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CLIMATE CHANGE AND CONFLICT IN SAHEL

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CONTENTS

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION

AC	Adaptative Capacity
CONASUR	Conseil National de Secours urgence et de Réhabilitation
CVD	Conseiller Villageois de Développement
CVI	Climate Vulnerability Index
EFI	Ethnicity Fractionalization Index
ENCOP	Environmental Conflict Project
FAO	Food Agriculture Organization
FH	Farmer-Herder
GDP	Gross Domestic Product
GECHS	Global Environmental change and Human Security
INSD	Institut National de la Statistique et de la Démographique
IPCC	Intergovernmental Panel on Climate Change
ISIS	Islamic State of Iraq and Syria
IV	Inverse of Variance
LVI	Livelihood Vulnerability Index
NAP	National Adaptation Plan
NAPA	National Adaptation Plan for Action
NDC	National Determined Contribution
ND-GAIN	Notre Dame Global Adaptative Initiative
IOM	International Organisation for Migration
ONAPREGEC	National Observatory for the Conflict Prevention and Management of Community Conflict
PCA	Principal Component Analysis
POLS	Pooled Ordinary Least Squares
TGI	Tribunal de Grande Instance
UCDP	Uppsala Conflict Data Program
UNDP	United Nation Development Programme
USAID	United State Agency for International Development
VCC	Vulnerability to Climate Change

VCD	Villager Councilor of Development
VCLC	Villager Commission of Land Conciliation

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Abstract

This dissertation assesses the effect of climate change on conflict in the Sahel. The first chapter reviews the major types and drivers of community conflict in Burkina Faso, from 2015-2022, highlighting land use disputes and farmer-herder tensions. The study finds that climate change act as a threat multiplier of community conflict in Burkina Faso in particular land-use disputes and farmer-herder conflict. In addition, some socio-economic factors affect the occurrence of community conflicts. This result implies that policies should address the social, political and institutional weakness that allow environmental stress to escalate into conflict. The second chapter investigates the effect of climate change vulnerability on farmer-herder conflicts. For this purpose, we constructed household-level vulnerability index to climate change from our survey data. By employing mixed methods using quantitative analysis and qualitative data description, we find that quantitively vulnerability to climate change positively influences farmer-herder conflict. This finding is confirmed with qualitative data description since both farmer and herder reveal that the degree of their vulnerability explains the emergence of conflicts. Then, when elaborating policies that can reduce farmer-herder conflict regarding their vulnerability, effort should be focused on increasing farmer-herder resilience via-a-visa of climate change effect and mitigate climate change effect, promote tolerance for social diversity, and support stakeholders (who intervene in conflict management).The third chapter investigates empirically the role of migration as a mediator in the vulnerability to climate change and internal conflict nexus. By employing structural equation modelling, the study finds that vulnerability to climate change affects directly conflict and that 73.5% of the total effect operates through migration channel. This means that migration plays a partial role in the transmission of conflict in the Sahel. Since vulnerability to climate change affect directly conflict in Sahelians countries, police response should focus on reducing climate vulnerability through adaptation measures. Together, the dissertation contributes to the literature on climate security by offering empirical evidence from a vulnerable region and provides policy recommendations to address emerging climate security risks.

Key Words: Burkina Faso, Climate change vulnerability, Community conflict, farmer-herder conflict, internal conflict, land-use disputes, migration, structural equation modeling, Sahel

Résumé:

Cette thèse évalue l'effet du changement climatique sur les conflits dans le Sahel. Le premier chapitre passe en revue les principaux types et facteurs des conflits communautaires au Burkina Faso, en mettant en évidence les litiges fonciers et les tensions entre agriculteurs et éleveurs. L'étude révèle que le changement climatique agit comme un multiplicateur de menaces des conflits communautaires, notamment les différends liés à l'usage des terres et les conflits entre agriculteurs et éleveurs. Ce résultat suggère de s'attaquer à la faiblesse des institutions, des politiques et du sociale au stress environnemental de se dégénérer en conflict. Le deuxième chapitre examine l'effet de la vulnérabilité au changement climatique sur les conflits entre agriculteurs et éleveurs. À cette fin, nous avons construit un indice de vulnérabilité au changement climatique au niveau des ménages à partir de nos données d'enquête. En utilisant une méthode mixte combinant une analyse quantitative et une description qualitative, nous constatons que, de manière quantitative, la vulnérabilité au changement climatique influence positivement les conflits entre agriculteurs et éleveurs. Ce résultat est confirmé par les données qualitatives, car tant les agriculteurs que les éleveurs affirment que le degré de leur vulnérabilité explique l'émergence des conflits. Le troisième chapitre examine empiriquement le rôle de la migration comme médiateur dans la relation entre la vulnérabilité au changement climatique et les conflits internes. En utilisant la modélisation par équations structurelles, l'étude révèle que la vulnérabilité au changement climatique affecte directement les conflits, et que **73,5 %** de l'effet total s'opère par le canal migratoire. Cela signifie que la migration joue un rôle partiel dans la transmission des conflits au Sahel. Dans l'ensemble, cette thèse contribue à la littérature sur la sécurité climatique en apportant des preuves empiriques issues d'une région vulnérable, et propose des recommandations politiques pour faire face aux risques émergents liés à la sécurité climatique.

Key Words: Burkina Faso, Vulnérabilité au changement climatique, Conflict communautaire, conflict agriculteur-eleveur, conflict armé interne, conflict foncier, migration, modélisation en équation structurelle, Sahel.

GENERAL INTRODUCTION

I. BACKGROUND

Africa has experienced a significant rise in conflict, both within states (intrastate conflict) and between states (interstate conflict). These conflicts vary by region and include civil war[1], terrorism movement[2], coups[3], ethnic[4] and religious[5](ongoing) conflict, Insurgency in Magreb, Erithrea-Ethiopia territorial dispute (Horn of Africa), as well as Environmental conflict such as Lake Chad Bassin conflict and in some instance post-electoral crisis[6](Collier & Hoeffler, 2007; Emeka et al., 2024; Ezeoha et al., 2023; Fang et al., 2020; Percival & Homer-Dixon, 1996; Siri, 2024). These events and disparities reflect the complex nature of conflict on the continent and have lot of consequences. These impacts include economic destabilization, displacement, loss of human life, contributions to weak state, long term instability, famine, and poverty. Then, conflict constitutes challenges for sustainable development, when strategic resources are difficult to protect during conflict.

Understanding factors affecting conflict has been a major focus of social science research. For example, economies and social inequalities, market shocks, price volatility, migration are among others the keys traditional factors affecting conflict(Collier & Hoeffler, 2004; Dube & Vargas, 2013; Gurr, 1970; Ongo Nkoa et al., 2024; Østby, 2007). Several policies have been implemented following the previous thought in developing countries including Africa to reduce conflict by reducing social distortion, integration of ethnic minorities, women and others vulnerable peoples(Ongo Nkoa et al., 2024). This is unfortunate that despite these efforts, 2023 emerged as the third most violent year since the Cold War, according to data from the PRIO/Uppsala database(Siri, 2024) and notably at continent scale, Africa is a continent with most state-based conflict.

In the recent literature, few reflections existed on additional factors that reinforce or affect conflict. Without being exhaustive, some researchers, high-ranking policymakers and institutions blame climate change(Buhaug & Von Uexkull, 2021; Issifu et al., 2022; Selby et al., 2017). Climate change is suggested as an additional factor that reinforces conflict in the countries with

[1] In Nigeria(1967-1970),Rwanda(1990-1994),Congo(1998-2003), Somalia(1991)
[2] In the Sahel and in Burkina Faso(2015-ongoing)
[3] In Burkina, Gunea, Mali, in niger and etc
[4] In Burundi(Hutu and Tutsi)
[5] Boko Haram in Nigeria
[6] Keneya, Cote d'Ivoire

predominately agrarian economies because of production instability resulting from climate shocks undermining the livelihoods of large segments. That can be the case of Sahel and Africa countries where most people derive their income and food supply on rain-fed agriculture (FAO, 2017). Then, climate change will intensify on the one hand competition for scarce resources and could be source of tension between users, and the other hand climate change will cause migration with associated conflict in the receiving areas(Crost et al., 2018a; Fjelde & von Uexkull, 2012). Thus, the debate on the genesis of violence becomes even more diverse and is no longer focused on political, geopolitical, cultural or religious reasons and ideologies. Scarcity, soil degradation, migration combined with natural disasters (flooding, drought, etc) caused by climate change and its variability on vulnerable locality as attracted attention to explain current conflicts.

Climate change through its impacts constitutes a threat for development (Mbaye & Signé, 2022; Baarsch et al., 2020; Barnett & Adger, 2007a). These threaten will be most important on the dry regions on the world and in Africa in particular(Baarsch et al., 2020b; Buhaug, 2015; Koubi, 2019a; Nagano & Sekiyama, 2023). Africa is projected to be seriously impacted due to its geographical risks, low income, greater reliance on sensitive-sectors and weak capacity to the changing of climate (Abidoye & Odusola, 2015). For example, a study by Dang & Trinh, (2022) in 166 countries concludes that higher temperature and poverty are positively correlated. Indeed, an upward variation of the temperature of 1°C leads to a 2.1% increase in the poverty rate. In Africa, survival from natural disasters and poverty are linked. According to the report by CEA, (2023), for any natural disaster occurring over the period 1995-2020, the number of poor households increased by 4.4% percentage points. A report by OIM, (2024) shows in sub–Saharan Africa climate change contributes to the reduction of GDP rate by 34% between 1961 and 2023. A study by Abidoye & Odusola, (2015) in 134 countries shows that an increase in temperature provokes a decrease of gross domestic product (GDP) growth by 0.67 point of GDP. In doing so, a deviation of the temperature from its normal pattern has at least two non-contradictory effects. The first is a decline in the economic performance of the state and the second is a decline in the welfare of households.

Furthermore, climate change and variability will impact sectors overall, and the effect will be pronounced in the agricultural sector (agriculture, livestock and forestry, and fisheries) and the impact will be greater in the most vulnerable regions, such as Africa. Then, climate change and variability could exacerbate food insecurity, poverty and migration patterns. Zougmoré et al.,

(2016) concluded that due to phenomenon resulting from climate change we should expect a reduction of 40% of the cereal production in West Africa. In addition, agriculture has the specificity of being the main source of income in Africa, making any shocks to this sector contribute significantly to increasing the vulnerability of its workers. In Burkina, Ouedraogo, (2012) found that an increase in 1°C temperatures lead to a 3.6% drop in agricultural income. Thus, in a context of low adaptive capacity, the development of the agricultural sector is subject to the dictates of climate change and variability, because the policy makers have insufficient control on climate change and vulnerability, even though it remains important and crucial for the economic growth of most African countries.

Scholars largely agree that climate change itself does not cause conflict, but it plays the role as a threat multiplier that exacerbates the existing social, economic, and political tensions. For example, Burke et al. (2009a) argues that water shortage and crop failure resulting from climate led to disputes between natural resources users and increased tensions in the Sahel and the Horn of Africa. Theoretical arguments (include Eco-scarcity theory and Tragedy of commons) and empirical evidence (around academy circle) have been advanced to explain whether climate change is a potential source of violent conflict onset.

- ✓ Concept of climate change and history

In the literature, there are plenty of researchers who defined the concept of climate. However, the definitions of climate change that much encountered in the literature are those from United Nations Framework Convention on Climate Change (UNFCC) and Intergovernmental Panel on Climate Change (IPCC). According to UNFCCC (1992), climate change means "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere." From IPCC (2001) point of view climate change refers to long-term alterations in temperature, precipitation, and weather patterns resulting from natural processes or human activities. In their Assessment report of 2014, IPCC (2014) give another definition of climate change as "a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longe

One can repartit the evolution of climate change in three periods, the pre-industrial period, the industrial period and the contemporary period

During the agriculture revolution and the period before, the climate variation followed the natural and cyclical influenced by volcanic activity, solar radiation and the earth movement called Milankovitch cycles (Ruddiman, 2001). In 19th century, John Tyndall (1859) demonstrated that water vapor and CO_2 absorb infrared radiation, while Svante Arrhenius (1896) was pioneers to calculate that doubling atmospheric CO_2 could increase global temperatures by several degrees Celsius. Then, the century marked a turning point in understanding the role of greenhouse gases.

The Industrial Revolution period is characterized by the massive fossil fuel consumption. Some authors including Steffen et al. (2015) argues that this period was marked by a significant increase of greenhouse gas emissions provoked by the burning of coal, oil and gas for energy and manufacturing. (Callendar, 1938) was the pioneer to establish the empirical evidence of human-induced warming and find the correlation between rising CO_2 levels and global temperature.

After the second war ii, la reconstruction de l'europe detruite par la guerre et la course a l'industrialisation a contribué a l'acceleration de l'expansion dans l'accumulation du CO_2. Durant cette période, the climate concerns remained largely confined to the scientific community. The establishment of the intergovernmental Panel on climate change in 1988 institutionalized climate science and produced the first global assessment report in 1990, confirming that human activities were influencing the global climate (IPCC, 1990). The Kyoto Protocol (1997) represented the first global effort to limit greenhouse gas emissions.

The twenty-first century has seen intensifying climate impacts such as heatwaves, droughts, rising sea levels, and extreme weather events. The Paris Agreement (2015) set a global goal to limit warming to well below 2°C, ideally 1.5°C, above pre-industrial levels(UNFCCC, 2016). The IPCC's Sixth Assessment Report declared with high confidence that climate change is "unequivocally caused by human activities." Current CO_2 concentrations exceed 420 ppm — the highest in at least 800,000 years (WMO, 2023). Without rapid decarbonization, models predict global warming of between 2.5°C and 4.5°C by 2100, leading to irreversible changes in ecosystems, biodiversity, and human livelihoods (IPCC, 2021).

- ✓ The Eco-scarcity theory

Scholar such Thomas Malthus observed the linkage between resources and population evolving at different rates. The resources had a slower growth than the evolution of the population. As result, this imbalance between resources and the number of mouths feed has consequences such as famine, societal collapse and conflict. The Malthusian idea has been expanded by several authors such Homer-Dixon to establish the link between environmental change as well climate change and conflict through Neo-Malthusian. Neo-Malthusian theory of conflict around Homer-Dixon (1999) is named also eco-scarcity theory. Homer-Dixon (1999) argued that environmental stress[7] as well as climate change could lead to community conflict and political instability. Indeed, resources such as water and arable land, become scarce due to population growth or climate change intensify competition. The competition could manifest in migration, tensions, and violent conflict where there a weak governance. The pathway that climate change can lead to conflict can be direct or indirect. Direct link, it's when competition for controlling scarce resources such as water and arable land finishes to violence between those who drive their livelihood on these resources (including farmers and herdsmen). Indirect link, it is when environmental stress leads to economic downturns, weak state or institution, push people to migrate and create conditions for conflict. In theory, Homer-Dixon hypothesized that: Firstly, he assumed that decreasing supplies of physically controllable environmental resources, such as clean water and good agricultural land, would provoke conflicts. Secondly, he stated that large population movements caused by environmental stress could induce "group-identity" conflicts, especially ethnic clashes. The third hypothesis suggested that severe environmental scarcity simultaneously increases economic deprivation and disrupt key social institutions, which in turn could cause "deprivation" conflicts such as civil strife and insurgency.The mechanism through which environmental contribute is explained by Figure 1.

