the variation between states. Using the ICC, we can check whether this is true or not. Model 3 receives an ICC-value of .202. From model 2, this is a drop of .101. In percentages, model 3 accounts for 33,3%[11] of the country-level variation in the dependent variable. Remembering that only one variable has been added since model 2, this is a notable change.

Next, I will look at the predicted probabilities of egalitarian democracy and its predicted probabilities at different drought values. The predicted probabilities show that in countries where the score on egalitarian democracy is between .80 and 1, the risk of violence comes in at 2%. This doubles for those between .60 and .80. Those who fall into the second lowest category receive a predicted probability of 23%, whereas the lowest are at 37%. The differences are noteworthy. Do these results change when looking at different scenarios of drought? If the longest streak of drought is one month, the predicted probabilities do not change. When the streak goes up to two months, the two lowest categories of egalitarian democracy gain increase by one percentage point each. In cases where over half a year has been ridden by drought, there is a 39% chance of violent conflict for the cases with an egalitarian democracy-value of below .20. For the category above, between .20 and .40 on egalitarian democracy, the predicted probability is 24%.

[11] Calculation: (0,303 – 0,202)/0,303*100.

	Model 4		*Model 5*		*Model 6*	
	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE
Grid-Cell Variables						
Drought	1.337	*0.446*	1.346	*0.447*	1.053	*0.430*
Agricultural Area	1.001	*0.001*	1.001	*0.001*	1.002	*0.001*
Urban Area	1.001	*0.011*	0.999	*0.011*	1.001	*0.010*
Irrigated Area	0.999	*0.000*	0.999	*0.000*	0.999	*0.000*
Distance to Capital	1.000**	*0.000*	1.000**	*0.000*	1.000*	*0.000*
Mountainous Area	1.002	*0.007*	1.002	*0.007*	1.008	*0.007*
Excluded Ethnic Groups	1.199***	*0.054*	1.198***	*0.054*	1.166**	*0.053*
Gross Cell Product	1.012	*0.007*	1.012	*0.007*	1.013	*0.007*
Population (1000s)	0.999***	*0.000*	0.999***	*0.000*	0.999***	*0.000*
Country Level Variables						
Egalitarian Democracy	1.358	*0.670*	1.068	*0.676*		
Access to public services, urban/rural	0.810	*0.164*	0.799	*0.170*		
Access to public services, social groups	0.672**	*0.142*	0.646**	*0.145*		
Property Rights			1.284	*0.414*	1.663	*0.370*
GDP-growth (%)			1.006**	*0.002*	1.007**	*0.002*

Educational Equality					0.423***	*0.095*
Power Distribution by Social Groups					0.853*	*0.078*
Model Stats						
ICC	.258		.261		.190	
AIC	9377.4		9374.1		10112.2	
BIC	9479.8		9491.1		10222.8	
N (Grid-cell-events)	11086		11086		11777	
N (Countries)	48		48		49	

^ $p < 0.06$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.3 Model 4-6: Access to public services, Property rights, country-level economic growth (full model) and alternate country-level variables. Source: PRIO-GRID (2019); SCAD (2017); author's calculations.

How does the hypotheses fare so far? If we look at model 3, which contains the most variables and is the most extensive model so far, one can see that drought is not itself significant. Essentially, there is no evidence so far that suggests that drought has a direct effect on conflict in itself. Hypothesis 1, which concerns the occurrence of excluded ethnic groups as a factor which increases the risk of violent conflict, is supported. The variable is significant with a positive odds-ratio. Population contradicts conventional neo-Malthusian arguments as well as hypothesis 12 which states that higher population density increasing the risk of violent conflict because of increased pressure on resources. Egalitarian democracy receives a considerable odds-ratio of 0,035. This highly supports the argument that more egalitarian and democratic states are less susceptible to violent conflict. States that provide political power across social groups, which have available important welfare services and that ensure a fairly egalitarian distribution of resources seem to mitigate the risk of violent conflict. As egalitarian democracy also measures the degree of democracy in a state, hypothesis 7 is also supported. This hypothesis states that more democratic countries are less prone to violent conflicts. Model diagnostics suggest that model 3 is more properly fitted than model 2, while also receiving a lower ICC.

Richer grid-cells are not significantly less exposed to violent conflict, as the variable assumes a positive odds-ratio while being non-significant. Hypothesis 4, arguing that richer grid-cells are less at risk for violent conflict, is not supported so far in the analysis. Distance to capital is supported, assuring support for hypothesis 10. Mountainous area loses its explanatory power as the models' progress, which translates to less support for hypothesis 9.

4.9 Model 4

In model 4, two more country-level variables are introduced. These two are measures of inhabitants' access to public services based on 1) social group affiliation, and 2) whether one live in urban or rural areas. Model 4 loses 691 grid-cell observations, and one country-level *N* from model 3. Because of this, evaluating model performance on the basis of AIC-value must be done with caution.

As access to public services increase, the risk of violent conflict decreases. Access to public services based on ones' location is not significant but has an odds-ratio of 0.810. Public service-access based on ones' social group affiliation is significant and has an odds-ratio of 0.672, making it the strongest effect of the two new variables. The predicted probabilities let us delve further into this; Where the state is the most restrictive with regards to social groups' access to public services, the predicted probability of the dependent variable is 20%. At the centre value of the variable, the percentage has dropped to 10%. This falls down to 5% in the cases where access to public services is not restricted by membership to social groups. Geographically hinged access does not have as strong effects. At the lowest value, the predicted probability comes in at 14%. This value moves steadily downwards to 5% at the highest value, i.e. where the rural population has better access to public services than the non-rural population.

Does it exist a pattern between access to public services and severity of drought experienced? Where access to public services is limited for social groups and there has been no drought, the likelihood of conflict stays at 20%. This likelihood increases by one percentage point if one month of drought is the longest drought-streak experienced. It requires 4 months of consecutive drought for the percentage to increase by yet another percentage point. Keep in mind this is in the cases where access to public services is the most restricted based on social group affiliation. At 7 months of drought, the likelihood is at 23%. Thus, longer periods of drought are correlated with modest increasements in the probability of conflict as access to public services is restricted by social class association.

Model 4's ICC-value is .258, meaning that it has increased from model 3. This means that model 4 explains 27,7%[12] less of the country-level variation than model 3 does. A higher ICC-value for a model which has introduced two more country-level variables is not a good sign, as it signals that it explains less of the variation at country-level. Meanwhile, the AIC-value is lower for model 4 than model 3. As mentioned earlier, model 4 has 691 less observations at level 1 than model 4. Yet, a lower AIC-value indicates a better model fit than model 3, although it ought to be taken with the caveat of fewer observations.