[7] Environmental stress refers to the negative impact of environmental factors on entire ecosystems

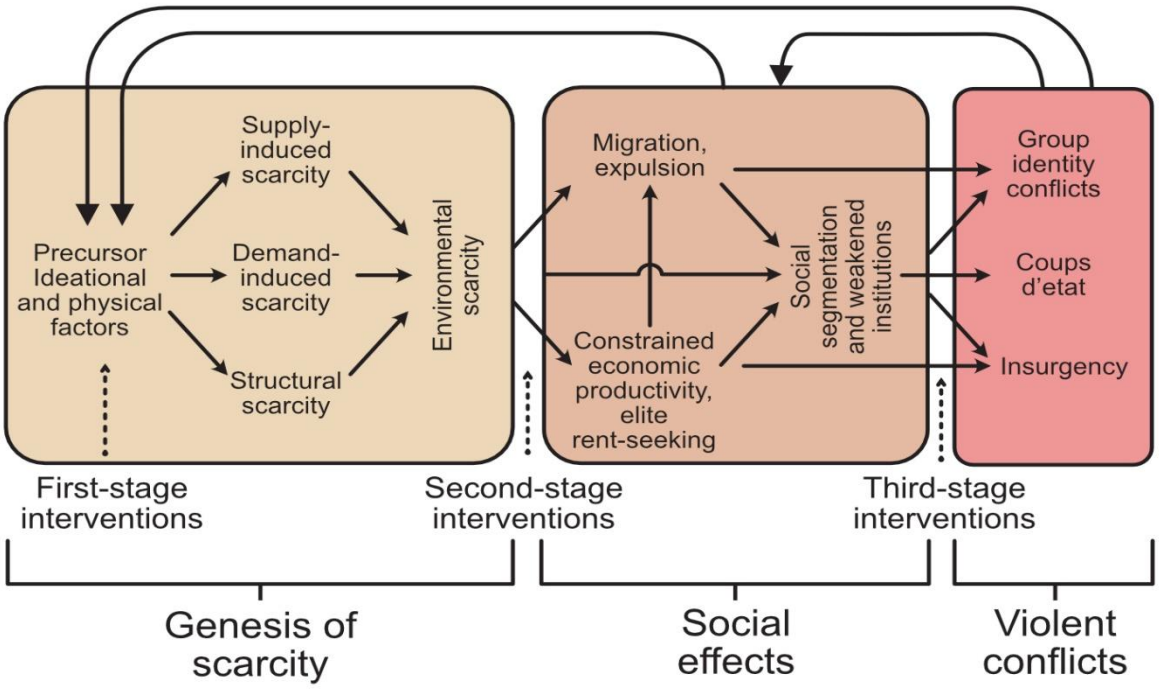

Figure 1: Mechanism through which environment scarcity affect conflict

Source: Homer-Dixon(1999)

✓ Theory of the tragedy of commons

The tragedy of commons is the theory of Hardin, (1968). Hardin's theory describes a phenomenon of overexploitation of the limited resources belonging to a given society. This competition between actors for access to a common resource thus creates a conflict between individual and collective interests. To describe his theory, Hardin starts with a grazing situation. The sharing pasture is opened to everyone. Without constraint on entry, it is hoped that each herdsman will enter as many cattlemen on the commons as possible. This decision to add cattle is more guided by a rational choice. Indeed, additional cattle have two contradictory advantages whose sum is non-zero. The first, positive one, goes to the owner of the cattle since he alone receives all the profits from the sale of his animal. The second, negative one, is the effect of overgrazing that shared by all the herdsmen. Under these circumstances and lack of remorse for the costs being passed on to others, the dominant strategy of each herdsman is to continually add an animal. That's the tragedy. Ruin in this case is the forgone destination in a society where individuals pursue their individual interests in the management of public goods.

Beyond theoretical arguments, empirical evidence advanced around academy circle in explaining environmental change as well climate change and conflict.

- ✓ Bächler and Spillmann's Zurich-based academy circle

This academy circle is led by Spillmann & Bächler, (1996). The two conducted research through a project named Environmental Conflict Project (ENCOP). The objective of the project was to explore the link between environmental stress and armed conflict in developing countries. Their research was based on qualitative cases on 40 environmental conflicts on several developing countries and the main assumption is environmental change does not directly cause conflict, but it plays an indirect effect on pre-existing socio-economic tension. The categories of conflict on their analyses included Centre-Periphery conflicts, Ethno-ecological conflicts, Regional, cross-border and demographically induced conflict, migration conflict, international water conflict and conflict arising from distant sources. ENCOP provided insight on how and why conflict emerges in specific contexts. Their approach is still impactful in academic and policy discussion regarding environmental security and conflict prevention, but their study has been submitted to several critiques. In response to various critics on their analysis, they advices the coming studies to develop additional approaches. Then, Gleditsch, (1997) concentrated on quantitative analysis of environmental factors and conflict while Matthew conducted the Global Environmental change and Human Security (GECHS) project focused on adaptive capacities of communities facing environment changes.

- ✓ Gleditsch's the Oslo-based academy circle

Gleditsch is a pioneer to use quantitative methods to analyze the link between conflict and environmental factors. The objective is to uncover the complex relationships between environmental factors and armed conflict and the work of this group of thought went beyond case studies and allows for a more global perspective on environment conflict. By collecting data from various sources including Uppsala Conflict Data Program (UCDP), Food Agriculture Organization (FAO) and World Bank, the group around Gleditsch find that resource scarcity can increase the risk of armed conflict in the area where economic and social vulnerability are pronounced. The

group of researchers has been criticized for their methods used. Indeed, scholars argue that quantitative methods may overlook the complexity and context-specific nature of conflicts that qualitative studies emphasize. Gleditsch quantitative methods and the followed critiques open the door for the further research to combines quantitative and qualitative methods.

- ✓ Richard Matthew's Irvine-based academy circle

Irvine group led by Matthew uses a distinctive approach compared to other previous research groups to study the link conflict- environmental stress and human security. This group concentrated their research on human security approach to understanding conflict in the face of environmental stress in the project Global Environmental Change and Human Security (GECHS). Then, the main hypothesis of this group of researchers is that environmental stressors such as climate change, resource depletion, and natural disasters, can undermine human security in vulnerable communities and increase the likelihood of conflict. By combining both qualitative insights and quantitative approach to nuance their view, the group of Matthew et al.(2003) finds that environmental degradation such as climate change, resource scarcity and natural disasters acts as a "threat multiplier", intensify the existing socio-economic vulnerability and increase the risk of conflict. The group emphasizes that societies in which people struggle to adapt to environmental stress combined with lack of strong institutions, lack of economic opportunities and social cohesion are more expose to conflict risk.

- ✓ Human Security and Climate Change Scholars

The key authors of this group of research are Barnett, (2001) and Adger et al., (2005). The objective of this group of scholars is to find the pathway through which climate related to environmental change included sea level rise, drought, resource scarcity affect security of vulnerable societies in the Global South. They assume that climate change acts as a threat multipliers, worsening the existing socio-economic and political vulnerability that increase the risk of instability, migration and conflict. As Irvine research group around Matthew, they use hybrid method, quantitative and qualitative. Barnett's 2001 wanted to know how environmental changes undermine state functions and resilience of communities and Adgers's 2005 focused on the adaptative capacities of communities and how institutional networks can mitigate or amplify the effect of environmental stress. They conclude that climate change does not cause directly conflict

but exacerbates the existing vulnerability. These scholars argue that conflict arises in th area with poor governance, weak institutions, significant social inequality and climate stress increase competition for scarce resources.

- ✓ Climate Change and Security Research Group

The main authors of this group of research areGleditsch, (1997), Buhaug, (2016), Theisen, (2012), Salehyan & Hendrix, (2014). These authors look to know how climate change can influence conflict risks in fragile regions. The main hypothesis of this group of research is that climate change acts as a threat multiplier rather than cause direct conflict. They argue that climate change can worsen competition for scarce resources, increase migration pressure and weaken states institution that can increase a risk of conflict in fragile regions. By combining qualitative and quantitative methods, the group of researchers finds that climate change alone does not cause conflict. A climate change and security research group argue that region with weak governance, poor resources management, and inequality are most vulnerable to climate conflict. For them, the link between climate change and conflict depends on contextual factor.

- ✓ Agreement and divergence between groups of researchers

The group of researchers all significantly contributed to understanding the link between environmental stress as well as climate change and conflict. The scholars agree that environmental as well climate may play a role on conflict onset, but the mechanism differ du to context dependent factors such as inequalities, weak state, poor governance, poverty, and poor resource management.

However, authors diverge mainly when it comes to the methodology design, level analysis. Indeed, the group of Gleditsch are concentrated on quantitative approaches others on qualitative approach(Bächler and Spillmann's Zurich) and others combining the qualitative and quantitative approaches Richard Matthew's Irvine)

II. PROBLEM STATEMENT

In the economic literature on conflict, scholars such as Collier and Hoeffler (2004) argue that variations in conflict incidence can largely be explained by changes in economic conditions. Their central finding is that economic downturns, marked by declines in growth, income instability, and

production shocks lower the opportunity cost of violence and consequently increase the likelihood of conflict. In agrarian economies, these economic downturns are strongly shaped by environmental stress, especially climate change, which disrupts agricultural production and rural livelihoods (Abidoye & Odusola, 2015; Percival & Homer-Dixon, 1996; Tsomb et al., 2023).

Countries with limited adaptive capacity such as many in Africa tend to experience high climate vulnerability. This vulnerability affects resource availability (arable land, water, pasture), heightens competition over shrinking resources, and can trigger migration to more favorable areas, which may generate conflict in receiving regions (Barnett & Adger, 2007; Ide, 2017). From the microeconomic perspective, the theoretical framework initiated by Becker (1968) and extended to conflict studies by Urdal (2005) and Vestby (2019) posits that climate-induced economic losses reduce individuals' opportunity costs, thereby making participation in violent activities more attractive relative to peaceful livelihoods. These mechanisms are particularly salient in Sahelian countries, where climate pressures coincide with widespread poverty, livelihood instability, and rising armed violence (Arnall, 2023; Siri, 2024).

However, this narrative is subject to significant theoretical controversy. While some scholars find that climate change increases conflict risk, others argue that the relationship is weak, indirect, or context-dependent, emphasizing the role of institutional quality, social cohesion, and governance capacity in mediating climate impacts. For instance, Buhaug (2010) rejects strong climate–conflict links, suggesting that conflict is primarily driven by political and socio-institutional factors rather than environmental shocks. Similarly, Theisen (2017) finds no systematic evidence that scarcity alone triggers violence, arguing instead that state weakness and exclusionary governance play a more decisive role. This debate remains unresolved, making empirical analyses in highly exposed countries both necessary and timely.

Against this background, Burkina Faso represents a critical empirical case. As a landlocked Sahelian country whose economy depends heavily on agriculture, it faces repeated climate shocks, erratic rainfall, prolonged droughts, land degradation, and rising temperatures (Burkina Faso, 2021). Approximately 63.4% of the labor force is employed in agriculture, livestock, fisheries, or hunting, with limited economic diversification (INSD, 2019). Climate shocks therefore impose severe constraints on livelihoods, contributing to poverty, food insecurity, financial stress, and

distress migration. These conditions destabilize human security and intensify competition for natural resources, particularly between farmers and herders, fueling a rise in farmer–herder conflicts (Cabot, 2017; Issifu et al., 2022; USAID, 2014).

Moreover, Burkina Faso is experiencing a deteriorating security landscape marked by the expansion of armed non-state groups, particularly in zones with low agricultural productivity. Evidence such as the Save the Children (2021) study shows that economic deprivation, social marginalization, and the need for protection are key drivers of youth recruitment into extremist groups—factors closely linked to climate-driven livelihood decline.

Given these dynamics and the ongoing theoretical controversies, there remains a lack of consensus on whether climate change directly fuels conflict, indirectly increases conflict risk through socio-economic channels, or only become violent when combined with weak governance and institutional fragility. This makes it essential to conduct context-specific studies in climate-exposed countries such as Burkina Faso.

This research therefore seeks to provide a more nuanced understanding of how climatic and non-climatic factors interact to shape conflict dynamics in Burkina Faso and the wider Sahel. By doing so, it contributes to the broader academic debate and provides insights into designing effective policies to mitigate climate-related conflicts in fragile environments.

III. RESEARCH QUESTIONS

The PhD research is guided by a central question: Does climate change affect conflict in Sahel?

The sub-questions are:

-What are the sources of community conflict in Burkina Faso and how others are resolved?

-Does climate change vulnerability affect farmer-herder conflict in Burkina Faso?

- Does climate change vulnerability affect conflict through migration in the Sahel.

IV. OBJECTIVES

The main objective of this dissertation is to assess the effect of climate change on conflict in Africa.

Specifically, we aim to:

O1: Explore the source of community conflict in Burkina and analysis the mechanism trough which others are resolved.

O2: Assess the effect of climate change vulnerability on farmer-herder conflicts in Burkina Faso

O3: Estimate the effect of vulnerability to climate change on conflict through migration channels in the Sahel.

explore the underlying source of community conflicts in Burkina Faso and to analyze the mechanism through which others are resolved

climate change vulnerability refers to the degree to wich a system is able or unable to cope with, adverse effects of climate change, including climate change variability and extreme

Conflict is defined as a contested incompatibility that concerns government and/or territory where the use of armed force between two parties results in at least 25 battle-related deaths in a calendar year"(N. P. Gleditsch & Nordås, 2009)

Community conflict is defined here as a disputes between social group over community of interest or over access to shared resources (Burkina Faso, 2018; Raleigh & Kniveton, 2012)

According to International Organization for migration (IOM), migration(international) is the movement of a person or group of people across an international border (voluntary or involuntary).

V. HYPOTHESIS

Principally we assume that climate change has a positive effect on conflict in Africa

Hypothesis 1: community conflicts are influenced by socio-economic factors and climate change.

Hypothesis 2: climate change vulnerability affects farmer-herder conflicts in Burkina Faso

Hypothesis 3: vulnerability to climate change affects conflict in the Sahel via migration.

VI. DATA AND METHODS OF ANALYSIS

To study conflict, economic literature proposes various methods. The most common are Formal game theoretic modeling, Empirical models using various econometric techniques, Laboratory, and field experiments with human subjects. Linking to climate change the most Common method is an econometric technique (Ide, 2017). To assess the impact of climate change on conflicts, the literature proposes linear regression methods, logistic regressions, regressions

based on structural equations, a Bayesian analysis, and Agent based modelling of environmental conflict methods. As part of this thesis, we will opt for both linear regressions methods and structural equation model. To conduct empirical tests of our hypothesis, we use both primary and secondary data. For the primary source, we conducted a survey at household level (farmers and Herdsmen) to collect information on the keys variables. The survey period covered from November to December 2023, and 440 households has been surveyed. The selection process was based on the combination of stratified sampling(by conflict intensity and occupation) and randomly sampling(to choose villages and households). For secondary, conflict data collected by the PRIO/Uppsala is used. PRIO/Uppsala conflict database is most used in conflict research (Gleditsch, 2012, Shawn et al., 2022; Tsomb et al., 2023; Ongo et al 2024). The conflict data from PRIO/Uppsala used in this study is the last version updated on their website in 2024 And other control variables came from other sources including Notre Dame Global Adaptation Initiative, United Nation, World Bank. All the data has been downloaded in 2024.

VII. THESIS STRUCTURE

In addition to the general introduction, this dissertation is organized into three chapters, and each addresses a critical aspect of the research topic. The chapter 1, examine the current state of community conflict within Burkina Faso. Chapter 2 explores how climate change vulnerability influence conflict between farmers and herdsmen. Chapter 3 investigates how climate change vulnerability influences migration patterns and contributes to conflict. Finally, we will end the dissertation with a general conclusion

CHAPTER 1: SOURCES OF COMMUNITY CONFLICT IN BURKINA FASO

Abstract

Burkina Faso has been most affected in recent years both by violent and non-violent conflicts, including increasing terrorist attacks, community conflicts, coups, popular insurrections, and political crises. This series of events along with the diversity and multiplicity of violence has exacerbated the pre-existing disparities within Burkina Faso and the country has been seriously affected. Under such circumstance with the context marked by climate change impacts that could intensify the competition for scarce resources, this study offers a first systematic analysis of the sources of community conflicts in Burkina Faso. It conducts literature reviews on community conflicts to assess factors influencing them. It also analyzes the different institutions involved in conflict management. We collected and analysis of community conflicts data, 2015-2022, from

national observatory for the prevention and management of community conflicts. Findings show that communities conflicts are a serious issue in Burkina Faso and offers evidence that phenomena resulting from climate change act as a threat multiplier on the conflict such as land use conflict, water use disputes and farmer-herder conflict. Other contributing factors are socio-economic conditions and structural including cultivation of pastoral zones, land tenure insecurity, obstruction of pastoral routes, government projects. We find also that, in the process of conflict management, people prefer to use the traditional methods. The evidence in this study can be used by policymakers to prevent community conflicts in Burkina Faso. Since the traditional conflict management is commonly used approach, the study calls for improving these methods to enhance their effectiveness in conflict resolution.

Keywords: Burkina Faso, climate change, communities conflicts, conflict.

management, violence

1. Introduction

Conflict in the Sahel part of Africa is more recurrent, popular and sometime with climate change footprint. At country level, Burkina Faso is most affected both by violent and non-violent conflict in the recent years by the increasing attacks of terrorism group, community conflicts, coups, popular insurrection, political crisis(Burkina Faso, 2018; Tsomb et al., 2023; USAID, 2014a).This series of events and, diversity and multiplicity of violence have exacerbated the pre-existing disparities within Burkina Faso and the country have seriously affected. In the economic literature conflict impact are abundant(Collier & Hoeffler, 2004; Emeka et al., 2024; Ezeoha et al., 2023; Fang et al., 2020). These impacts included loss of human life, destruction and degradation

socioeconomic infrastructures, degradation social cohesion due to ethnic stigmatization, exacerbated the existence education and health challenges with 2000 schools closed, change of political regime (five presidents in 8 years) and more than 40% of the territory under terrorist influence and massive internal displacement(UNDP, 2021).

In addition, most terrorism attacks occur in agriculture and mining area (strategic resources) that impact economic growth and reduced production yield (Adele Orosz, 2021). Under such condition the achievement of sustainable development objectives seems to be improbable because the current situation of this recent decade reinforced the vicious circle of poverty[8](objective 1: No poverty), favorized precarious living condition[9](objective 2 & 12: Zero hunger and responsible consumption and production), reduced access to healthcare and schools[10](objective 3 et 4: Good health and well-being and Quality of education), deterioration of social cohesion due to ethnic stigmatization, more than 2 million displaced due to terrorism attack (objective 16: Peace, Justice and strong Institution). Then, conflict impose socioeconomics condition that is highly unfavorable for achieving strong growth needed for the country development (Abadie, 2006; Baah & Lakner, 2023; Collier & Hoeffler, 2007; Emeka et al., 2024). Conflict contributed in Burkina to reduce the economic contribution of peripheral areas and exacerbate the violence between farmers and herdsmen and natural resource scarcity could plays a central role in the dynamic of violence.

Conflicts researchers nowadays agree that conflict, violent or not, is a multidimensional phenomenon, and its recurrence depends on context-specific factors such as institutional, social, economic, historic and in a specific area, climate change may have its footprint. For example, in area such as Sahel marked by climate arid, recurrent phenomenon resulting from climate change and human negative action lead to harsh dry spells. As consequence, severe decrease in production (agriculture, livestock), food insecurity, and dispute over remaining natural resources due to the higher level of land degraded, low agricultural productivity. This seems to cover some aspects of what researchers prophesied in climate change conflict literature. In fact, theorists hypothesized that climate change impact could increase land, water users' competition, deprived users will

[8] According to the INSD, the poverty rate rose from 40.1% in 2014 to 43.2% in 2021

[9] One over two households reported being worried about not having enough food, and 30.8% of the population is undernourished (INSD, 2018)

[10] According to the International Peace Institute (2021), more than 2,000 schools were closed.

engage violence, fuel anti-state grievance, deteriorate governance in a weak state, cause migration with conflict in the host area. Then, one can conclude that climate change impact is likely to cause intrastate conflict rather than interstate conflict.

Intrastate conflict is the most prevalent conflict in this century and Burkina Faso seems to be crucial case study in the context where disputes are unfolding in the serious climate change challenge (Siri, 2024). The objective of this study is to analyze the incidences and drivers of the community conflicts in Burkina Faso. To the best of knowledge, there is lack of study to explore the sources of community conflict within Burkina Faso in the context of climate change. It contributes to the wider literature on community conflict by providing synthetic empirical evidence and provides understanding of the factors affecting community conflicts. It is organized as follows: section 2 explains the method used. The section 3 analyses the types of community conflict and related causes in Burkina Faso. The section explains the climate change in Burkina Faso. The conflict resolution methods in Burkina. At the end we conclude.

2. Methods

Data and Selection of studies

For this study we considered the data on community conflicts reports by the National Observatory for the Conflict Prevention and Management of Community Conflict (ONAPREGEC). We choose the ONAPREGEC data because it has the advantage to cover all the Burkina Faso regions. ONAPREGEC is a national non-jurisdictional monitoring, alert, and intermediation structure, responsible for contributing to the prevention and peaceful resolution of conflict. It was created by the government decree in 2015, and they didn't have a website, so their reports are printed. Then, the annual community conflict report data started from 2015 to 2022. ONAPREGEC data is useful to understand the phenomenon, but it must note that, it misses to consider all community conflict that happened in Burkina Faso during a civil year because they do not have their representative in all village of Burkina Faso. To overcome this, they use the conflict

which has been recorded at the level of the departmental courts of the provinces where they do not have a representative. As consequence, loss of some data at village level. Considering that all community conflicts appear departmental courts or high courts seem to be a mistake. Sometime conflict appears in court when protagonists fail to solve it at village level or amicably. A survey conducted by Sanfo (2015) show in Eastern and central regions of Burkina Faso 82% and 95% of the respondents reveal that they like to manage conflict respectively amicably with local conciliator and traditional chief.

3. Examining the causes and distributions of community conflicts in Burkina Faso

The objective of this study is to explore the underlying source of community conflicts in Burkina Faso and to analyze the mechanism through which others are resolved. An analysis on six major community conflicts of ONAPREGEC annually report from 2015 to 2022 and the report of the ministry of territorial administration revealed that each region is affected by conflicts. The figure1 gives insight in the disparity of regional diffusion of community conflict in Burkina. For example, on the one hand land use (green color) conflict is most recurrent and recorded in Burkina Faso. This observation can be attributed to Burkina Faso being a country that agriculture is a backbone of the economy, employs 86% work in this sector, lack of clear land tenure and increasing of land users over time. On the other hand, the farmer-herder (conflict is the second most violence and reflects the competition over resources such as grass land, water between sedentary farmer and sedentary herders, and between sedentary farmers and nomadic herdsmen. In terms of regional variations, Hauts-bassins, East and Centre East faced a higher number of conflicts notably in land use and farmer-herder conflict. The Sahelian region is less affected by land use disputes but dominated by farmer-herder conflict reflects the region's reliance to pastoralism.

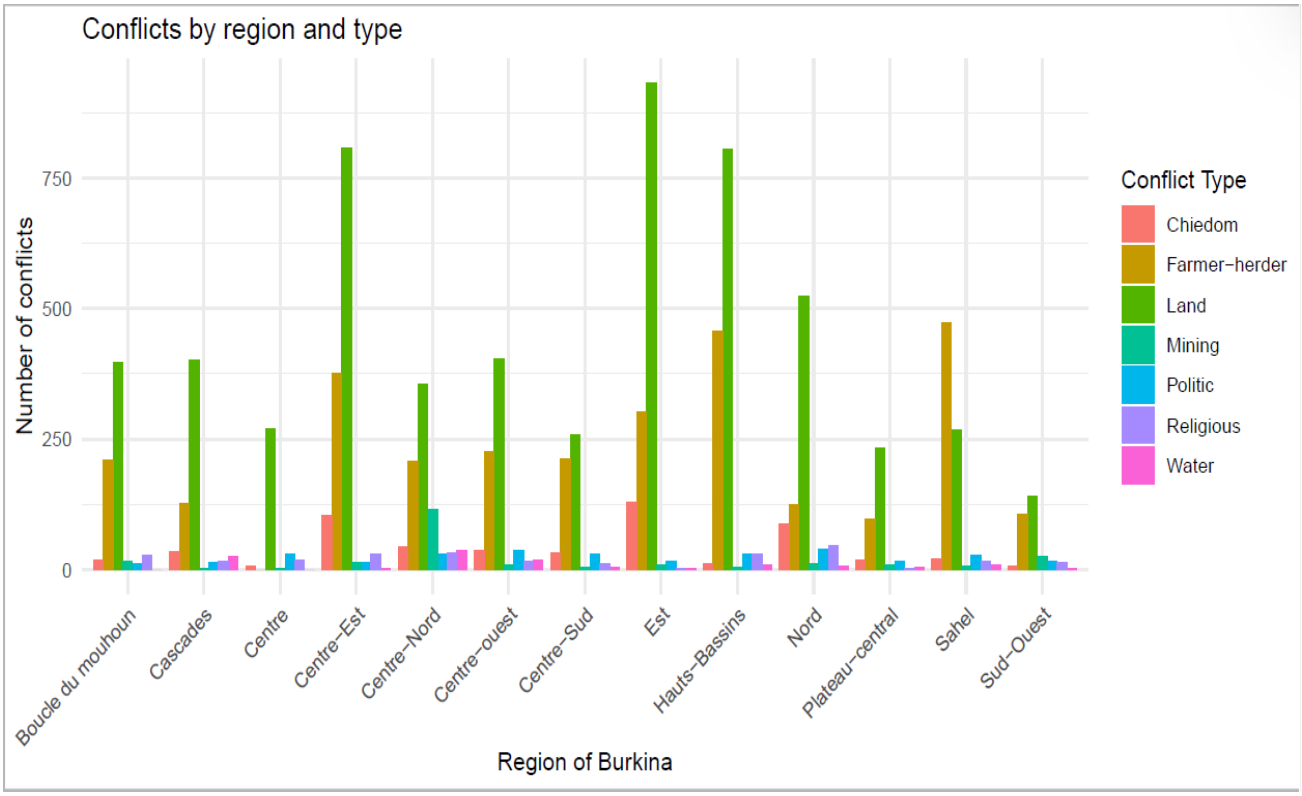

Figure 2: Frequency of community conflicts in the regions of Burkina Faso
Sources: authors's presentation based on ONAPREGECC database from 2015 to 2022

Land use conflict: an overview.

An analysis of ONAPREGEC's annual report, along with the Ministry of Territorial Administration reports, reveals that land use conflict is a most common, frequent and prominent type of community conflict in Burkina. It's any dispute over land that arises when people or community interest diverge (FAO, 2021), and can be occurred both in urban[11] and rural[12] areas, but land use conflict in rural area is by far the most prevalent form of land use conflict in Burkina Faso. Since 2009, policymakers adopted ''la loi nº 034-2009/AN du 16 juin'' governing land tenure and its implementing decrees, thus providing legal and institutional mechanisms for land management and conflict management. In theory, it's hypothesized that the predicted land crise

[11] Land conflict is urban when it concerns buyers and sellers of plots and/or conflicts between plot owners
[12] Rural land conflict is any dispute related to access to and/or exploitation of rural land and natural resources , except for areas governed by specific regimes such as mines(Burkina Faso, 2012)

could start by the combined effects of several factors increased competition for control and use of land, multiplication and aggravation of conflicts over land development and use of natural resources, intensification of inter-regional agricultural migration and pastoral transhumance, and the low effectiveness of legal and institutional mechanisms for land management and conflict management in rural areas. Conflict over land is a common issue in Burkina, occurring both between and within communities notably between field frontiers, between farmers, farmers and pastoralists, indigenous and newcomers, extraction company and local population(USAID, 2010). Indeed, Annually reports hold by institutions and ministries, has been marked by numerous land-use conflict in the recent years (Benjaminsen et al., 2012; Burkina Faso, 2018). For example, according to various source of reports, such as (FAO, 2021), (Konrad Adenauer, 2018) and (UNDP, 2021) recorded respectively between 2015 and 2016, 1390 land-use conflict; in 2019 it was 1198 land-use conflict and 758 in 2020. As consequences, destruction of property rights, injuries, loss of human life, migration. Several studies revealed numerous drivers, (Blattman et al., 2014). In Burkina Faso, this causes include, expansion of arable land, internal migration, population growth, lack land tenure security, land market development, wars. These various factors reveal that there is no single land issue. However, one can resume it in term of access and control over land (natural resources).

The expansion of arable land. This happens when farmers increase the amount of land for crop production. The goal behind this behavior is to cope with the instability and/or the drop in production as consequence of climate variability and land degradation (Azzari et signorelli, 2020; Crost et al., 2018). Also, extension leads to encroachment on common resources, exploitation of protected areas and even use of pastoral areas and cattle tracks. Extension is the result of poor mechanization of the agricultural sector or low level of technology use. In fact, in certain regions of the country, including the Sahel and the North, where the land is arid, techniques for improving agricultural yields are little used due to a low financial capacity of subsistence farmers, leading subsistence farmers to periodically seek out arable land around or beyond their properties (Burkina Faso, 2018, 2021; Cabot, 2017a).

Population growth. Burkina Faso including a lot of African countries was consider as a relative land-abundant country due to a low-density population but high population rate over time lead to increase the density rate and contributes to create scarcity. In environmental security literature, Homer-Dixon, (1994) argues that natural resources scarcity as well land scarcity is the

most single triggers of violent conflict. According to INSD, (2022) the rate of population growth is 2.94% per year with a large contribution of rural area. Under such circumstances, low mechanization of agriculture leads to low land availability with respect to demand. Reduced availability of the land resource increases competition between individuals and potentially causes intra-family conflicts, between migrants and indigenous populations, and the questioning of ceded land in terms of donation (Das, 2013; Tsomb et al., 2023).

Migration (Internal) is often considered as a response to resource pressure or poverty, viewed as an integral part of some people's livelihood such as pastoralist transhumant, reaction to conflicts, or as part of resettlement driven by government policies aimed at development or conservation policies OIM (2024). This seems to be the case of Burkina Faso. According to INSD (2022), floods or disasters, the search for arable land, insecurity, climatic stress or environmental conditions, community conflicts are among others the main reasons for internal migration in Burkina Faso. In climate migration literature, migration movement has been identified as a cause of conflict whatever the form and the background (Kelley et al., 2015). However, one of the fundamental issue related to migration and land is that who is the first comer and who is the newcomer and this does not cause problem when land is relatively plentiful and that users can extend the cultivated spaces as they wish but there is numerous evidence in literature it cause problem when competition for land is increasing or in case of poor land management. For example, in the Southeast of Burkina, natives argue that the Mossi group and Fulani are responsible for mismanagement of land by excessively increasing the cultivated spaces (Mossi) and letting the animals wander into the fields of farmers and reserves (Maiga, 2007a).

When migrant reach a new areas, the population in this area increase and decrease in the same time the availability land or resources per capita.This situation could increase the competition for the scarce resources (land, water, food) and in the specific context push deprived individuals (native) to the hand of violence and undermine the state capacity(Barnett & Adger, 2007a; Homer-Dixon Thomas., 1999). Land tenure insecurity: in Africa and Burkina Faso in particular, most rural household lives and make farming on their ancestral lands general without a formal land title. This lack of legal recognition makes them vulnerable to encroachment and defends their claims during legal disputes. A report by (Benjaminsen et al., 2012) indicate land conflict occur in Burkina Faso when autochthons attempt to repossess the land that was transfer as a loan and when migrant attempt to appropriate it as a loan.

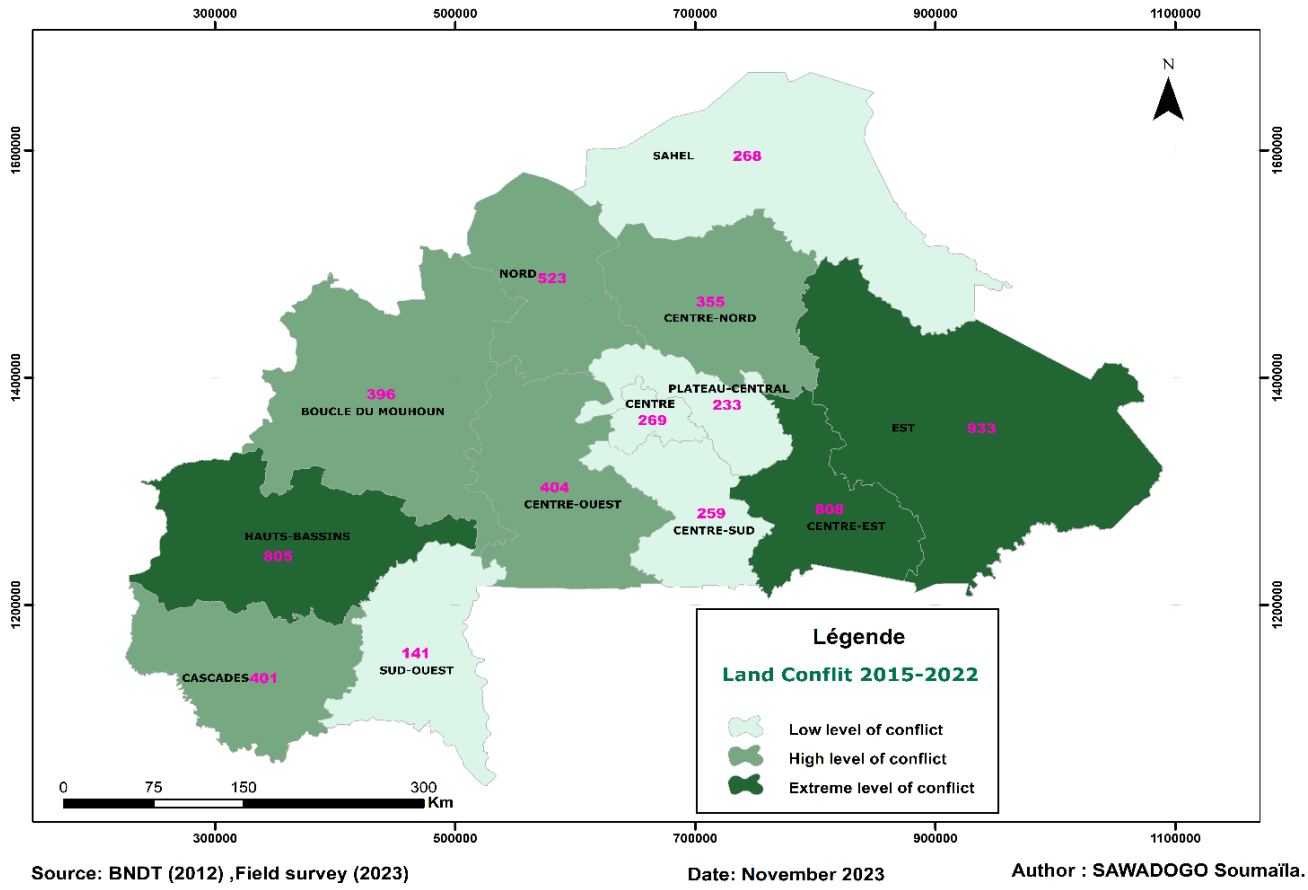

Figure 3: Regional distribution the occurence of Land use conflict in Burkina Faso
Sources: authors's presentation based on ONAPREGECC database from 2015 to 2022

The below map indicates a geographic disparities of land conflict level across different regions of Burkina Faso from 2015 to 2022 and categories into three tiers: low, high and extreme. East, Center and Hauts-Bassins indicate an extreme level of conflict while regions in lighter green have low level of conflict and others between these extremes vary in terms of conflict intensity. For instance, the concentration of conflict in East, Center and Hauts-Bassins regions could be explained by the combination of socioeconomic and environmental challenges, land tenure insecurity or a rapid land use change. A report by USAID, (2014b) in Burkina shows that migration of people from arid region to Hauts-Bassin exacerbates land use disputes in the receiving area. These increases of migrant flux increase pressure on limited agriculture resources, leading to the competition between local population and newcomers, fuel tensions over land ownership, access and usage right

Overview of farmer herder conflict and water dispute

Farmer-Herder conflict is a variance of land use conflict. It occurs in agrarian community randomly under some institutional and environment characteristic(Eberle et al., 2020; Nnaji et al., 2022). This conflict is recurrent and the second community conflict in Burkina after land use conflict(Burkina Faso, 2018). The graph below gives an overview of the regions affected by farmer-herder conflict in Burkina.