These results suggest that states wherein discriminatory politics are led, the chance of conflict occurring is more likely. This supports hypothesis 3. As more groups have access to necessary public services, it becomes easier for people to implement measures which mitigate the hardships that climate variability or -change brings. While the confidence of the results gained from the urban/rural-variable is unsatisfying, access based on social group affiliation reaches the requirement. It must also be stated that because conflict is such a complex phenomenon, it should be expected that is also can have a multitude of sources. These sources are likely to interact together, creating highly complex mechanisms that are hard to measure and test statistically. The odds-ratio of egalitarian democracy in model 4 is curios, because I generally expect more egalitarian democracies to be less prone to violent conflict than less egalitarian democracy. However, the variable is not within required confidence intervals in this model, and thus the result should be taken with a grain of salt.

[12] Calculation: (0,202 – 0,258)/0,202*100.

4.10 Model 5

Model 5 is the original full model. Two more country-level variable is introduced from model 4, which is GDP-growth in percentage and property rights. Based on economically grounded theoretical arguments presented earlier, I expect GDP-growth to have a negative effect on the probability of conflict appearing. The same expectation goes for property rights. Therefore, its explanatory power with regards to the hypotheses presented will be important, as it should be expected that the model fares reasonably well when compared to the others when looking at model diagnostics. This model will also be subject to specifications of random slopes and intercepts, as it is advised to convey these tests on only the full model. By using random slopes and intercepts, I will be able to investigate whether allowing variables to vary between countries makes a difference in the results.

Drought is not significant in this model either. Its odds ratio suggests that the effect of drought is intensifying on the dependent variable (OR = 1.346). The odds-ratio has increased slightly from model 4, by 0.009. It is not surprising that this result show that drought does not have any direct effect on violent conflict within an acceptable confidence interval. Specifying drought to vary between countries has no effect on the significance of the variable, but the odds-ratio drops by quite a bit, to 0.674. Agricultural area is barely showing a positive odds-ratio, which is also non-significant (OR = 1.001). Urban area is not significant either, with an odds-ratio of 0.999. The same results are found for irrigated area. Capital distance stays significant, receiving an odds-ratio of 1.000. Mountainous area stays positive (OR = 1.002), but it does not fall within a satisfying confidence level interval. Excluded ethnic groups are significant, with an odds-ratio of 1.198. This variable has been consistent both when it comes to its significance level and direction of the odds-ratio. From this I take that the exclusion of ethnic groups in a society increases the risk of violent conflict. Gross cell product stays slightly intensifying with regards to its direction (OR = 1.013) but is significant. Population stays the same as in previous models, being significant with an odds-ratio of 0.999.

The grid-cell-level results show that drought does not have any significant direct effect on violent conflict. It also illustrates that excluded ethnic groups is an effective explanatory variable insofar it is within required confidence intervals and has a positive effect. This gives support to hypothesis 1 which argue that excluded ethnic groups contributes to the probability of violent conflict happening. Importantly this analysis does not test if climate variability leads to exclusion of ethnic groups. It still remains to be seen if drought can be proven as an explanatory factor for excluded ethnic groups. Distance to capital and Population both being significant with respectively neutral and marginally mitigating odds-ratios (1.000 and 0.999) suggests that non-central areas are more prone to violent conflict than the areas closer to a country's capital.

What then about the country-level variables? Two new variables have been added to the model since model 4, which will be discussed later. Egalitarian democracy, which direction proved unexpected in model 4, is still above 1 (OR = 1.068) though it is still not significant. Access to public services based on urban or rural location is not significant either but has an odds-ratio which falls more into the direction expect (OR = 0.799). Public service access based on social group belonging is significant with an odds-ratio below 1, suggesting that the variable is a mitigating factor against conflict spurring. With an odds-ratio of 0.646, the effect is noteworthy. This result can be used to argue that states which are happy to provide necessary public services to all groups of society will be less likely to experience conflict. Although this variable is not a direct measure of adaptive capacity and preventive measures, one could argue that accessibility is a necessary part of the concept. The first of the new variables is a measure of the degree to which property rights are upheld and followed in a country. Theoretical arguments argue that cases where property rights are weak, conflict is more likely. On the basis of theoretical arguments presented earlier, I expect property rights to have an odds-ratio below 1. This expectation is not met. Property rights ends up with a non-significant odds-ratio of 1.284, suggesting that as people enjoy the right to property more, conflict is more likely. The second new variable, GDP growth, shares the expectation of the previous, that it should have a negating effect on the chance of violent conflict occurring. Here I experience the same as with property rights – the effect is opposite to what was expected. GDP-growth gain a modest odds-ratio of 1.006, which also is significant. Although the odds-ratio is moderate, the predicted probabilities will allow to dive more thorough into the likelihood of the variable.

For GDP-growth, the predicted probabilities show that the relationship is opposite to what was expected. In the cases where there is the strongest economic decline rather than growth, the predicted probability of the dependent variable is only at 6%. Where the economy is closer to 0% growth, the predicted probability rises to 10%. This likelihood keeps increasing, going up to 20% at the highest growth-percentage. Conventional economic arguments and more contemporary arguments found both within the climate-conflict-nexus and general conflict theory would expect an opposite relationship, i.e. the worse economic performance a country experience, the higher likelihood of conflict. Because of this it is interesting to see results that oppose these claims. Coupling GDP-growth with drought-intensity, there is a mild increase in the predicted probabilities. At the highest growth-rates where drought lasts for 7 months, the chance of violent conflict goes up by 3 percentage points, to 23%. 1 month of drought equals a predicted probability of 21%.

I will also examine the predicted probabilities of property rights, both on their own and in tandem with the drought-variable. On its own, property rights experience little variation in the predicted probabilities. At the lowest value of property rights, the predicted probability comes in at 9%. This only rises to 11% at the highest value. Examined together with drought, there is small changes in the percentages. Where there has been 4 months of drought, the predicted probability for the highest property rights value increases by one percentage point. When the drought-value equals 5 months, the lowest value for property rights goes from 9% to 10%. Other than that, the predicted probabilities remain the same.

Next, I will review the model diagnostics in relation to the previous model in order to see whether the model is properly fitted. Model 4 and 5 are similar with regards to the number of observations, which makes these models comparable. This means that I expect this model to perform better when it comes to both ICC and AIC-values. The ICC-value of model 5 is .261, which is higher than model 4. An increase of .003 in the ICC is small, however it is still worth noting that the explained variance at country-level is escalating. The difference in variation explained is 1,16%[13] higher in model 5. The AIC-value, on the other hand, is slightly lower in model 5 than the previous model. With a difference of 3,3[14] model 5 is to be preferred over model 4 when it comes to the AIC-value.

[13] Calculation: (0,258 – 0,261)/0,258*100.
[14] Calculation: 9377,4 – 9374,1 = 3,3.

To explore the model further, I will specify various variables in the model as random effects. By doing this, I can investigate whether the effects of vary between the groups in the analysis. It is likely that the effects vary between countries, and this is a thorough way to investigate such claims.

First, I specify drought as a random slope to examine whether the effect varies. Allowing drought to vary between countries, the AIC of the model goes up by 2. That implies that the effect of drought does not vary substantially between the countries. It also leads the drought-variable's odds-ratio to drop below 1, to 0,674. Such a result seems like further evidence that drought in itself does not have a direct effect on violent conflict occurring. Then, I set Capital Distance as a random effect. This time the AIC drops by 201,4, which signals that the model is more properly fitted. Here, drought's odds-ratio goes up from the original model 5, to 1,557 while it stays non-significant. Capital distance stays significant and increases by 0,001.

I do the same with the GCP-variable. This gives similar results as with capital distance, where the AIC-value drops. Here, it drops by 129,3. While not as big as the drop from when capital distance was specified as a random slope, it is still sufficient to infer that the model is better fitted than the original model 5. When the population-variable gets the same treatment (set as random effect), both the urban area and agricultural area variables becomes significant. Agricultural area goes slightly over 1, while urban area sneaks just below 1 (Odds-ratio's = 1,005 & 0,948 respectively). The AIC suggests that also this version of the model fits better, with a drop of value of 219,5.

Besides the attempt of specifying drought as a random slope, the model proved to be better fitted when variables were set as random slopes. This should be seen as evidence for the fact that the effects of the model vary between countries. Whereas AIC-levels generally goes down if we count out drought, the ICC-levels tend to rise.

So far, I've not been able to prove that drought has a direct effect on the occurrence of violent conflict. On one side, the theoretical and conceptual framework led into what could be considered a “most-likely” framework, primarily by a low death-threshold. At the same time, because the assumed relationship is thought to be in-direct, it is not such a big surprise. The wide sample might also contribute to varied results.

I’ve presented and reviewed the full model, model 5. It is the model with the most explanatory variables. Simultaneously, two variables are omitted because they lead to erroneous results for the egalitarian democracy variable. This happens because educational equality and power shared between social groups are part of the egalitarian democracy index, which leads to issues with multicollinearity. Yet, as model 5 is the full model, the hypotheses would need confirmation here in order to properly be confirmed. I will discuss the results’ implications for the two remaining hypotheses, H2 and H8, after model 6 has been presented and discussed.

Hypothesis 1 states that the more excluded ethnic groups there are in a grid-cell, the more likely it is that that grid-cell experiences violent conflict. In model 5, that hypothesis is supported. If there are excluded ethnic groups within a grid-cell, the risk of conflict rises. Hypothesis 2 will be discussed further after model 6 as it is not measured here because of previously mentioned issues. One hypothesis that cannot be confirmed so far is that richer areas are less prone to violent conflict. Model 5’s results contradict that statement. Rather, richer areas are in this analysis at a higher risk of experiencing violent conflict. A similar result is found for GDP growth at country level. This does not stand in line with the idea that countries that experience better economic performance should experience less conflict than those who suffer from weaker economic performance. Hypothesis 4 is thus not supported.

How does the assumptions that touch on the physical terrain fare? In model 5 support for hypothesis 10 is found; distance to capital is positively correlated with conflict-occurrence. Mountainous areas are more ambiguous – the odds-ratio of the variable is above 1, however it is not significant. I can therefore not confirm hypothesis 9, which states that more mountainous areas are more prone to violent conflict. Hypothesis 11 does not seem to stand either as the indicator lacks the necessary significance-level in the model. The urban/rural divide with regards to access to public services does not have a significant effect on the likelihood of violent conflict. Therefore, the null hypothesis, that access to public services in distant areas is not significantly correlated with violent conflict, cannot be rejected, and hypothesis 11 is not supported here.

Property rights is another variable that does not confirm what was theoretically expected. Hypothesis 6, which says that stronger protection of property rights in a country, is not supported in model 5. The same goes for egalitarian democracy. Its odds-ratio goes up above 1, signalling that it is an intensifying factor, contrary to theoretical expectations. Because the variable is not significant, the null-hypothesis cannot be rejected. Egalitarian democracy does not seem to significantly affect the probability of violent conflicts. Hypothesis 7 is therefore not supported. Economic growth is significant and positively related to the occurrence of violent conflict, which contradicts hypothesis 5. Hypothesis 5 argues that economic growth at the country level is a mitigating factor for violent conflicts. Equal access to public services between social groups has a significant mitigating effect on violent conflict. This supports hypothesis 3, which argues that countries where there is an unequal access to public services between social groups are more exposed to violent conflict.

4.11 Model 6

In model 6, two alternative variables are introduced at the country-level. These variables are both parts of the egalitarian democracy variable, which cannot be a part of model 5 because of multicollinearity. Educational equality refers to the degree to which different groups in a society experience equal access to essential education. Power distribution by social groups indicates to what extent power is shared across social groups in a country. Model 6 has 11777 observation at the grid-cell level, and 49 at country level. This is some more observation than the previous two models.

Neither here is drought significant. It's odds-ratio is lower in model 6 than model 5 (1,053 vs. 1,346 respectively). Most of the grid-cell-level variables experience little to no change. Urban area increases by 0,002, which makes it go from below 1 to above 1 (0,999 vs. 1,001). The variable is however not significant. Excluded ethnic groups stays significant but drops by 0,032 in its odds-ratio (1,198 vs. 1,166). Population holds on to both its significance level and odds-ratio.

Egalitarian democracy and both access to public service-variables have been replaced in this model. Property rights stay and receive an odds-ratio of 1.663. This is an increase by 0,379 from model 5. The variable is not significant at any satisfying level. GDP-growth increases by 0,001. It stays within the required confidence intervals. Education equality, the first of the two new variables, show a strong, significant effect. The variable's odds-ratio is 0,423. This makes it the strongest effect within the model. From this I gather that societies where access to education is equally shared between social groups are noticeable less exposed to violent conflict. Power distribution is less significant than educational equality, but still within the necessary confidence intervals. The effect is also more moderate than educational equality, but still noteworthy at 0,853.