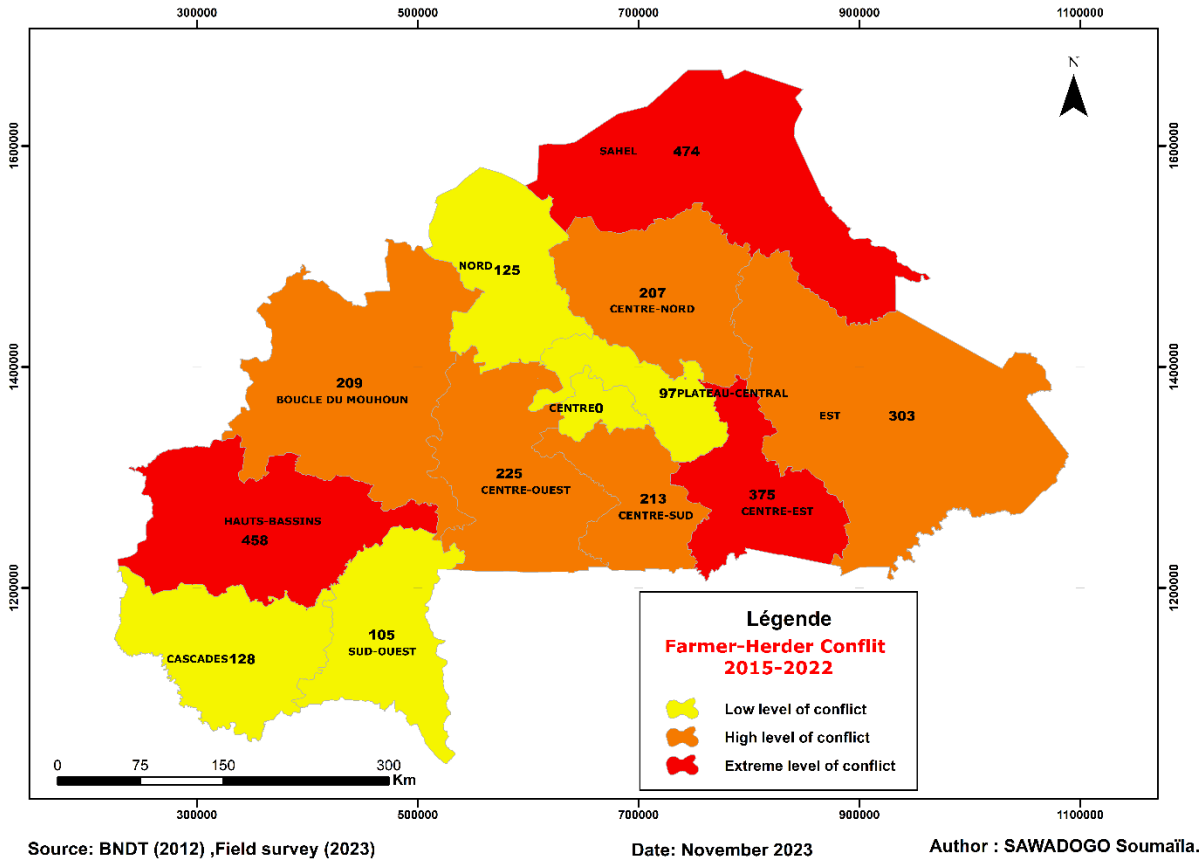

Figure 4: Regional distribution of the occurence of Farmer-Herder conflict in Burkina Faso
Sources: authors's presentation based on ONAPREGECC database from 2015 to 2022

The map shows regional disparities of farmer herder in Burkina Faso. The regions like Hauts-Bassins, Sahel and Center East are more vulnerable to farmer-herder conflict compared to other regions in Burkina.

The economic literature on the cause and source of break out of farmer herder conflict are abundant. Natural resources competition and inequitable access to, agriculture encroachments and grazing land encroachments, pastoral routes obstruction, crops damage, corruption, and poor cattle management system (Benjaminsen et al., 2012; Kugbega & Aboagye, 2021; Nnaji et al., 2022). These authors did not consider the environmental stress in which this violence occurs. Nowadays, authors suggest considering the footprint of climate change on local conflict between crop farmer and herder because the phenomenon resulting from climate change can jeopardize natural resources, agriculture instability and lead to disputes over natural such land, water, grazing land or contribute to conflict (Cabot, 2017a, 2017b; Nordås & Gleditsch, 2007; Odoh et al., 2012; van Weezel, 2020).

Burkina Faso agriculture and livestock sectors are vulnerable to climate change(Abroulaye & Abalo, 2015; G. Anderson et al., 2012; Burkina Faso, 2021; NAP, 2015). Livestock sector is affected directly by the phenomenon resulting from the direct manifestation of climate change such heat stress, drought affecting the availability of grazing (Burkina Faso, 2021). For example, one of the major impacts of climate change on the livestock sector is the reduction in grazing areas, and in particular strategic zones such as lowlands, ‘’bourgoutières’’ and watering points. Indeed, the variability and decline in rainfall have led to the extension of cultivated land and the agricultural use of lowlands. As a result of population growth and climate aridification, farmers are tending to compensate for lower crop yields by increasing the area under cultivation and making greater use of the lowlands. Thus, we are witnessing a reduction in grazing space and overgrazing leading to the disappearance of perennial grass. For instance, Sahel region is marked unpredictable rainfall, land degradation and frequent drought, this environmental stress contributes to increasing competition between farmers and herdsmen for scarce resources, intensify pressure points where conflict are more likely to escalate(Cabot, 2017a).

As climate variability and change limited the availability of pasture and water to feed safely their animals this led herdsmen people to move from where the resources are scarcer to where resources are abundant (Abel et al., 2019; V. Mueller et al., 2020; OIM, 2023; Sawadogo,

2021). This displacement can be both international migration or internal migration. International migration to feed animals(transhumance)is dominated in Burkina by Fulani who migrate seasonally and temporary mainly into Benin, Cote d'Ivoire, Ghana and Togo more economically and less vulnerable area in the face of climate change where the vegetation continues to offer home both for herdsmen and animals in the face of climate variability and change(Amole et al., 2022). This type of migration to look for better space in natural resources to feed animals is not passive. This likely to increase local conflict between transhumant (Herdsmen) and local population(Das, 2013; V. Mueller et al., 2020; Tsomb et al., 2023) . For instance, it's estimated 60% central southern nomadic herder from Burkina Faso live in the other side of Ghana border for seeking grassland for their livestock and could lead to cross-border conflict between farmer-herder (IRN, 2010).

Within Burkina Faso Fulani herdsmen like to migrate to adapt their activities to climate variability and extreme weather condition. Herdsmen migrate from the Sahelian, plateau central (mossi area) and north to south, southwest and east where the vegetation continue to offer refuse both for herdsmen and animals from more vulnerable areas to less vulnerable region of Burkina Faso (USAID, 2014). This relocating of population growth in the host areas diminishes or provoke the loss of per capita availability of natural resources and contributes to land degradation in the receiving areas that Fulani migrants are looking for, such as grazing land, water(Amole et al., 2022). As consequence, increase competition and could lead to break out of farmer herder conflict in some area of Burkina Faso because the host farmers and herdsmen want to secure their per capita availability of natural resource and the newcomers want grassland and water to cat their cattle or to feed their animals(Hagberg, 2007). This situation can align with what we observe on the map in Hauts-Bassins with stable resources and better rainfall.

As internal migration another major adaptive response to climate variability and change to Burkinabe farmer and herder is the convergence to agropastoralism(USAID, 2014a). On the one hand Farmers response to environmental stress by doing other activities, most of them engage in livestock production. On the other hand, pastoralists converge on crop production to supplement household revenu. This intensification of farming activities and herding recedes both grassland and arable land. These farmers and herdsmen convergence toward to both each other activities (agropastoral) as a climate resilient livelihood leads to the encroachment on farms, increase fields damage, recede of pastoral areas, poisoning of animals and disputes relative to access to points

and bodies of water areas or when water from dams runs out and market gardeners use pesticides near water points , often polluting water resources and creates the new circumstance and form of conflict (Afane & Gagnol, 2014; Benjaminsen et al., 2012; USAID, 2014b).

Burkina's water resources are almost exclusively dependent on rainfall which ensures the recharge of groundwater tables and the filling, to varying degrees, of surface water lakes. The impact of the increase in temperature and the decrease in rainfall will result in: a drastic reduction and degradation of pastures, a deficit in the pastoral and food balance, and a worsening livestock watering condition and increase water use dispute.

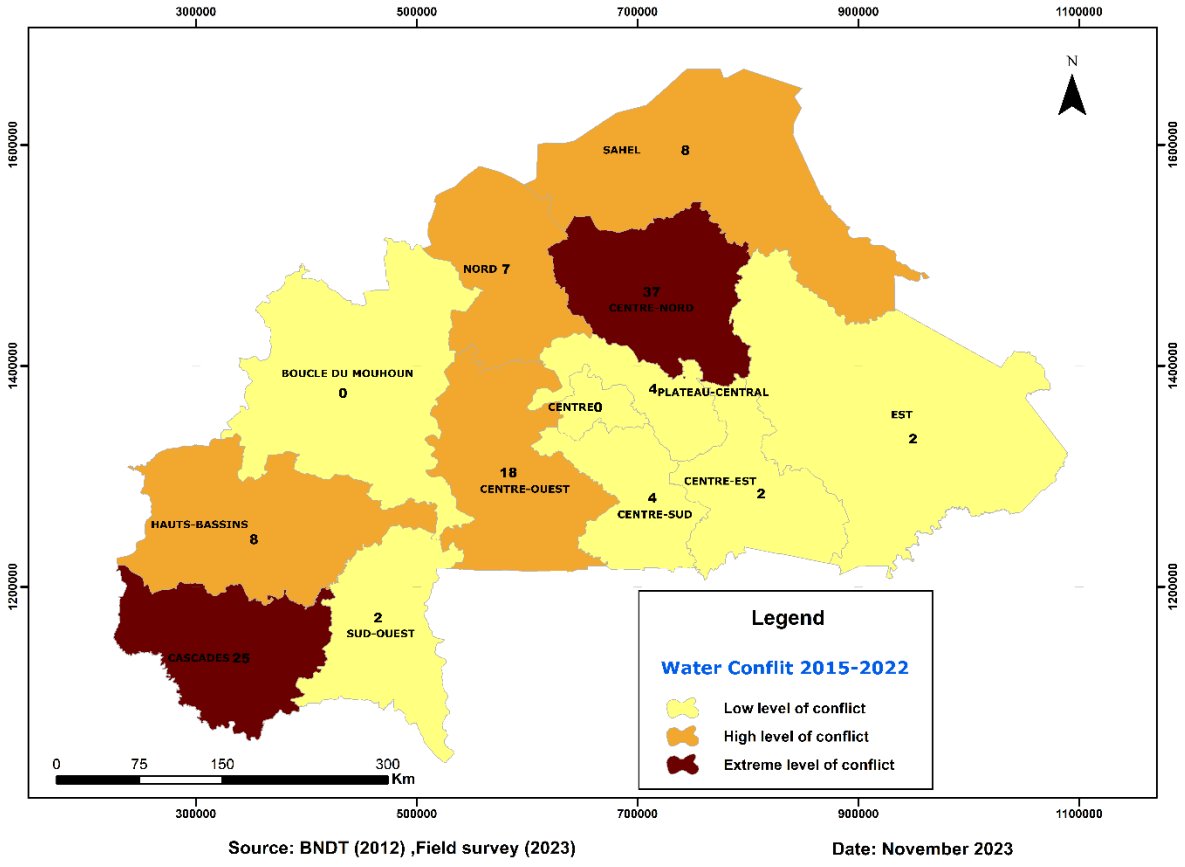

Figure 5: Regional distribution of water use conflict in Burkina
Sources: authors's presentation based on ONAPREGECC database from 2015 to 2022

Overview of political and chiefdom conflict

In Burkina Faso, chiefdom conflict is a conflict linked to the successive and opposing evolution generally, two or more people or, two or more communities.

Like many colonized countries, the traditional chiefdom in Burkina is marked by two majors' periods. On the one hand, during the pre-colonization period all the power including political, administrative, and cultural were held by each chief on his jurisdiction. On the other hand, during and after colonization, the traditional chieftaincy has, to a certain extent, lost or shared its political and administrative role with the government, but practically retained its cultural role understood in the sense of managing custom. Despite the reduction of the power of the customary chief, it is the object of covetousness and generates conflicts between the candidates. For example 2020 and 2022, conflicts related to traditional chieftaincy ranked second.

Chiefdom conflict risk is driven by several factors:

- succession disputes,
-often leading to the questioning of the legitimacy of the persons designated,
-politicization of traditional chieftaincy,
-absence of written rules governing succession,
-questioning of cultural values.

Other cause of traditional chief disputes is bicephalism. According to ONAPROGECC, 26 cases were recorded in 2022 and is in second place after the challenges of the successor to the chief. This enthronement of two chiefs in the same village leads to diarchies in these villages and causes the customary skills of a chief to be contested, often causing disturbances to public order. This situation is more common in the eastern region of Burkina.

The other variances of the conflicts related to the chiefdoms are the questioning of the territorial competence between two chiefs, the dismissal of a chief for the benefit of another. The graph below gives an overview of chiefdom conflict in Burkina Faso

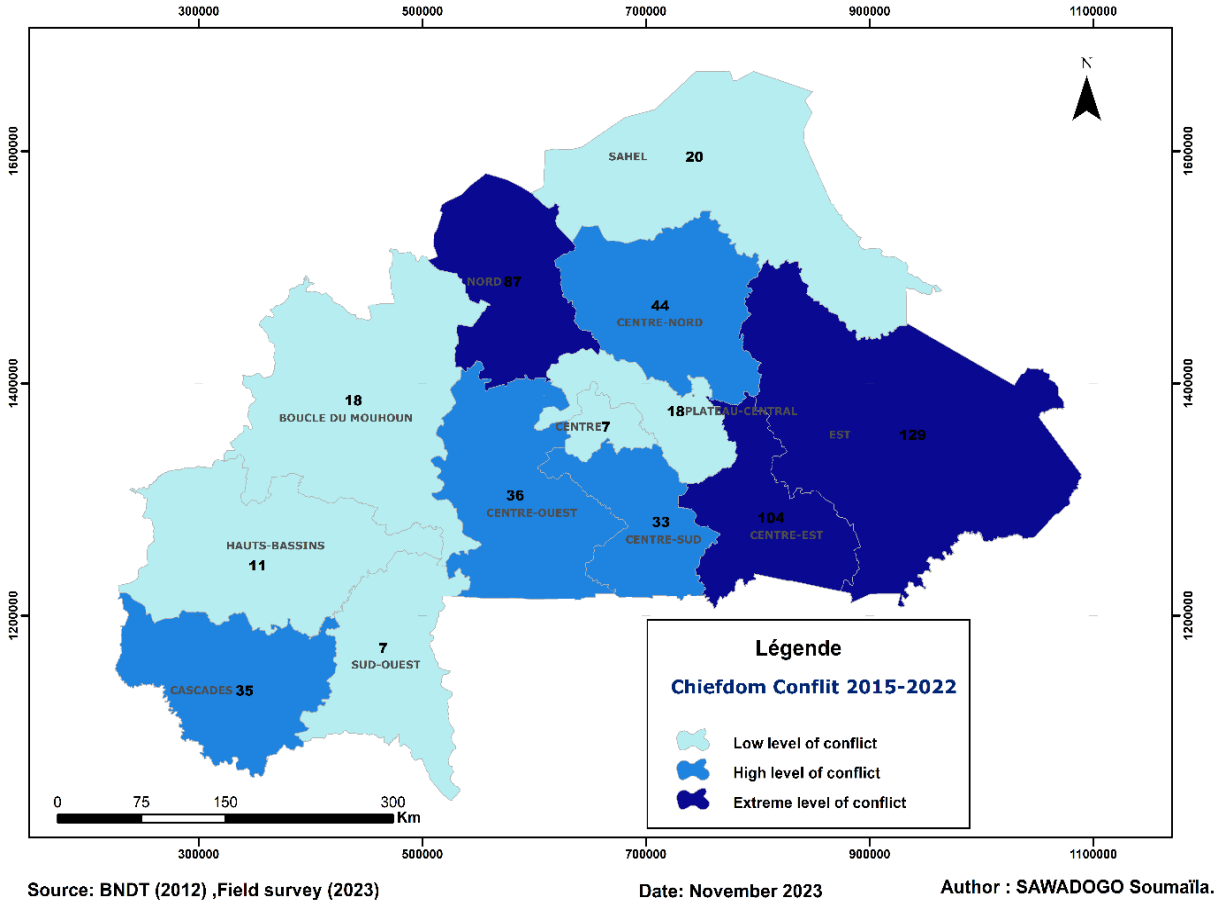

Figure 6: Regional distribution of the occurence of Chiefdom conflict in Burkina Faso
Sources: authors's presentation based on ONAPREGECC database from 2015 to 2022

The maps show the level of chiefdom conflict in Burkina Faso from 2015 to 2022. This period is a period in which Burkina Faso Burkina Faso experienced sociopolitical trouble including terrorism, weak governance, ethnic tensions. The conflict level is categorized into three levels, low level, high level and extreme level. Regions such as the East, Center-East and the North show a higher level of disputes compared to other parts of the country. This situation reflects a variation on sociopolitical structure, governance and communities' relationships with others external variations such migration pattern and ethnic division. Some authors show that historical grievance and ethnic divisions contribute to chiefdom conflict(Hagberg, 2007).