I will dive further into the predicted probabilities of the two variables to illustrate how these affect the dependent variable. First, educational equality will be looked at. At the highest value of educational equality, i.e. where the equality of access to education is the highest, the predicted probability of conflict is 1%. As the educational equality diminishes, the probability of violent conflict increases in an exponential way. At the lowest of the two centre values of the variables, the percentage doubles from 7% to 14%. From here, it goes to 26%, 44% and ends up at 63%. This means that, in the population that the data represents, in the cases where educational inequality exists, violent conflict is more likely to happen than not. There are no changes in the predicted probabilities when educational equality is teamed up with drought,

Power shared between social groups will also be subject to an examination of the predicted probabilities, both on its own and in tandem with the drought variable. This variable follows the same pattern of coding as the previous, i.e. highest value equals the highest degree of power shared between social groups. At the highest degree of power-sharing, the predicted probability comes in at 8%. This rises steadily, clocking in at 11% at the centre value. At the least amount of power-sharing, the chance of conflict has doubled from the beginning, at 16%. Neither this variable is affected by drought.

Next I will review random slopes. I specify GCP[15] as a random effect, because it is expected to vary between countries. By doing so, the variable itself becomes significant. Agricultural land and mountainous area experience the same. The model also receives a lower AIC-value when it is done (AIC drops by 125,2). I take this as a signal that the model is more properly fitted when GCP is specified as a random effect. A similar experience is gained when specifying urban area as a random effect. A larger AIC-drop is noted (AIC drops by 185,8). Urban and agricultural area are both significant. GDP-growth also becomes more significant than in similar models. At last I apply population size (in 1000s) as a random effect. Here I also receive a lower AIC (AIC drops by 220,8 from the original model). Agricultural land and urban area become significant. The same does capital distance, mountainous area and GCP. These results indicate that specifying grid-cell level variables as random effects tend to make for a better model fit. It should not be that surprising, as most of these variables are effects of factors of the countries' they are based in.

Lastly, I will consider the model diagnostics of the original model (model 5) in contrast to previous ones. As noted in the beginning, model 6 contains the same number of observations on both levels as models 2 & 3. Although those two models have fewer variables than model 6, I will still primarily compare model 6's AIC-values to those two. The ICC-value will be compared to model 4 and 5 with no problems. Model 6's ICC-value is quite a bit lower than that of model 5. In percentages, model 6 explains 27,5[16] more at the country-level than model 5 does. This ought to be seen as a testament to the country-level variables explanatory power vis-à-vis model 5s'. Regarding the AIC, model 6 has a lower value than model 3 (Difference of 113,7). Considering that model 6 has 3 more variables than model 3, and that AIC prefers smaller models, this is a sign that model 6 should be preferred to model 3. This should be expected because the added variables are thought to explains more of the variance.

Model 6 test two different variables to model 5 – Egalitarian democracy is removed and educational equality and power sharing between social groups are brought in on the country level. Ideally, I would have been able to use these in model 5, but because both of the variables

[15] Noting for the record that GCP and GCP-growth are two different variables.
[16] Calculation: (0,261 – 0,190)/0,261*100.

introduced in model 6 are components of egalitarian democracy, they skew the odds-ratio of egalitarian democracy.

Educational equality has a strong mitigating effect in model 6. The predicted probabilities illustrate the severity of its effect. This seems to support Barnett and Adger (2007) argument which states that education is one major component of human security, as well as hypothesis 8. Hypothesis 8 declares that equal access to basic education is an important factor in mitigating violent conflicts. One could argue that the variable also touches on a states' capacity and will to perform basic services. Nevertheless, hypothesis 8 receives strong support from this result.

Hypothesis 2 states that countries that share political power between social groups are less likely to experience violent conflict. This variables' effect is neither as strong or as significant as educational equality but is still within what was expected from hypothesis 2, and it is mildly significant. Its predicted probabilities are not as strong as educational equality's, but they are still worth noting. Going from 8% to 16% probability, it does indeed increase the chance of conflict. Hypothesis 2 receives support in this analysis. The fact that model 6's ICC is higher than model 5 suggests that the model explains more of the country-level variation.

4.12 Summary of results

What has this analysis found, and what does it mean for the hypotheses? First of all, there is little evidence of climate parameters having strong effects on the occurrence of conflict. The climate variables tend to be non-significant. This is not all that surprising, given the emphasis the contemporary literature puts on the relationship being in-direct and pathways highly complex. I hold that, because of how the relationship(s) are believed to work, these results should not be seen as detrimental to the idea of climate variability- and change being an important factor when it comes to the occurrence of conflict.

The analysis found that areas further away from a country's capital are more prone to violent conflict than areas closer to it. This is evidence for H10, that areas further away from a country's capital are more prone to conflict. Urban areas are less exposed to violent conflict. This suggests that rural areas are more likely to experience violent conflict. The more desolate, understood as far away from the capital, the more risk is at place. Worth noting here is that access to public services based on location is not significant in any of the models. This should cast some doubt on whether a states' ability to perform public services across the whole country impacts the occurrence of conflict. Mountainous area is non-significant in models 3 to 9, making it impossible to view hypothesis 9 as validated. Hypothesis 11, relating to accessibility of public services by location, does not stand as the indicator is not significant at the necessary level.

Neo-Malthusian claims argue that population pressure increases the risk of conflict. Results from the analysis contradict such claims, as it consistently receives a mitigating effect throughout the models. One reason for this could be that state power is greatest in densely populated areas and especially capitals. Capitals tend to have the highest population estimates and bearing in mind that distance to capital has a positive effect on conflict this might ring true. Hypothesis 12, which argues that higher populated areas (in this case grid-cells) are more exposed to violent conflicts is not supported from this analysis. Rather, the trend is that less populated areas more often experience violent conflicts. This is also supported from the results from the urban areas variable.

Exclusion of ethnic groups is a robust explanatory variable throughout the models. The more ethnic groups involuntarily excluded from political life, the higher the risk of violent conflict is. Hypothesis 1 is supported on the basis of these results. One excluded ethnic group is sufficient to view a society as ethnically fragmented, and thus at higher risk for conflict. It could be seen as unlikely that the *number* of excluded ethnic groups matter. Nonetheless, hypothesis 1 is supported based on the evidence presented. Similarly, hypothesis 2, which states that the more social groups share political power in a country, the lower the likelihood of violent conflict, is also confirmed. The variable has a notable alleviating effect on conflict all through the models. Equal provision of public services between social groups also proved to be a strong explanatory variable, rendering support for hypothesis 3. Hypothesis 3 argued that countries which ensured equal access to public services between social groups would reduce the risk of violent conflict. All together these result show that societal cleavages matter for the occurrence of violent conflict.

What about economic factors? Here, the results were surprising considering the theoretical arguments presented beforehand. Gross cell product was not significant, while GDP growth at the country level received a positive and significant effect on violent conflict. The effect was positively correlated with violent conflict, contrary to hypothesis 5. Hypothesis 5 stated that countries which experienced economic growth would be less exposed to violent conflict. This hypothesis does not receive the necessary support in this analysis. Neither hypothesis 4, which stated that richer areas, i.e. grid-cells with higher GCP-values would be less likely to experience violent conflict. The variable was not significant, and the odds-ratio was above 1, which suggests that higher values of the variable lead to higher probability of violent conflict.