Burkina Faso experienced a series a political crisis. For instance, between 1960 to 2022 Burkina has experienced four republics which succeeded each other through political crises except for the first republic (socio-political crises and political-military crises) Burkina Faso. The

austerity policy established by President Maurice to deal with public finance deficits including reforms such as a 20% deduction on the salaries of civil servants and the army, the reduction in the monthly family allowance rate, the reduction in veterans' pensions, blocking of advancement in public service, etc. the popular discontent resulting from this situation combined with other frustrations experienced due to the authoritarian drift and presidentialist power strongly contributed to ousting him from power by a popular insurrection on January 3, 1966. After this insurrection, the country was marked by socio-political and politico-institutional crises which led to frequent changes of regimes and governments. For example, during the first semester of 2011, the country was marked by a situation of insecurity deletary due to a growing discontent within military, student protests police brutality and rising concerns between business community over vandalism and attacks led insecurity in Ouagadougou and other regions(USAID, 2014a). Under such condition of instability, the former president Blaise Compaore pursuit reform and redistribution of resources to face to the disenchantment. But, in October 2014, Blaise Compaoré was overthrown by a popular uprising as he attempted to repeal the constitutional limitation that prevented him from running for re-election to power in 2015. Since 2016, the country has been shaken by an escalation of violence committed by terrorist groups accompanied by political instability. For example, between 2020 and 2022, the country has had 3 presidents, two of whom were the result of a coup d'état.

Below map presents regional disparities of chiefdom conflict between 2015 and 2022 induced by various factors including mistrust vis-à-vis of authorities, poor management of political parties, political rivalry, leadership conflict, intolerance, weak institutions, electoral conflict, and obsession with power.

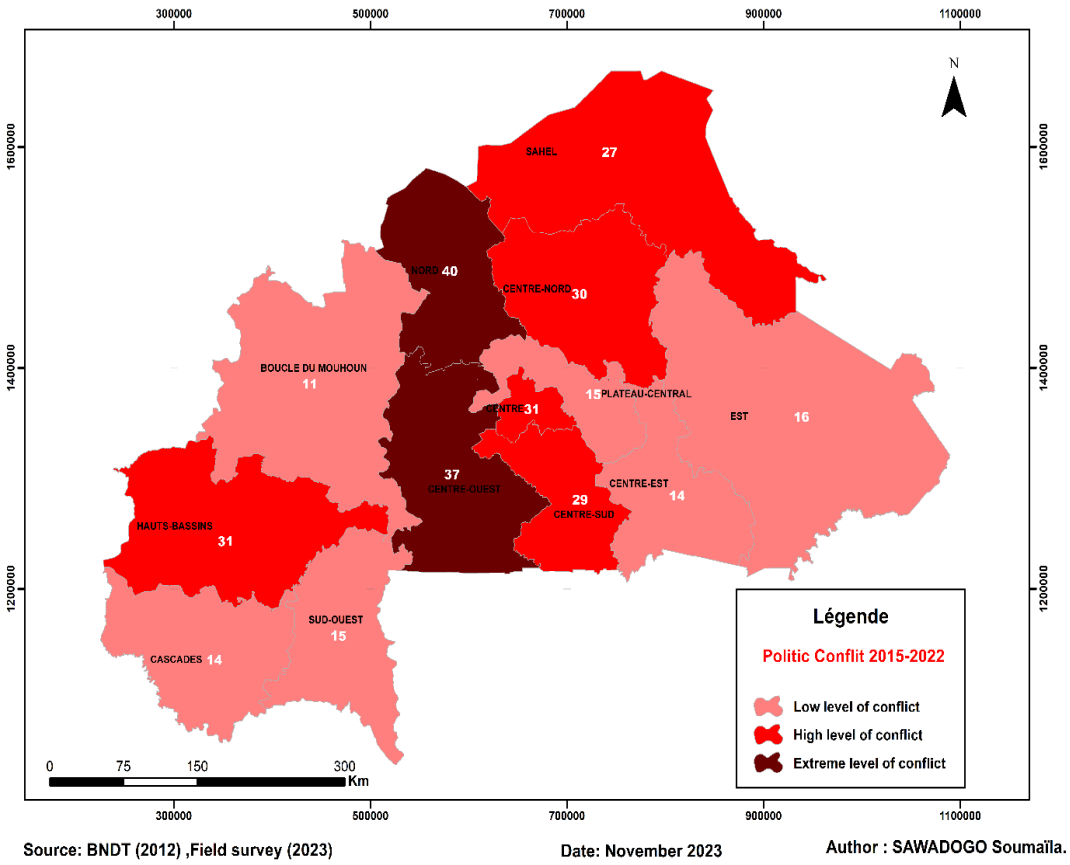

Figure 7: regional distribution of the occurence of Political conflict in Burkina Faso
Sources: authors's presentation based on ONAPREGECC database from 2015 to 2022

The map below indicates political conflict across different regions Burkina Faso categorized into low, high and extreme between 2015 and 2022. According to the map, some regions, for instance Cascades has a low level of political instability while the North and West-center are most affected with incidents of conflict. For instance, the extreme level of political instability reaching up to 40 cases in the north region could be explained by the fact that the region has a high security threat and environmental stress challenges.

Mining conflict

Since the past decade, gold has become Burkina Faso's leading export product, relegating total agriculture (including farming and livestock) to second place(INSD, 2019). The mining sector expanded in Burkina at the end of 1990s. It is organized in large-scale gold mining (foreign investors) with 13 industrial mines including 12 of the gold type and one zinc mine and Artisanal and small-scale gold mining. The number of artisanal mines differs from one institution to another, highlighting the difficulty of controlling the informal sector in developing economies. For example, a survey conducted by the National Assembly of Burkina Faso reveals that Burkina has 1000 gold panning sites while this figure is 448 according to the National Institute of Statistics and Democracy(Engels, 2020). The governance system of production and commercialization of gold in ASGM is structured in hybrid patterns, formal legislation, and informal arrangements under the national mining code.

Despite the effort of the state to give formal recognition through licenses and permits, several stage of gold production in Burkina Faso is still partially informal. According to Artisanal Gold Council, in 2021 the informal sector was the largest provider of jobs compared to formal sector. It's estimated that 13 times more informal workers (included vulnerable people like women and children) than formal employees in Burkina Faso's mining sector. Artisanal gold mining sectors in the Sahelian countries and in Burkina has been seen by rural population working on climate related activities as adaptation strategies to climate change. For example, when agriculture becomes unproductive or when the yield and/or income from agricultural activities declines due to phenomenon resulting from climate change such as irregular and failing seasonal rainfall or pronounced drought or during dry season, about 60% of people in some villages shifted from dependence on agriculture for their livelihood to artisanal gold mining activities(USAID, 2017).

The extraction of mining products in Burkina takes place in rural areas and most often on agricultural land or on pastureland, destroying the activities of the local population. As a result, population eviction, a reduction in agricultural and grazing areas and leading farmers and breeders to cover relatively long distances. Thus, the installation of an industrial or artisanal mine is done to the detriment of traditional production activities and often in violation of laws relating to land grabbing for extraction reasons. Burkinabe law provides that providing proof of the consent of the population constitutes one of the conditions for granting an operating permit. A report by Glocon

finds that in some localities of Burkina such as Essakane (40%), Bissa (25%) and Taparko (29%), Perkoa(80%), Karma(57%) and Youga(55%) people are not aware or not informed that the installation of mine. This situation creates conflicts between miners and local populations because they see their livelihoods threatened (agricultural land and pastureland).

The literature on the causes that trigger conflicts in mines is abundant, including the loss of livelihoods of producers in rural areas with its corollary consequences (unemployment, poverty), illegal occupation of cultivated land by mining operators, illegal extension of mining perimeters, pollution of the environment and natural resources (water, land) caused by mining activities, protest the installation of a mining company. Another source of violence when company stop paying the amount allocated for using the land of rural population. Indeed, extraction company pay between 175000 and 500 000 CFA per year and per hectare during 5 years for using the land of rural household. However, the extraction extraction can last between 15 and 20 years, which creates frustration between former landowners (Drechsel et al., 2018).According to onapregecc, a conflict is said to be mining when the conflict is between mining operators (mining companies) and local populations, gold miners and landowners, gold miners among themselves, gold miners and industrial between gold miners and industrial operators over mining operations. The following graph presents the state of mining conflicts in Burkina Faso over the period.

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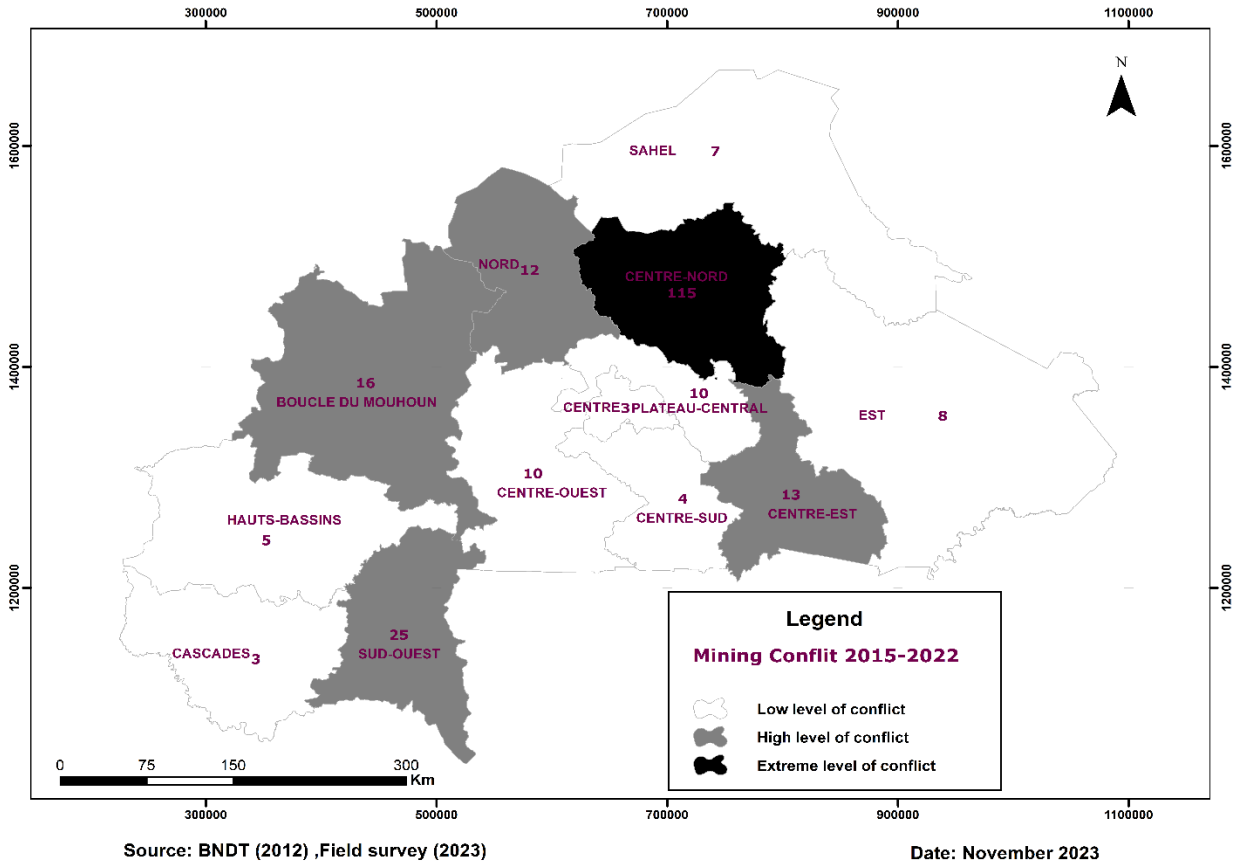


Figure 8: Regional distribution of the occurence mining conflict in Burkina Faso
Sources: authors's presentation based on ONAPREGECC database from 2015 to 2022

The graph above presents the situation of mining conflicts in Burkina Faso over the period 2015 to 2022. The number of conflicts varies from one region to another. For example, over the period of the study, the most conflict-prone region recorded 125 conflicts (north-central region). This significant number of conflicts in this region could be explained by the fact that it is home to the largest number of industrial mines (Guiro-Diouga mine, Yeou mine, Samtenga mine, Bouroum mine, Bissa-Zandkom, Taparko,), a threat to traditional production activities and therefore a perpetual conflict between local population and miners due to the lack or decline of opportunities to generate income after the loss of their fields .

4. Climate change action: Overview

According to Notre Dame Global Adaptative Initiative(ND-GAIN), Burkina Faso is among other countries most vulnerable to climate change. In 2022, the country combined both a high vulnerability score (0.524) and low readiness score(0.284) placing it in the upper left quadrant of the ND-GAIN matrix(ND-GAIN, 2024). The country is more vulnerable to droughts and floods due to is low and rainfall variability(Burkina Faso, 2021). For example, the majors' droughts are those recorded early 1970s, 1990 to 1991, 1995 to 1996, 1997 to 1998 with associated food crises due to its erratic rains, its poor water retention capacity combine the extension of its dry zone since 1902. In addition, the country becomes hotter over time. Indeed, since 1975, the temperature increases 0.15 per decade(USAID, 2012). In terms of floods, the country is also vulnerable, in less than two decades the country recorded eleven majors' floods with associated consequences included crop destructions, loss of human life(Crawford et al., 2016). As in many African Countries, the main causes of floods are heavy rains with poor infrastructure and land degradation.

Like many Sahelian countries, Burkina lacks a national policy specifically focused on climate change mitigation. However, the country has defined it adaptation priorities through a series of key documents, including National Adaptation Plan for Action (NAPA), National Adaptation Plan (NAP), National Determined Contribution (NDC). These aims to address climate change vulnerability with focus on its priorities vulnerable sectors (Agriculture, Livestock production, environment, healthcare, energy, infrastructure and housing, and water security it and develop its adaptation plan. Then, various projects and programs have been implemented to reduce vulnerability to climate change at regional and national levels vulnerability with focus on community-based adaptation, capacity building, policy formation and integration.

Agriculture sector granted majors projects that aims increasing the resilience of Burkinabe rural communities through adaption strategies included crop diversification and improve practice to face the severe rainfall variability and increase temperature through: Climate resilience into Agriculture and Pastoral Production for Food Security in Vulnerable areas Through Farmers Field school Approach, and Changing Farming practices to Prepare Heavy rains and High Temperature. In the same perspective, Access to Safe, Nutritious, and Sufficient Food project has been implemented and supported by Canadian that aims to promote eco-friendly farming practice

to combat desertification. The project looked at diversifying agriculture production, introducing new crops and improving family diets.

In another perspective, the country receives a numerous support to build community resilience on natural resource management and improve access to climate information through projects such as Climate Governance and Sustainable Decentralized Forest Management, Adapting Natural resources Depends Livelihoods to Climate Induced Risk and, Strengthening Climate Information and Early warning Systems for Climate Resilient Development and Climate change Adaptation. In addition, others effort includes trans-border livestock mobility, water infrastructure to support local adaptation to climate change through poverty reduction, biodiversity conservation and improved livelihoods; the similar efforts have been done include climate smart villages.

Burkina has institutional structures for climate governance including National Council for Environment and Sustainable Development (CONEDD: Conseil National pour l' Environment et le Development Durable) and National Council for Emergency Relief and Rehabilitation (CONASUR: Conseil National de Secours urgency et de Rehabilitation). The role of CONEDD is both to coordinate and harmonized the government environment intervention to archive sustainable development (included planning and monitoring of climate policies, intersectoral consultations) while CONASUR is mandated to prevent natural disaster, risk reduction (build resilience to risk), humanitarian response (Coordinate relief and humanitarian aid actions in the event of disasters) and post crisis management (rehabilitation and reconstruction to help affected population).