Hypothesis 6 argues that countries with stronger protection of property rights are less susceptible to violent conflict. None of the models with the variable included provided robust results for this variable as it was consistently non-significant across all models. The odds-ratio of the variable also stays above 1, conflicting with the H6. Democratic and egalitarian countries were hypothesized to alleviate the chance of violent conflict in hypothesis 7. The egalitarian democracy variable only provided significant results when it was the only country-level variable in model 3. Its effect was within the direction presumed by theory. Hypothesis 7 can however not be confirmed as egalitarian democracy was not significant in the full original model (model 5). Educational equality was shown to have a strong moderating effect on violent conflict in model 6. The variable was only included in model 6 because of issues of multicollinearity. However, the effect of the variable was both strong and significant. Therefore hypothesis 8 is supported.

The next chapter will investigate whether alternating the climate variable of the analysis matters for the results. This will be done through 3 models – one with the first alternative climate variable, the second with the second alternative variable, and the third will use both, but lagged for one year. Doing this will both reveal information with regards to droughts' explanatory power and serve as a robustness-test for the previous models. After that I will perform a mediation analysis where all three climate variables are included. This is done in an attempt to discover in-direct relationships which regression analyses are unable to pick up.

5 Alternative Models

So far, the full original model has been built, where variables have been added gradually. This Chapter will be devoted to testing alternative models to see whether the results will differ from the original models. I have previously investigated what happens with alternative country-level variables in model 6. For reasons of analytical robustness and rigour, I will now review results for models where I use alternative climate variables. These two variables measure respectively temperature and precipitation. Where drought measures a concrete effect of climate variability, these two measures are rather more direct measures of climate parameters. At last, a mediation analysis will be performed as an attempt to measure in-direct effects of climate variables.

5.1 Alternative climate variables

This section of the analysis (model 7 – 9) is devoted to testing alternative climate variables. I do this to infer whether using other climate variables alter the results of model 5. Thus, this also works as robustness-checks. Building on model 5, I use other climate parameters than drought; I begin by substituting drought with temperature in model 7, and precipitation in model 8. Model 9 contains two climate variables. These are lagged variants of the two previously mentioned variables.

5.2 Model 7

The first of the alternative climate variables that I will use is temperature. Besides that, the model is the same as model 5, the full original model. Doing this, I will be able to tell whether the alternative climate variables are to be preferred over the drought variable. Model 7 has 10998 observations over 48 countries, whereas model 8 has 11086 over the same amount of countries. As the difference in observations is only 88, I will allow myself to compare the two models more thoroughly than I've done with previous models. This will however be done with caution.

Model 7 is similar to model 5 both in the variables included and, in the results, gathered from the analysis. The most noteworthy difference with regards to the climate variables is that whereas drought stays non-significant, temperature is significant with a mild positive effect (OR = 1,028). Temperature's effect is somewhat lower than droughts (1,028 vs. 1,346 respectively). Urban area becomes significant in model 7, with the same effect of 0,999. The same applies for excluded ethnic groups, which experiences a dip in its effect of 0,009. GCP becomes significant with an odds-ratio of 1,015.

When it comes to egalitarian democracy, the effect of the variables returns to an area which was expected – the odds-ratio goes below 1, to 0,953. The variable is not significant. Access to public services based on social group affiliation is significant with an odds-ratio of 0,653. Its twin, based on location, is more moderate in its effect and not significant. The same applies to property rights, which still stays above 1 in the odds ratio. GDP-growth is still slightly positive and significant.

Next I will review the predicted probabilities of the temperature variable. The trend is that as temperature increases, the likelihood of violent conflict follows. In the cases where the average temperature over a year is at 5 degrees, the chance of violent conflict becomes 6%. This increases steadily until the highest average temperature, where it lands at a predicted probability of 13%. If the predicted probabilities of temperature are coupled up with the population variable, one can see that as there are fewer inhabitants in a cell, the more likely conflict is. Where the highest likelihood came in at 13% in the single predicted probability, it is at 21% at the highest when in tandem with population.

Model 7's AIC-value is 9290,2. This is a reduction of 83,9 from model 5. Meanwhile, I want to reiterate that model 5 has 88 more observations than model 7, which should make one careful of being to deterministic regarding the two models' goodness of fit. The ICC-value of the model is .254, which is .007 less than model 5. Translated to percentages, model 7 explains 3%[17] more

[17] Calculation: (0,261 – 0,254)/0,261*100.

of the country-level variation than model 5. If I specify temperature to vary between countries, model 7 ends up with an AIC-value 27,2 lower than the original.

Does this give any hints as to which climate variable should be preferred? Not with great certainty. Although one can use the AIC-values to some degree, the difference in observations should mean that one is careful in making any claims. Temperature is significant, with an odds-ratio quite similar to that of drought (slightly above 1). Model diagnostic values were lower than they were in model 5. So far, I can hardly make any definitive statements with regards to the power of the different predictors.

	Model 7		*Model 8*		*Model 9*	
	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE
Grid-Cell Variables						
Temperature	1.028**	*0.009*			1.024** (Lagged)	*0.009*
Precipitation (MM's)			0.999	*0.000*	1.000 (Lagged)	*0.000*
Agricultural Area	1.001	*0.001*	1.001	*0.001*	1.001	*0.001*
Urban Area	0.999**	*0.011*	0.999	*0.011*	0.999	*0.011*
Irrigated Area	0.999	*0.000*	0.999	*0.000*	0.999	*0.000*
Distance to Capital	1.000**	*0.000*	1.000**	*0.000*	1.000**	*0.000*
Mountainous Area	1.003	*0.007*	0.998	*0.008*	1.004	*0.008*
Excluded Ethnic Groups	1.190**	*0.054*	1.213***	*0.055*	1.186**	*0.055*
Gross Cell Product	1.015*	*0.007*	1.013	*0.007*	1.014	*0.007*
Population (1000s)	0.999***	*0.000*	0.999***	*0.000*	0.999***	*0.000*
Country Level Variables						
Egalitarian Democracy	0.953	*0.676*	1.022	*0.678*	0.968	*0.680*
Access to public services, urban/rural	0.802	*0.170*	0.809	*0.170*	0.799	*0.171*
Access to public services, social groups	0.653**	*0.144*	0.644**	*0.144*	0.652**	*0.144*
Property Rights	1.189	0.413	1.273	*0.413*	1.212	*0.414*

GDP-growth (%)	1.006**	0.002	1.006**	*0.002*	1.006**	*0.002*
Educational Equality						
Power Distribution by Social Groups						
Model Stats						
ICC	.254		.255		.257	
AIC	9290.2		9373.0		9290.4	
BIC	9407.1		9490.0		9414.6	
N (Grid-cell-events)	10998		11086		10995	
N (Countries)	48		48		48	

*^ $p < 0.06$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 5.1 Model 7-9: Temperature, precipitation and temperature & precipitation lagged as alternative climate variables. Sources: PRIO-GRID (2019); SCAD (2017); author's calculations.

5.3 Model 8

Model 8 tests the second alternative climate variable, precipitation (measured in millimetres downpour per year). Something to note before I delve into the model and its results here is that precipitation could theoretically have grave effects on a society both by being higher and lower than what is usual. As I mentioned in the previous section, this model has 88 more observations than the previous one, at 11086.

In this model, the climate variable is not significant, with a mild negative effect (OR = 0,999). Urban area is not significant either and keeps it effect from the previous model. Distance to capital, excluded ethnic groups and population stay significant, keeping the direction of their effects. Mountainous area loses its significance, and its odds-ratio falls below under 1 to 0,998.

There is little change in the country-level variables as well. Most variables stay the same, except egalitarian democracy, which now again moves over 1 to 1,022. Access to public services for social groups stays significant with a similar effect. Access to public services based on location keeps its effect and does not fall within any required confidence intervals. Property rights still sits with an odds-ratio above 1 while not being significant.

What so about predicted probabilities? Precipitation on its own gives mild results. Cases where there has been the least precipitation give the highest predicted probabilities, at 10%. The lowest predicted probability comes in at the highest value of precipitation. Here, the predicted probability is 7%. Thus, an overall change of 3% from highest to lowest is found. Next I investigate the same with the variable in tandem with population-size. This time the predicted probabilities vary somewhat more. In the lowest populated areas, with the least amount of precipitation, the chance of violent conflict occurring becomes 17%. For the same area with the most precipitation, the likelihood is at 12%. In the most populated areas, the effect is opposite. Here, when precipitation is at its lowest, the probability of conflict happening is 6%, dropping to 4% at the highest precipitation-cases.

Next in line is random slopes. Specifying precipitation as a random effect between countries brings about an AIC-drop of 220,9. Based on previous discussion of what constitutes a notable drop in AIC, this is a large drop. Doing that also makes GCP, excluded ethnic groups and mountainous area significant. Such a results indicates that allowing the effect to vary between countries lead to a better fit of the data. It does also make the variable drop in its odds-ratio by 0,001, and property rights drops below 1 to 0,825. The original AIC of the model, i.e. before specifying precipitation as a random effect, suggests that the model is less precisely fitted than model 7, although I keep in mind the difference in observations.

5.4 Model 9

Model 9 includes both measures of precipitation and temperature, however this time the variables are lagged by one year. This means that the values for the year 2000 are placed at the row for 2001. I test out this model because the climate of today does not necessarily affect what happens today, but more likely coming times. Deviations in climatic factors might need some time to have their effect, and perhaps even more time for them to translate into violent conflict. This model contains 10995 observations, which is 3 fewer than model 7 and 91 less than model 8.

In this model as well, the results are similar. Temperature and precipitation both gain mild positive effects. Whereas temperature is significant, precipitation is not. Distance to capital is still significant with an odds-ratio of 1,000. Urban and agricultural area both stay within odds-ratios of 0,999 while being non-significant. Mountainous area moves above 1 again, to an odds-ratio of 1,004. GCP stays with a slight positive effect, while population keeps its mitigating direction. Population stays significant, contrary to GCP.

How about country-level variables? Egalitarian democracy moves back down under 1, to an odds-ratio of 0,968. It is not significant. Access to public services based on location is not significant either. This variable receives an odds-ratio of 0,799. The other variable that touches on public service access is however significant, with a mitigating effect (OR = 0,652). Property rights continues to have a positive effect on conflict while not being significant. GDP-growth keeps its significant odds ratio (1,006).

Predicted probabilities reveal that the lagged precipitation variable has little to no effect on the dependent variable. Its value stays the same over the course of variation of precipitation for the previous year. The temperature variable reveals a more varied pattern, although it is not as large as previous patterns found in predicted probabilities. Its lowest predicted probability is found at the lowest value, i.e. where the average temperature has been the lowest. Here, the predicted probability is 7%. When the average temperature increases to 20 degrees, the chance of the dependent variable increases to 9%. At the highest average temperature, which is 35 degrees, the likelihood of violent conflict is 13%. Joining the two climate variables together for predicted probabilities only reiterates that temperature is the variable which has some correlation to the dependent variable.

Specifying the climate variables as random slopes will be done next. First, I use the lagged temperature variable. This yields a drop in the AIC-value from the original model 9 (AIC drops by 49,2). This suggests that the effect of lagged temperature varies between countries, as the model that allows for that variation is preferred over the one that does not. The lagged temperature variable loses its significance, and GCP becomes significant. Egalitarian democracy's odds-ratio drops from 0,968 to 0,646. If precipitation is specified as the same, the AIC of the model drops further, by 185,9. In this case, temperature becomes significant again. The same happens to mountainous area. Property rights' odds-ratio also drops down below 1, to 0,929.

Model 9's AIC-value with no variable specified as a random slope is 9290,4, which is 82,6 lower than the AIC of model 8. Meanwhile, model 9 has 91 fewer observations. As AIC prefers smaller models, it is hard to conclude definitively on which model is to be preferred. Model 9 contains one variable more than model 8. The ICC of the model is .002 more than that of model 8, suggesting that the model explains a tad less of the country-level variation.

Do these alternative climate variables shift the results in any way? The answer is no. Temperature itself is significant with a mild positive effect in model 7. Its predicted probabilities do increase as temperature increases, suggesting that as higher temperatures are measured, the risk of violent conflict increases. One must ask oneself, however; Is it the case that conflict happen where there are higher average temperatures, or are conflict prone areas hotter by chance? Obviously, no causality is detected here. Therefore, with the uncertainty of the direction of the relationship it is impossible to state much with confidence.

The other variables more or less stay the same. In model 7 urban area is significant. This diminishes in the subsequent models. Distance to capital, excluded ethnic groups, population, access to public services by social groups and GDP growth stay the same with regards to significant level and direction of the effects. The results are robust through four iterations of climate variables, which should be seen as a testament to the hypotheses that have gathered support so far. GDP growth continues to have an odds-ratio in the opposite direction of what was theoretically expected. In general, the theoretical claims are occasionally supported, however not consistently. For instance, mountainous area is rarely associated with increased risk of violence, contrary to theoretical claims. Egalitarian democracy received unexpected directions with regards to theory, undermining hypothesis 6.