5. Conflict resolution

Establishing an effective and peaceful management and resolution mechanisms for conflict is crucial when conflicts seem to be inevitable. There are three main methods of conflict resolution in Burkina Faso: traditional methods, the judicial system, and alternative mechanisms. A resolved conflict may mean that it has been brought to legal proceedings and resolved. However, a conflict can be managed without being resolved because the verdict rendered by authorities does not guarantee full acceptance by parties involved. Among the conflicts that are dealt with, there are those that are accepted as such by the protagonists, and those that are not. A rate of so-called resolved conflicts can hide a level of dissatisfaction or frustration with the verdict that does not contribute to a reduction in tension in real society, and therefore in the application of deliberations (Tiéba et al., 2001).

- Traditional methods

This method is the prerogative of customary chiefs and differs from one village to another or even from one ethnic group to another one. Previous studies in Burkina Faso reveals that when community conflict occurred, people like to manage it amicably and, local councilor and chief traditional (Abroulaye & Abalo, 2015; Maiga, 2007a). Using two communes in the East region of Burkina Faso, Abdoulaye and colleagues find that people prefer to manage amicably or using chief to mediate or regulate conflict when it occurred. People's preference to manage amicably or mediate with the local councilor or chief is due to the peaceful way of managing it (not very restrictive compared to justice decision and concerned with the preservation of social cohesion) and the fact that people still believe in the integrity of their leader. More than 88% of the respondents reveal that chief or local councilors are not corruptible, no ethnic or religious bias in conflict management. The justice rendered by the guarantors of tradition has the merit of rebuilding the social fabric weakened by the conflict. This is why, in some cases, people are witnessing the rejection of conflict files to justice when it is not passed to the court of the guarantors of tradition.

Maiga, (2007b) find that in the southeast region of Burkina, the choice of customary authorities to regulate conflicts depends on ethnic groups and the main activity of the household. In the case of dispute, farmers and herdsmen prefer the regulation by village chief and the prefectural authority. For them, theses leaders are more suited to mediate conflict and maintain

harmony within community. However, the choice of dispute resolution methods vary between native and non-native. Non-native prefer involving prefectural authorities, considering them as more impartial arbiters while natives like the intervention of village administrative manager.

In the case of land use conflict, the customary authority most empowered to resolve is the land chief. The conciliation is made beforehand by the village chief. In the event of failure, in certain situations the land manager is requested for mediation. When protagonists agree, the land chief uses ancestral methods such as chicken, cola, bean and others:

- **The chicken method** consists of asking each protagonist to bring a chicken. The land chief invites the conflicting parties to the disputed land to make incantations and to immolate the two birds on the disputed land in the presence of several people including the village chief. The one who sees his chicken die on his back is the true owner of the land.

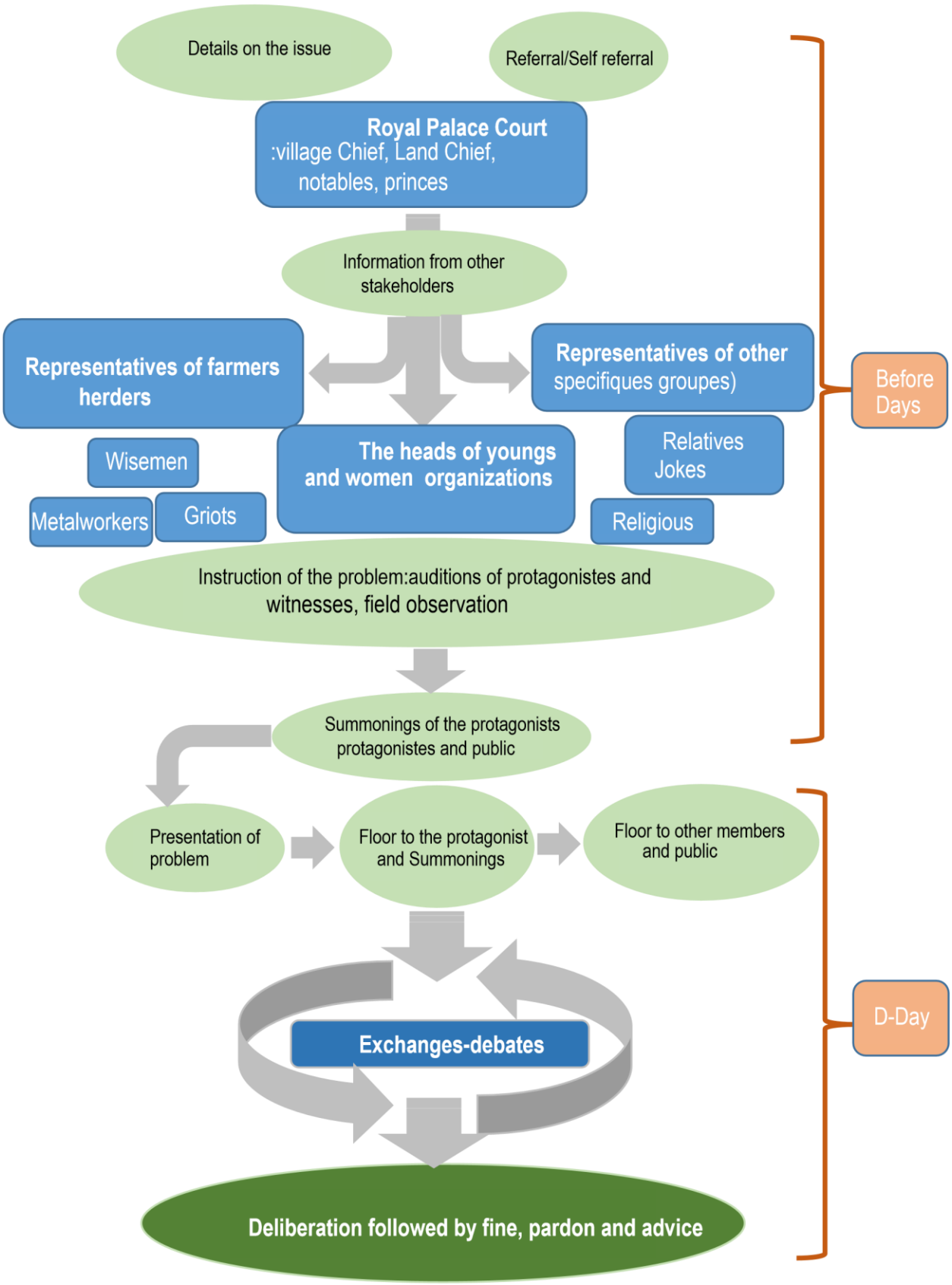


Figure 9: Synthetic diagram of the process of concialition by the customary chiefdom

- Another very similar **method is cola** by the land chief. In this case the protagonists can agree to buy a single cola, or everyone brings their own cola. The fetish method consists in certain localities of coming to swear on the fetishes. In the latter case, misfortune falls on the family of the offender and this, repeatedly.
- **The cowrie's method**. Its practice differs from one ethnic group to another but leads to the same result: the death of the culprit. It consists of putting in a new calabash containing three white cowries and water, sand from the land that is the subject of dispute. Subsequently, the two protagonists are invited to drink this mixture, the consequence is very fatal for the culprit (results in his death).
- **The bean method** achieves the same result as the cowrie method, but the process differs. Indeed, it consists of cooking beans near to the disputed land and inviting the protagonists to eat.

In some regions[13], there is no land chief, it is rather the college of elders around the chief who mediates on land issues with the protagonists. In general, the mediation of the sages is not refused for fear of being excluded or having difficulty succeeding.

In some ethnic groups when mediation fails regardless of the type of conflict, another resource person is called upon, the blacksmith. The latter generally comes from a tool that symbolizes it and encourages the protagonists to move towards reconciliation and gives the benefits of social cohesion. Forgeron insists on those who believe they are right to accept forgiveness. In several ethnic groups and among the Mossi, the majority ethnic group in Burkina Faso, the intervention of the blacksmith is successful because his mediation is not generally refused.

Also, often joking relationships can be used to quell conflict; the mediation of a joking parent cannot be refused. For example, in the 3rd republic, the criterion for transferring civil servants in Burkina was based on alliances or kinship, the Shamo (ethnic group) were sent to the moaga areas, the Bissa (ethnic group) to the yatenga province.

➢Departmental court or alternative dispute resolution mechanism

When the attempt of the chiefs fails, the conflict is transmitted to the departmental court with a non-conciliation process for new mediation through amicably settlement. In the case of crop

[13] Sahel region

destruction induced by animals, the prefect requisitions an agricultural agent and an livestock agent to assess the damage. The departmental court presided over by the departmental prefect is authorized to manage conflicts when the damage committed by one of the protagonists does not exceed 300,000 FCFA. Sometimes, other actors intervene in the management of the conflict such as villager Councilors of Development (CVD: Conseiller Villageois de Développement), the villager Commissions of Land Conciliation (CVCF: Conseiller Villageois pour Conciliation Fonciere) at the level of the villages, the deputies accompanied by the technical agents of agriculture, animal resources, and the environment. In the event of failure of the mediation of the departmental court, the protagonists are referred to the high court of the region with report of non-conciliation of the protagonists.

- judicial system

The High Courts (TGI: Tribunal de Grande Instance) at the regional level ensure the judicial settlement of conflicts. But for most cases, these are land disputes with the direct involvement of clerks and secretaries of the prosecution from their registers. As the processing of disputes generally takes several months to verify the offenses and make findings, many disputes declared to the meaning and submitted during the period are not processed during the same judicial year. It is only those relating to criminal matters that are quickly dealt with.

6. Conclusion

This chapter explores community conflicts unfolding in the context serious climate challenges in Burkina Faso (Sahelian country). To achieve our goal, we collected data on community conflict from Burkina Faso National Observatory of Conflict Prevention and Management by exploiting their archives. To obtain a more comprehension about the factor contributing to the communities' conflict, we added other papers on some community's studies done in some localities of Burkina Faso. ONAPREGEC data and papers provide evidence that community conflict is a serious issue in Burkina and provides a little evidence that phenomenon resulting from climate change (water scarcity, land degradation, internal migration, etc.) are threat multiplier of community conflicts in Burkina. Other factors contributing to the conflict are structural and socio-economic conditions. For the case of land use conflict and farmers -Herder's conflict, land tenure insecurity because the rural household are living in their ancestral home combine with low standard living condition, most are not able secure their land with legal formal title. Cultivation of pastoral zones, obstruction of pastoral routes, government project such as climate smart village. This situation is due to the government's policies in favor of agricultural and to protect environment.

To reduce the incidence of conflict, three main methods exist, traditional system, intermediate methods with and Tribunal. The most method for conflict resolution is the traditional method. This trend may be explained by the fact the verdict rendered by the local court is generally accepted and because to leave the traditional court for the next court (departmental court) some document is required.

CHAPTER 2: EFFECT OF FARMER-HERDER VULNERABILITY TO CLIMATE CHANGE ON CONFLICT IN BURKINA FASO

Abstract

Has there ever been a period of year in Burkina when no conflicts were recorded between farmers and Herder? Burkina has faced and continue to face numerous conflicts, including farmer-herder conflict, land disputes and terrorism. In this context marked by a persistence conflict between farmer-herder and the intensification of climate change effect, this study aims to analyses the effects of farmer-herder vulnerability to climate change on their local conflict. For this purpose, we constructed household-level vulnerability index to climate change from our survey data in two regions of Burkina Faso. By employing mixed methods using quantitative analysis (linear regression) and qualitative data description, we find that quantitively vulnerability to climate change positively influences farmer-herder conflict. This finding is confirmed with qualitative data description since both farmer and herder reveal that the degree of their vulnerability explains the emergence of conflicts. Our result proposes new approaches to combat the occurrence of farmer-herder conflict. As it seems practically impossible to combat climate change since it is exogenous to the country and to the study area in particular, the research proposes to encourage policy that can mitigate its effects and increase the resilience of farmer-herders.

Keywords: Burkina Faso, Climate change vulnerability, Household vulnerability index, Farmer-herder conflict, mixed methods.

1. Introduction

Has there ever been a period of year in Burkina when no conflicts were recorded between farmers and Herder? Burkina has faced and continue to face numerous conflicts, including farmer-herder conflict, land disputes and terrorism. Farmer-herder conflict is the second most common community conflict in the country, following by land use dispute (Burkina Faso, 2018). Recently, the Institute for Economics and Peace observed that herder-farmer conflicts have become the fourth most dangerous terror group in the world after the Islamic State of Iraq and Syria (ISIS), al-Shabaab, and Boko Haram(Lenshie et al., 2021).

In the literature, the causes of farmer-herder conflict are widely studied across various disciplines including economics. The main factors identified include natural resources scarcity, poor grazing policies, disputes over usage rights, challenging traditional rules, agricultural encroachments, struggle over grazing land, inappropriate management, obstruction of pastoral routes, crop damage, climatic condition, corruption and in some cases the reallocation of water

away from grazing land to farmland has been identified as the major causes (Abroulaye & Abalo, 2015; Adano et al., 2012; Buhaug, 2015; Clanet & Ogilvie, 2009; Lenshie et al., 2021; Nnaji et al., 2022).Then, the link between farmer's valuable asset and the herder treasured resources creates competition over land use which combined with other factors contribute to conflict.

Collier & Hoeffler,(2007),Mueller & Tobias,(2016), among other scholars agree that conflict has devastating social, economic and demographic consequences; divert resources away from development and social spending(Fang et al., 2020). These effects challenge the effort to achieve the United Nations sustainable goals such as ''no poverty''(goal 1), zero hunger''(goal 2), ''peace, justice and strong institutions' (goal 16). When development policy aimed at significantly reducing conflicts that undermine the development of African countries, several factors has been identified, including climate change. That is in line with the objective of United Nations Sustainable Goals regarding action to combat climate change and impact (goal 13) and promote peace and inclusive societies, provide access to justice and account and inclusive institutions (goal 16).

In another perspective, the literature on climate change impact predicts the intensification of competition between resources users (crop farmers and herdsmen) over scarce resources such pasture, land, water, food, etc leads to production crises or instability in countries where the economy is based on sectors whose activities are highly dependent on the climate (e.g., African countries including Burkina Faso). Climate change and weather shock are threating livelihood and limiting or reducing the availability of resources for herdsmen to feed for example their animals (Cabot, 2017b; Issifu et al., 2022; Kugbega & Aboagye, 2021).As result, affected people can migrate with the risk of conflict onset on receiving areas, worse governance in a weak state or region, fuel anti-state governance (Crost et al., 2018b; Ide, 2017a; H. Mueller & Tobias, 2016).

In addition, some studies support that climate change by having effect on resources availability may provoke new conflicts or exacerbate the existing ones' conflict. Crop farmer and herdsmen conflict is coming from the effect of climate change and population growth, according to Day & Caus, (2020) . Climate change and weather shock are threating livelihood and limiting or

reducing the availability of resources for herdsmen to feed for example their animals (Cabot, 2017b; Issifu et al., 2022; Kugbega & Aboagye, 2021).

Burkina is most vulnerable to climate change and its agriculture sector will be most impacted and for decades, the country has been in a situation of climate crisis(Burkina Faso, 2021; MEV,2007). This crisis is characterized in Burkina by a drop in rainfall, an increase in temperatures extremes disappearance of certain plant species, soil degradation (that can be specific to all Sahelian countries) with its corollary consequences (on food and cultural security) in a context where Burkinabe agriculture is little-irrigated combine with the poor agricultural credit market(Burkina Faso, 2021).

Like the agriculture sector, livestock subsector occupies a central and strategic position on the economy in ensuring food and cultural security. The country has a comparative advantage over most of its neighbors especially its coastal neighbors (Benin, Cote d'Ivoire, Ghana and Togo) where livestock farming is little practiced. The farming systems practiced were transhumant pastoral farming, extensive sedentary farming, intensive sedentary farming, nomadic farming, farming in pastoral areas and foreign transhumant farming. The country has two types of livestock systems like the Sahelian countries depending on the predominance of the activity: the pastoral livestock system and the agropastoral livestock system. Dominated by extensive livestock farming whose main source of food is natural pasture, the subsector is suffering from the effects of climate change both directly (heat stress) and indirectly (reduction of fodder, water, disease).

In view of the above, climate change worsens the vulnerability of farmers and herders by reducing access to essential natural resources (e.g., water and pasture), lowering productivity (e.g., livestock and crops), and diminishing income. This loss of livelihood increases household insecurity, economic, food, environmental, and health related. These insecurities, in turn, serve as the channels through which climate vulnerability escalates tensions and triggers conflict between farmers and herders. Reduced resilience, loss of adaptive capacity, and increased dependence on contested resources drive groups toward confrontation, particularly in already fragile socio-political environments.

A survey conducted by Abroulaye & Abalo, (2015) shows that rainfall variability and temperature reduce farmer herder water and pasture availability, reduce livestock

productivity and crop yield (therefore loss of income). As result, they become more insecure to food, economic, health and environmental scarcity, the severity to which their insecurity may explain conflict. Therefore, the conflict between farmer-herder conflicts due to climate change itself seems to be improbable rather than vulnerability to climate change. The vulnerability of the country like Burkina Faso territory may expose it to the severe impact of climate change. Vulnerable areas increase the vulnerability of people and may expose them to conflict. Therefore, it becomes essential to know whether farmer-herder vulnerability to climate change influences their local conflict.