5.5 Mediation Analysis – Investigating in-direct pathways

This section will be devoted to tests of in-direct relationships between climate variables and violent conflict. By utilizing a mediation analysis[18] I will be able to test whether any of the climate variables have an in-direct effect on violent conflict. As this is a test of an in-direct relationship, there must necessarily be some mid-way variable(s) which the effect "goes through". This variable is called the mediating variable, as it is assumed that the relationship is dependent on the variable for it to exist. I will take advantage of multiple mediating variables, initially economic ones. Both of the model's economic variables will be tested. Doing it this way also allows to test the relationship both on grid-cell- and country-level variables.

I will look at the drought variable first. It is argued in theoretical arguments that one of the mechanisms in which climate change can affect violent conflict is through weakening the economic performance. This can happen both at country-level or in a local scope. I will also see whether the variable has any notable change in power when mediated through excluded ethnic groups and population (in 1000s).

[18] This is done using the Mediation package in R.

	X: Drought *Y: Violent Conflict*	Average Proportion Mediated	P-value
M-1	GCP	1,4%	<0,001
M-2	GDP-Growth	0,01%	0,710
M-3	Excluded Ethnic Groups	0,1%	<0,001
M-4	Population	-0,1%	<0,5

Table 5.2 Results from mediation analysis with the drought variable. The results show the four different mediators of the effect of drought on violent conflict. 1000 simulations were done for each of the mediators.

Generally, the effect is weak. The pathway where drought has the highest effect is through GCP, where the proportion of the relationship mediated is at 1,4%. The relationship is significant at the 1 percent level. As mentioned earlier, conflict is highly complex. The fact that the relationship is highly significant is worth noting although the actual effect is rather low. For the other economic variable, the relationship is quite weaker. It is not significant within any required confidence interval, and the average proportion of the relationship mediated is a slender 0,01%. I take from this that local level variations in drought struggle to have any effect on conflict to the country-level economic performance.

Excluded ethnic groups gives similar results to the grid-cell-level economic variable. The effect of the variable is at 0,1%, while being significant at the 1 percent level. It seems from this that drought in a very small way influences the effect of drought on violent conflict. The size of the effect ought to be emphasized – 0,1 percent is marginal; however, it is significant statistically. Population on the other hand leads to a significant negative effect. It is within the 5 percent confidence interval, with an average mediated effect of -0,1%.

	X: Precipitation *Y: Violent Conflict*	Average Proportion Mediated	P-value
M-1	GCP	0,000%	<0,001
M-2	GDP-Growth	0,000%	<0,001
M-3	Excluded Ethnic Groups	0,000%	<0,001
M-4	Population	-0,000%	<0,001

Table 5.3 Results from mediation analysis with the precipitation variable. The results show the four different mediators of the effect of precipitation on violent conflict. 1000 simulations were done for each of the mediators.

	X: Temperature *Y: Violent Conflict*	Average Proportion Mediated	P-value
M-1	GCP	0,001%	<0,001
M-2	GDP-Growth	0,000%	<0,001
M-3	Excluded Ethnic Groups	0,000%	<0,001
M-4	Population	0,002%	0,76

Table 5.4 Results from mediation analysis with the temperature variable. The results show the four different mediators of the effect of temperature on violent conflict. 1000 simulations were done for each of the mediators.

Testing the same pathways for the two other climate variables, the results are alike. For precipitation, all of the relationships are found to be significant below the 1 percent level. The effects of the relationships are approximately zero, although for the population variable the sign in front is negative, in contrast to the other variables. For temperature, the results vary more.

The pathway through GCP is significant with an 0,01% in-direct effect. Population is not significant with an effect of 0,02%.

Mediation analysis is a suitable way to test in-direct effects between explanatory variable, intervening variable and outcome variable. Based on contemporary arguments this analysis should be more suited to discover such in-direct relationships. Even so, this mediation analysis struggle to discover effects. I have tested all three climate variables on four different mediating variables. Most relationships tested in this analysis are weak – the strongest effect, in average proportion mediated (%), is at 1,4%. This if found with the drought variable, using gross cell product as the mediator. The rest of the effects are below 1%, if not negative.

What does this mean for theory and hypotheses? First and foremost, weak or no evidence is found for the relationships tested between all climate variables. This means that 1) no direct effects are found from the regression analyses, and 2) only one in-direct relationship was found in the mediation analysis. Drought weakly affects gross cell product, which is related to conflict at a low degree. Most variables are significant, but with muted effects. It might be the case that neither this analysis is able to take into account enough important factors. As discussed before, these causal processes and mechanisms are assumed to be highly complex. It is also unknown how big of a role climate variability play. It is typically recognized that it works as an intensifier of other, more conventional drivers of conflict. Perhaps is this the level of the relationships. To ensure that would require a great deal of further research, however.

5.6 Summary of results

This chapter began with test of alternative climate measures in order to investigate whether results would change. Temperature and precipitation replaced drought in respectively model 7 and 8, while model 9 contained both variables, lagged for one year. In general, few changes are noted. Neither climate measure gives any reason to believe that drought is an unsuitable variable to explain the occurrence of violent conflict. Nor lagged editions of the variables proved to yield variation in the results. One could reasonably expect lagged variables to influence the results in some way. While climate variability happens at one specific time, its impact might not be felt for some time. These results should not be taken as further signs that climate variability does not impact violent conflicts. Too much uncertainty is present with regards to temporal scale, unit of analysis and so on. Specifying climate measures to vary between countries prove that the effects does vary based on country.

The mediation analysis did not provide strong evidence for an in-direct relationship between climate and conflict. Although it should, based on theory, be more equipped to detect any in-direct relationships, the results were not able to uncover any strong effects. An extensive test of all three climate variables were conducted on four different intervening variables. Yet, the strongest in-direct effect was found with drought, through gross cell product. The effect was miniscule, with an average proportion mediated of 1,4% (see table 5.2). The rest of the results were weak or non-existent (see table 5.2, 5.3 and 5.4). Based on this, the mediation analysis did not provide any further evidence strengthening the claim of a relationship. Other than droughts' small effect through GCP, the mediation analysis proves fruitless in attempting to reveal a relationship.

The first three models of chapter 5 served two purposes; Tests of alternative climate measures and robustness-tests of the previous 6 models that applied a different climate variable. The results reiterate the findings in the previous chapter. Temperature is the only significant climate variable, with a modest effect. Excluded ethnic groups, access to public services across social groups, distance to capital and population are consistently significant throughout the models. Hypothesis 1, arguing that excluded ethnic groups increase the likelihood of violent conflict, and hypothesis 3, which holds that countries with equal access to public services across social groups are less likely to experience violent conflict are both still supported. H10, that distance to capital is positively correlated with violent conflict is also reinforced. Population size is still negatively related to violent conflict, contrary to H12. These models proved to reinforce the results found in the previous chapter, with miniscule deviations in the results.

6 Conclusion

This thesis provided an exhaustive analysis of the proposal that climate variability has an effect on violent conflict. Through an original understanding and operationalization of the concept of conflict, with a lower than usual threshold with regards to battle-related deaths, I create what theoretically can be understood as a most-likely structure. Because of the unusual death-threshold of the dependent variable, I contribute to a further understanding of low-level conflicts. I also emphatically underline the thesis' focus on climate variability and not climate change. Following the conceptual baseline, the theoretical model is presented.

First, a brief walkthrough of central classic contributors is conducted. I built my theoretical model, starting with cultural arguments, where ethnic divisions and group exclusion are paramount ways in which climatic components can in-directly affect conflict. Economic arguments are next in line. Both at state level and local level, the economy matters. It can impact the effectivity and legitimacy of a state, or it can contract livelihoods and future prospects at the local level. Third are institutional arguments. Here, legitimacy and efficiency of state institutions are of importance. Conflict resolving institutions, for instance, are dependent on legitimacy for them to perform their tasks. Institutions are important also at the local level, where they can perform state-level tasks with greater legitimacy for the locals. Equal educational access is one influential factor for whether young people join violent groups or not. Lastly, geography and accessibility are discussed. Remote areas with tough terrain and weak infrastructure are seen as less likely to experience state services and aid in the same manner as central areas. Mountainous areas are thought to be advantageous to rebelling groups because of tactical benefits.

Focus on low-level conflict and dis-aggregated data should provide a structure wherein correlations between climate variations and violent conflict were found. Considering then the lacklustre evidence with regards to the climate variables themselves, it is clear from the analysis that climate parameters do not directly impact the likelihood of conflict. This is not in itself surprising. Contemporary consensus states that if there is a relationship present, it is in-direct.

The full model reveals some interesting findings. Economic growth at the state level is *positively* related to violent conflict. This contrasts theoretical arguments which state that positive economic performance is related with a reduced risk of violent conflict. One reason for this might be related to the countries included in the analysis. Most countries have weak economies and while their economy grows, the situation can still be perceived as negative. Had I included European countries in the analysis the results could have been different. Distance to country's capital is also positively related to violent conflict, supporting the geographic arguments. As areas get longer away from the capital, the likelihood of conflict increases. Mountainous area does not explain low-level conflicts in a satisfactory way. Contrary to neo-Malthusian arguments, population size has an alleviating effect on violent conflict. The number of excluded ethnic groups are also positively correlated to the likelihood of violent conflict happening, a result which is in line with mentioned theory, i.e. Buhaug, Cederman, and Gleditsch (2014). Here it should be worth considering whether the risk increases as the number of excluded ethnic groups increases or if the effect stays stable. One excluded ethnic group indicate ethnic fragmentation in a society, which theoretically should be sufficient to increase the likelihood of violent conflict.

Alternative explanatory variables in model 6 reveal that equal access to education has a strong mitigating effect on conflict. This supports the arguments presented by Barnett and Adger (2007) which argue that equal access to basic education works as a relieving effect on human insecurity. Education proves to be a strong mitigating factor for violent conflicts. Countries wherein power is shared between different social groups, the prospect of violence becomes lower. From this I gather that not only ethnic groups are important regarding societal tensions and its potential to fuel conflict. It seems that societal cleavages more generally mark a heightened possibility of violence within the sample. Alternative climate variables proved little effect. Results were similar to those in chapter 4, providing further support for the findings there.

A mediation analysis was performed in order to test the in-direct effect of all the three climate variables. These were tested on four intervening variables. Out of the three climate variables, drought had the largest effect through Gross Cell Product with an average proportion mediated was 1,4%. Similarly, to the regression models, there is little evidence of a robust relationship between climate variables, intervening variables and conflict. Further tests should be done with both different climatic variables as well as different mediating variables. Previous case studies could inform choice of mediating variable.

How come the evidence generally is so weak? One possibility is that the relationship is non-existent or as weak as found in this analysis. Another reason can be that the paths climate factors take in order to have an effect are so complex that statistical methods struggle to identify these mechanisms. Not only are the presumed processes highly complex, but there are a multitude of pathways they can take. Which pathway it takes can vary from country to country and region to region. Perhaps was the sample in this analysis to broad. At its lowest the models contained 48 countries with many different climatic and political contexts.

The grid-cells are non-political, artificial units which are insensitive and independent of political boundaries. It is possible that this also matters; the results may have been different had I used administrative regions instead of these non-political entities. Despite that, the non-political nature of the grid-cells bring about advantages relating to circular relationships between the outcome variable and political boundaries. Another challenge relates to the location wherein violent acts take place relative to where the effects of climate variability is experienced. I will provide an example: One grid-cell experience a sustained drought. This drought impacts people living in that cell in a dramatic way which leads these people into action. This action could be protests, public meetings or violence. However, it is not given that that action will be conducted in the same grid-cell. Perhaps is the local big city within a different grid-cell. The main argument is that climate-induced violence does not necessary happen in the grid-cell as the climate factors are felt.

6.1 Future Research

The climate-conflict field is still young and is thus in need of more research. One key area that needs development in the field is the further development of concise theory. At the moment, theoretical arguments more resemble loosely tied suggestions that are translated from other subfields. Inductive qualitative research with the goal of developing dense theory should therefore be conducted. Such qualitative case analyses can also produce greater understanding of the complex mechanisms. Contingent on a stronger connection between the qualitative and quantitative camps on the field, such advancements could help identify key intermediate variables that climate parameters work through.

It will also be important that future research investigate in what ways different climate parameters affect violent conflict. Increased rain or higher temperatures can have different impact in different parts of the earth, depending among other things on geographic features and location. This would require a great deal of cooperation between scientific strands. Biologists, physicists, geographers and social scientists just to mention some, must work together in order to identify the correct mechanisms at the correct places. Specifying where and how various climate factors impact violent conflict would help further the knowledge and potentially help build peace in the long run.

A variety of analytical units should also be examined. Grid-cells, which are completely artificial and non-political in nature are one way with their own strengths and weaknesses. Administrative regions are another avenue for research. Significant contrasts lie between these two units. Administrative areas are inherently political, perhaps even shaped *by* conflict. Others have advocated for an increased focus on households and their livelihoods (Deligiannis 2012). All these units ought to be subject for further analysis. Future research should also be aware of where events take place, as discussed above.

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