It appears from the literature that most of the studies on climate change and conflict are more theoretical and general (Barnett & Adger, 2007a). Some study has investigated the link between climate change and farmer herder conflict in Burkina Faso and, Burkina and its neighboring countries (Abroulaye & Abalo, 2015; Cabot, 2017a). Others, studies have been done also on farmer-herder conflict regarding climate change and human security. What is less clear are the ways that farmer-herder vulnerability to climate change vulnerability affects conflict. There is lack of studies on farmer-herder conflict regarding their vulnerability to climate change. To the best of ours there no studies that constructed vulnerability to climate change to assess its influence on farmer-herder conflict.

The objective of the current study is to address this gap by focusing on vulnerability to climate change and how it influences farmer-herder conflict. The vulnerability is important to clearly identify the values that influence conflict (Cardwell, 2018; Tsomb et al., 2023). Given the state of the country vulnerability to climate change and the impact of environmental stress on resources availability, the occurrence of farmer-herder conflict will continue. Therefore, estimate the effects of vulnerability to climate change on conflict will allow evidence-based police simulation in Burkina Faso and similar countries.

The rest of this paper is structured as follows. The second section provides the related literature review. We discuss our conceptual framework and estimation strategy in the third section. Next, we describe the data, variable measurements, and descriptive statistics. The “Results and discussion” section presents and discusses the empirical results, while the final section summarizes the results and discusses policy implications.

2. Literature review

2.1 Theoretical literature

The eco-scarcity theory introduced by the neo-Malthusian Homer-Dixon to explain the link between natural resources scarcity and conflict, involving farmers and herdsmen. The main Theoretical assumption of Homer-Dixon is that resource scarcity is coming from insufficient supply, exceed demand, or unequal distribution because of environmental hazard that forces some sector of a society into a condition of deprivation and violence. Homer-Dixon theory has been expanded to establish a link to climate change. Fresh water, cropland, forests, and fish are environmental resources affected by climate change. The affected areas will experience scarcity that in turn will constrain livestock, agriculture and in general economic productivity. The decrease in economics opportunities of affected groups may push them to expel or to move to the news lands, with the corollary of consequence that this resettlement can generate with the host population. For instance, the areas where group religious, ethnic cleavage were noted are more likely to record the increased number of conflicts (Homer-Dixon Thomas., 1999).

Another argument in the literature is from Political ecology. For this theory, conflict resulting from environmental problems cannot be understood in isolation from political and economic process. Then, land access, land right and state policies are the main mediators of conflict. Within this theory, farmer-herder conflict goes beyond resources scarcity to include injustice(power asymmetries), marginalization and unequal access to land and representation; what people look resources conflict is often shaped by colonial land policies, post-independence structure and exclusion of nomadic communities from formal institutions.

In contrast to both previous arguments, the social identity theory focuses on intergroup dynamics. When herders and farmers identify strongly with their respective groups, especially in areas where historical grievances exist, minor disputes can escalate rapidly due to stereotyping, mistrust, and ingroup-outgroup polarization. This theory underscores the psychological and cultural dimensions of conflict, rather than material causes alone**.**

2.2 Empirical Literature

Calling for adequate research explaining or contesting the conflicting findings on the link climate change and conflict nexus, this study aims at investigating the link between climate change

vulnerability and farmer-herdsmen conflict. Farmer-herdsmen conflict is among other types of conflict, the recurrent one. Economic literature established several reasons.

Farmer-herder conflict occurs when destruction of crop happened in the farmland by herders animals, leading to crop production and incomes losses for farmers(Nnaji et al., 2022). In retaliation, farmers injuries animals but if the destruction is caused by nomadic herders animals farmers force them to leave the community. This often prompts herders to counteract, escalating the situation in violence(Dimelu et al., 2017). The loss of resources such as water and pasture, land per capita threat livelihood and may provoke dispute between crop farmers or farmer-herdsmen over remaining resources (Cabot, 2017b; Issifu et al., 2022; Meyer, 2017) in some areas facilitate rebel group to recruit marginalized people (Crost et al., 2018). User when deprived of his only means of subsistence or observe it decrease, is more tempted to join non-state forces since their cost to leave legal activities is lower. This situation is argued by (Collier & Hoeffler, 2004) as an opportunity cost for joining rebel group.

In another perspective, it's hypothesis in theory that climate change will cause migration with associate conflict in host area(Barnett & Adger, 2007b). Climate change induced migration of herdsmen from most impacted area to less impacted area to graze their cattle or to resettle. Therefore, this resettlement puts pressure on resources (e.g water, grazing land), generate competition with sedentary pastoralist and/or host farming communities and lead to conflict. In some cases, the conflict between herdsmen and host communities turns into ethnic or religious or ethnoreligious conflict. In fact, the ethnic group that has animal husbandry as its main activities or their identity are the Fulani and most of them are Muslim; their interaction with host Christian farming communities creates ethnoreligious hostility(Barnett, 2001; Usman, 2019a). (Issifu et al., (2022) argue that in Agogo region of Ghana the ethnic conflict put face to face the union of both nomadic-sedentary Fulani, and the host farming community. In the same ligns authors find that Boko Haram insurgency in Nigeria forced people to be displaced from insecure regions (eg. North) to secure region (South), leading on the one hand to pressure on resources and the second hand to conflict between famers and transhumant in central and southern regions(George et al., 2020; Ojo, 2020)

The climate change condition contributes to farmer-herder conflict(Adano et al., 2012; Buhaug, 2015). Eberle et al., (2020) argued that climate shocks have increase the probability of conflict

between farmer and herdsmen. When the temperature increases, this increases also the conflict in mixed and non-mixed areas in Africa. Indeed, +1 increase in temperature leads to +54% increase in conflict probability in mixed areas populated by both farmers and herdsmen, compared to +17% increase in non-mixed areas.

Farmer-herder conflict over natural resources has an increasing trend in vulnerable areas. This trend is explained in Sahelian countries by both rapid population growth and the effect of environmental stress. Day & Caus, (2020) find that areas facing a rapid population growth combining with the intensification of climate change effects are more exposed to farmer-herder resources uses conflict. Sahelian countries, including Burkina Faso, is among most vulnerable continent to climate change and variability due to his sensitive sector to climate change and location and projected to be seriously impacted (Abidoye & Odusola, 2015; Dell et al., 2014. Agriculture and livestock should be seriously impacted due to their strongly dependence in weather. The expected effect of climate change is the reduction of livelihood, water, food, arable land (Barnett & Adger, 2007a). Then, this situation exacerbates the current food security, vulnerability and intensify conflict over scarce resources that people are competing for (Solow, 2013). In Burkina Faso, severity to which farmer-herder are insecure to food, economic (e.g income losses), health and environmental scarcity induced by Rainfall variability and temperature explain farmer-herder conflict escalation (Abroulaye & Abalo, 2015).

3. Material and methods

3.1 Variables and data

The main variables are **conflict** and **vulnerability to climate change**

3.1.1 Variables definition

In economic literature, several authors provided explanations for conflicts. The most encountered in many studies is the definition of Gleditsch & Nordås, (2009). They defined conflict as "a contested incompatibility that concerns government and/or territory where the use of armed

force between two parties' results in at least 25 battle-related deaths in a calendar year". Most studies following the previous definition use conflict data from PRIO/Uppsala database. The inconvenience of following this definition and using this data is the restriction on the number of fatalities and the types of actors involved and are not particularly suitable for household level studies. The study is focused on internal conflict, the one between farmer-herder (FH). we define FH conflict following Nnaji et al., (2022) as the disagreement, fight and clash between FH. The advantage of our data is that it will allow us to capture the number of conflict, number of death, loss of yield and the property right in contrary to the PRIO/Uppsala database that record the number of deaths. During the field, numerators ask to the CVD respondent, how many farmers and herdsmen have been in discordance, clash or fighting in his community? In addition, numerators ask to the household respondent: are you been in discordance, clash or fighting against farmers or herdsmen in 2022? If the household responds 'yes'' in the previous question, we ask how many and we check if the conflict lead to the losses of yield, property right, loss of human life.

The household size (*Hhsize*) is measured as the number of household members. We expect that household size will influence conflict. The idea is that household size offers more fighting power then may increase the risk of conflict. **The household income** captures as the total income for household member. Income variable is expected to increase conflict and capture the opportunity cost to engage in conflict. In theory, collier and Hoeffler(1998) hypothesis that is an important predictor of conflict. **Crop diversificatio**n is several crops cultivated by the household. We assume that farmlands with more than one crop attract animals. This hypothesis follows one part of the literatures that finds that households implying in crops diversification experience more farmer-herder conflict(D'errico et al., 2021; Nnaji et al., 2022). **The household head age**. We expected that age variable would be negatively correlated with conflict. The literature characterizes certain ages with wisdom; therefore, we consider people with old age are less motivated to get involved in a deadly battle. **The household sex:** We expect that males are more likely to participate in conflict than female. **The variable Education**: more educated individuals are less involved in conflict, and this is negatively correlated with conflict (Becker, 1968; Collier & Hoeffler, 2004). This variable is measured as the number of years in school. **The farm size** is the total farmland measured in hectares. We assume larger size of farmland often reduces grazing area and increase

farmer-herder violence. **The road quality variable** is measured as a dummy indicating household perception of the road quality from their village to their farmland. We assume poor infrastructure exacerbates conflict. The presence of organization to prevent conflict. When their local tool to manage conflict exists people prefer to use it and then reduce the incidence of conflict.

Migrant. We expect that being a migrant can increase the risk of conflict.

Vulnerability to climate change (VCC). VCC " is the degree to which a system is able or unable to cope with adverse effects to climate change, including climate change variability and extremes(IPCC, 2001, 2014). In the existence study, we build climate change vulnerability index from our survey data. The literature offers a lot a of quantitative methods of vulnerability assessment including livelihood vulnerability index(LVI), LVI-IPPC, climate vulnerability index(CVI), Livelihood Effect index. In our analyses, we follow the method suggested by Xu et al. (2020) to construct an extended framework of climate change vulnerability assessment at the household level by combining the Intergovernmental Panel on Climate Change vulnerability assessment framework with the sustainable livelihood framework. After the method is determined, the next step was the choice of the methods to weight after normalization of each to calculate a comprehensive index. In this step the literature offers a lot of techniques such as the analytic hierarchy process, entropy weight, equal weight, expert score, the inverse of variance, principal component analysis. We combine principal component analysis (PCA) and the inverse of variance(IV).

To calculate vulnerability index, the literature offers various analytical formulas including vulnerability= exposure + sensitivity – adaptative capacity and vulnerability= (exposure +sensitivity)/ adaptative capacity, we choose the first one. Exposure is a nature and extend of a system's exposure to climate change, such as change in the intensity and frequency of rainfall, droughts or floods. Sensitivity refers to a system's responsiveness to climate change impacts. And adaptative capacity is an ability to a system to mitigate potential losses and take advantage of opportunities or cope with climate change(IPCC, 2014).

Methods for vulnerability assessment.

We are interested in the construction of vulnerability index using its components such as adaptive capacity, sensitivity and exposure components. For different components of vulnerability an adequate formula has been used.

- ✓ Exposure component

To construct the exposure index, all its indicators(extreme events intensity) for a household is normalized by dividing the sum of climate event by the maximum of intensity observed for all the household. The mathematic for formula for this computation is :

$$E_j = \frac{\sum_i^j E_{ij}}{max\left(\sum_I^j E_{ij}\right)}$$

With E_j the exposure of the j[th] household, E_{ij} the intensity for the j[th] household and the i[th] extreme climate event.

- ✓ Sensitivity component and Adaptative component

In this part, indicators that are binary variables, a value of 0 or 1 were assigned to each of them. For the ratio and classification indicators, the normalization is done using the following two formulas depending respectively on the positive or negative indicators.

$NS_{ij} = \frac{a_{ij} - min(a_{ij})}{max(a_i) - min(a_i)}$ and $NS_{ij} = \frac{a_{ij} - max(a_i)}{min(a_i) - max(a_i)}$

Where NS_{ij} denotes the final normalized score of the i^{th} indicator for the j[th] household, a_{ij} is the original value of the i[th] indicator for the j[th] household, and a_i represents the set of all scores for the i[th] indicator across all households.

For continuous variables a value of 0 was retained if the original value was 0. All non-zero values were ranked in ascending order and then categorized into four equal groups, assigned normalized scores of 0.25, 0.5, 0.75, and 1, respectively. This approach was used to reduce the influence of outliers and ensure comparability across different types of variables.

Since this step of normalization is done, we use inverse of variance and PCA to calculate a comprehensive index

The weights of each indicator were computed using the square root of their variances, as follows

$$W_i = \frac{c}{\sqrt{var(x_i)}}$$

W_i is the weight of indicator x_i

$var(x_i)$is a variance of indicators x_i

C is a normalization constant, defined as:

$$\mathrm{C} = \left[\sum_1^i \frac{c}{\sqrt{var(x_i)}}\right]^{-1}$$

This ensures that the sum of all weights equals 1 after standardization. The weights were calculated separately for the sensitivity and adaptive capacity components.

Next, each raw weight w_i is normalized within its component to produce a new standardized weight:

$$w'_i = \frac{w_i}{\sum_{i=1}^n w_i}$$

w'_i is the normalized weight used to calculate the subcomponent scores,

n is the number of indicators within the subcomponent

The subcomponent scores for Sensitivity (S) and Adaptive Capacity (AC) for each household j are calculated as respectively:

$$S_j = \sum_1^i W_S{}' \, NS_{ij} \qquad \text{and} \qquad AC_j = \sum_1^i W_{AC}{}' \, NS_{ij}$$

The scores of individual subcomponents within each component were aggregated to derive a composite index for that component. Specifically, by computing the exposure, sensitivity, and adaptive capacity scores for each household, an average vulnerability score was obtained to represent the overall vulnerability of the region. Once the indices for exposure (E), sensitivity (S), and adaptive capacity (AC) were established, the regional vulnerability index was calculated using a composite vulnerability equation (V=S+E – AC)

Table 1: Indicators and their relation with vulnerability

components	subcomposantes	Factors	Indicators	link to vulnerability
Exposure(E)	**Hazardous Event**	Drought	perception of the frequency of drought in these 10 last years	Positive (+)
		Flood	perception of the frequency of flooding in these 10 last years	Positive (+)
		wind-violent	perception of the frequency of the winds violent in these 10 last years	Positive (+)
		freshness extreme	perception of the frequency of extreme freshness in these 10 last years	Positive (+)
		insect-pest	animals affected by pests and animals insects in these last years	Positive (+)
		heat extreme	perception of the frequency of the heat is extreme, these 10 last years	Positive (+)
		variation rainy season	perception of the frequency in the offset of the beginning of the rainy season	Positive (+)
Sensitivity(S)	**Factor demographic**	Ratio dependence	Number of person who are not of working age on the number of working age	Positive (+)
		member-menage involved in Agriculture	number of the member of the household directly use in Agriculture/total menage	Positive (+)
		Medical Service	the number of times a member of the household, went to a hospital in 2022	Positive (+)
	Water	Quality of water	Access to a source of drinking water	Positive (+)
		availability of water	the frequency in the non-availability of water	Positive (+)
	Energy	Energy	availability of energy	Positive (+)
	Earth	Area of land	the total area of your agricultural land	Positive (+)
		Type of land	number of type of land	Positive (+)
	Breeding	Animals	number of animals	Positive (+)
	Home	materials of construction	materials of construction	Positive (+)
Adaptive capacity(AC)	**Human Capital**	Education	level of education of head of household	Negative (-)
		workers in non-agricultural	proportion of workers in non-agricultural in the household	Negative (-)
		insurance-health in the family	proportion of family member with insurance sante	Negative (-)
		Agricultural training	proportion of member of the family who have taken a training in agriculture 2022	Negative (-)
		decision-making	voices of women in decision-making	Negative (-)
	social capital	social network	number of family members participating in the activity social	Negative (-)
		Trusted	confidence in a member of your ethnic group	Negative (-)
			confidence in a member of another ethnic group	Negative (-)
		number of sales(sales channels)	number of times a member of the household went to sell at the market	Negative (-)
	Physical Capital	Self-sufficiency	the share of production spends for domestic consumption	Negative (-)
		Diversity of agricultural	diversity of culture farm	Negative (-)

capacity(AC)	Physical Capital	Accessibility in the hospital	distance to the nearest hospital	Negative (-)
		Accessibility to the market	distance of walk to the nearest	Negative (-)
		communication equipment	ratio: amount of telephone/number of the members of the household	Negative (-)
		means of transport	Means of transport belongs to the household(horse, bicycle, motorcycle, vehicle...)	Negative (-)
	Financial Capital	Income	A total of household income	Negative (-)
		source of income	diversification of income sources	Negative (-)
		savings of the household	percentage of members of the family with a bank account	Negative (-)
		Agricultural Insurance	percentage of land covered by insurance	Negative (-)

3.1.2 sampling procedure, data and profile of the study area

The study regions are East and Hauts-Bassins, located in distinct climatic zones, each with its geographical and climatic characteristics that can influence their socio-economic dynamics and vulnerability to climate change. East region is in Sudano-Sahelian zone which lies the parallels 11°30' et 14°N, experiences high temperatures, with the peaks close to 48°C during the drying season. Annual rainfall ranges 600 to 900 mm which is relatively significant but still subject to considerable year-to-year variability. This region faces intense drought followed by heavy rains making it vulnerable to floods and land degradation, which affect directly agriculture productivity and water availability for both crops and livestock. The Hauts-Bassins region is in Sudano-sudanian zone, south of the 11°30'N parallels, the region enjoys a more temperate climate compared to Sudano-sahelian area with abundant and stable rainfall exceeding 900 mm annually. This favorable climate, combined with the fertile soils, makes Hauts-bassins one of the agricultural productive hub of Burkina. Hauts-bassins support diverse range of crops staple food(millet, Maize, rice, sorghum) and cash crops(cotton). Despite its agricultural potential, climate changes poses significant challenges including occasional drought, soil erosion and shifting rainfall.

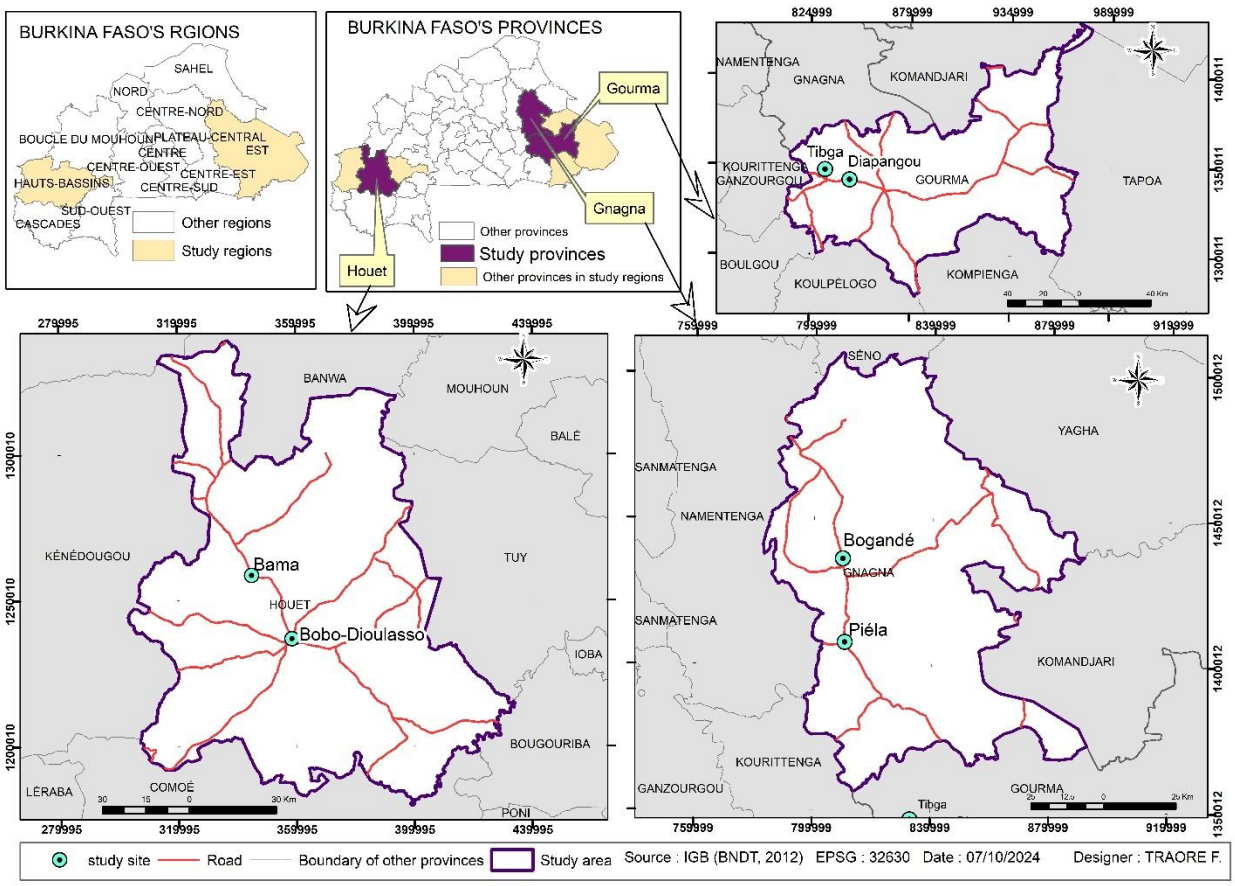


Figure 10: Study area
Source: authors presentations based on field work data

A **sampling procedure** can be defined as a method used to select a subset or sample from a whole population for study. When studying the entire population is impractical or complicated due to constraints such as time, cost or access researchers use to draw sample from the whole population. Then, when constructing the sample it is important to pay attention in order to ensure that the sample drawn is representative of the entire population. The literature offers two key of sampling procedure, probabilistic sampling procedure and non-probabilistic sampling procedure. The first one is a sampling procedure where every member has the same chance to be selected. The advantage of this method is that it ensures that the sample is representative and minimizes the bias. It can divide into in five types, Simple Random Sampling, The Systematic Random Sampling, the Stratified Random Sampling, the Cluster Sampling and the Multipli-Stage Techniques. In contrast, in the non-probabilistic sampling procedure, not every member of the population has the same chance to be selected, as consequence we can meet bias problem. It includes four types,

Convenience Sampling, Purposive (Judgmental) Sampling, Snowball Sampling and Quota Sampling. Considering the advantages and disadvantages of two methods, sampling procedure was selected in this study.

Our study focuses on two regions, East and Hauts-Bassins, situated in distinct agroecological zones. Based on secondary sources, these regions have reported the highest frequency of farmer-herder conflicts. In the Hauts-Bassins region, we selected one province, while in the East region, we chose two provinces due to security concerns. To increase variation in our sample and improve representativeness, we selected two communes within each province: one with the highest occurrence of farmer-herder conflicts and one with fewer conflicts. Thirdly, we randomly selected four villages within each commune. From each village, heighteen households were randomly chosen, totaling approximately 440 households, consisting of both farmers and herdsmen. The selection of active farmers and herdsmen household in each village was carried out with the assistance from their community representatives. The selection process was randomized, based on list of farmer and herder households provided by the representatives to ensure fairness and inclusivity. How was this sample size determined?

In empirical studies like this study, the sample size is a key element when the objective is to infer entire population characteristic to the sample. To make valid generalizations from a random sample and minimize sampling errors or biases, the sample must be adequate size(Taherdoost, 2018)

The literature offers methods or formulas to determine the sampling size such as Yamane, Krejcie & Morgan Formula, Cochran, Green formula, Jacob formula. In this study we follow the formula suggested by Cochran. Cochran proposed in the literature two formulas to compute sample size, one when we are finite population and another one when the population size is unknown. In this study we used the formula in the case when the population size is infinite. The equation of this formula is:

$$n = \frac{p(1-p)\, z^2}{\varepsilon^2}$$

Where n: sample size, p is the population proportion that is 0.5 $p(1-p)$is the estimate of variance , Z = 1.96 is the critical value that represents the numbers of standard deviations from the means

corresponding to the desired confidence level(95%), e is a margin of error or desired level of precision(5%)

$$n = \frac{0.5(1-0.5)\ 1.96^2}{0.05^2} = 384.16 \approx 384 \text{ respondents}$$

Following Cochran, our sampling size is 384 respondents. In social research, methods like surveys are commonly used for data collection, but response rates generally fall significantly below 100%. In light of this, some researchers recommended for oversampling(Salkind, 1997). Given the sensitive nature of our topic, which involves conflict in a context where 40% of the country is under terrorist control and over 2 million individuals are internally displaced, we have decided to expand our sample size to 440 respondents (it represents about 15% increase). This adjustment aims to account for potential biases resulting from non-responses; researchers such as Donald (1967), Hagburgt (1968), Johnson (1959) suggest that to take a random sample of 10-20% of non-respondent's follow-up analyses. The survey conducted between October and November involved both quantitative(questionnaire) and qualitative (focus group discussion) approaches to examine the complex dynamics of farmer-herder conflicts. This mixed-method approach allowed for a more nuanced understanding of the causes and consequences of these conflicts and covering the period from October to November 2023. Questionnaire and focus group discussion has been implemented to respectively interview and captures farmers and herdsmen and the causes and consequences of conflicts. Additionally, interviews were conducted with key individuals experienced in conflict management, providing essential insights into the strategies and challenges in resolving disputes. Before deploying the interviewers, we conducted an exploratory survey with 25 respondents to anticipate potential challenges. This helped us identify issues such as unclear questions (e.g., those regarding climate change perceptions, conflict).

3.2 Empirical model

The objective of the study is to assess the effect of farmer-herder vulnerability to climate change on conflict. The literature offers many methods including econometrics techniques. Broadly speaking, one can distinguish between linear regression approach, logistic regressions, Instrumental methods, Two stage least square methods, regressions based on structural equations

modelling and Agent based modelling of environmental conflict(Fjelde & von Uexkull, 2012; Maystadt & Ecker, 2014; Tsomb et al., 2023; van Weezel, 2020). The choice of one statistical technique over another depends both one the nature of the conflict data (dichotomous or continue) and the objective pursued by authors in their study. The statistical technique that we used to analyze the data and produce the results is the linear model, an appropriate regression model applicable when the dependent variable is continuous. The linear regression model using OLS provides a powerful tool for investigating the relationship between an outcome variable and multiple explanatory variables that are potentially correlated with each other. The impact of one variable can be investigated, controlling other variables or confounding factors (if these are observed). Another advantage of linear regression is that it useful in empirical work, even if there is no behavioral content in the model. Below, we provide the details of the model formally.

$$\mathrm{FH}_{\mathrm{conflicti}} = \boldsymbol{\alpha_0} + \boldsymbol{\beta_i} X_i + \boldsymbol{\theta_i} IVCC_i + \varepsilon_i$$

where $\mathrm{FH}_{\mathrm{conflicti}}$ is the incidence of farmer-herder conflict in the study area. Xi represents a vector of the control variables (e.g., age, gender, education, household size, and farm size, ethnicity fractionalization, local institution, etc); IVCC means vulnerability to climate change index and εi is error terms.

3.3 Descriptive statistics

The control variables in this study are selected based on the relevant literature (Issifu et al., 2022; Kugbega & Aboagye, 2021; Nnaji et al., 2022; Tsomb et al., 2023).

In our sample its composed of farming activities household and livestock activities household in two regions of Burkina Faso.

The FH conflict variable, with an overall a mean of 3.67(out 30), indicates that, on average, farmer herder conflicts occurred about three times in the communities surveyed in 2022. The regional disparities, with the Hauts Bassins region averaging 5.3 conflict compared to 1.7 in the East suggest more tensions in Hauts-Bassins.

The assessment of the vulnerability to climate change at household level reveals regional disparities. These disparities are due to the key component of vulnerability such as exposure, sensitivity and adaptative capacity. The vulnerability index of our study area is 0.46097 driven by it key component: exposure score 0.6564, sensitivity score 0.5203 and adaptative score 0.5358. Theses aggregate score figures mask significantly disparities. Indeed, East has a vulnerability score of 0.5029 while Hauts-bassins has 0.3985, based on these scores, East stand out as the most vulnerable region.

In terms of its key components, the exposure contributes significantly to global vulnerability in the two regions, with the East scoring 0.4197 compared to Hauts-Bassins 0.3554. in addition, the sensitivity score of East is relatively higher 0.4744(0.4814316) than Hauts-Bassins 0.4245. Despite both it higher score in terms of exposure and sensitivity, the East has the lower adaptative capacity 0.4008, which exacerbates its vulnerability. In contrast, Hauts-Bassins region more expose but has significantly lower sensitivity combined with a strong adaptative capacity 0.3814, which alleviate it vulnerability

In the communities surveyed, on average the households have 9 members, with the head averaging 46,28 years of age. In addition, the household is involved in crop diversification, cultivating more than three crops (3.21) on an area of approximately 4 hectares (3.96). Also, in the communities surveyed, about thirteen percent of the respondents indicated that they are from other communities. When classifying them as internal migrants, a figure closely aligned with 13.4% reported by INSD (2019). About nine percent of our sampled household heads are female. In comparison, data from the General Census of the Population and Housing in Burkina Faso INSD(2022) reported about fifteen heads are female. The difference may be explained by the regions covered in our study are among those with the lowest proportion of female household heads compared to other regions in Burkina Faso.

The household income is 342413.53 and about 66 percent of our household perceive that the road from their village to farmland is bad quality. About 66% of our reveal that there is the presence of local organization to manage or mediate conflict. In the communities surveyed, the household spend on average 46 minutes to reach the close police station.

Table 2 : Descriptive statistics of variables

Variables	Definitions	Min	Mean	Std dev	Max
Conflict	Number of farmer herder conflict in the community	0	3.67	7.03	30
Age	Age of household head(years)	18	46.28	12.8	99
Farm Size	Total cultivated farmland(hectares)	0	3.96	6.65	10
Gender	**1** if household head is male, 0 otherwise	0	0.91	0.29	1
Education	Education of household head (years)	0	2.04	3.92	14
Household Size	Number of household members (persons)	1	8.95	6.06	43
Crop diversification	Number of crops cultivated by household	1	3.21	1.22	8
Time taken to police station	Time spent on the road from household to the closest police station(minutes)	10	46.92	60.55	680
Migrant	**1** if the household does not originate from the locality	0	0.126	0.33	0
Local institution	**1** if there is a local institution to manage and prevent conflict in the community	1	0.661	0.47	1
Vulnerability index	Climate change vulnerability index	0.23	0.46	0.17	0.77

Source: authors based on field word data

Table 3: Matrix of correlation

Variables	1	2	3	4	5	6	7	8	9	10	11	12
(1) Conflict	1											
(2) Age	-0.05	1										
(3) Gender	0.08	0.01	1									
(4) Local institution	-0.18	-0.09	-0.1	1								
(5) Time taken to police station	-0.08	0.09	-0.06	0.03	1							
(6) Migrant	-0.05	-0.01	-0.06	-0.12	0.01	1						
(7) Road quality	-0.03	-0.03	0.03	0	0.03	0.13	1					
(8) Vulnerability to climate change	0.03	-0.01	0.07	0.03	0.05	-0.04	0.09	1				
(9) Sensitivity	0.02	-0.06	-0.04	-0.02	-0.04	0.02	-0.1	0.81	1			
(10) Exposure	0.02	0.04	0.07	0.03	-0.05	0.05	-0.12	0.84	-0.69	1		
(11) Adaptivity	-0.05	0.04	0.06	-0.07	-0.03	0.05	-0.02	0.53	-0.39	-0.4	1	
(12)Revenue	0.03	0.12	0.04	-0.07	-0.06	-0.01	-0.03	-0.03	0.08	-0	0.1	1

4. Results and discussion

In this section, we present the effect of climate change vulnerability on farmer-herdsmen conflicts in our study area, using both quantitative analysis and qualitative description

4.1 Quantitative results

The table 3 reports the effect of farmer-herder vulnerability on conflict. The first column indicates the list of independent variables in our analysis. The table shows that the relationship between the two main variables, farmer herder vulnerability to climate change index and conflict, is positive and the associated coefficient is significant at level of 5%. Although the 5% significance level only supports relationship between our main variables, our analysis remains consistent with the literature on the link between climate change and conflict, which identifies climate change vulnerability as a threat multiplier of local conflict risk. The result reflects the fact that an increase in vulnerability to climate change positively influences conflict. The result support previous studies that find that climate change through its effects on agri-food resources lead to an increase in conflict in Africa (Crost et al., 2018; van Weezel, 2020). A previous study in Burkina Faso reveals that farmer-herder vulnerability increases their insecurity and then multiplies the occurrence of conflict (Abroulaye & Abalo, 2015). The result is also understandable since farmer-herder vulnerability increases their competition for resources; it is a major driver of violence (Eberle et al., 2020). This means vulnerable to climate change acts as a stressor, exacerbating tensions and disputes over shared resources. Our result is very important since it supports previous studies and has implications for policy design. It suggests that when elaborating policies to reduces farmer-herder conflict in the context of climate change, the effort should be focused on the reduction of their vulnerability instead of fighting against climate change itself because the cause is exogenous to the study area(even to the country) which represents less than 1% of

To be more comprehensive, we check which component of vulnerability contributes to conflict because the level of vulnerability is induced by its component. The second regression indicates that the exposure component and sensitivity component have a significant positive effect on farmer herdsmen conflict. The higher level of exposure to environmental stress increases the farmer-herder conflict by 0.011 unit. This result resonates with Meyer, (2017) who found that environmental stress-driven exposure, for instance, to drought leads to intensifies competitions and conflict over resources in agrarian area in West Africa. This is understandable since exposure

depends on environmental factor over which peoples in our study area have not control because it is exogenous to them. The variable sensitivity affects positively farmer herder conflict. This reflects that high sensitivity to environmental change (water scarcity) amplify tension in agrarian and pastoral communities. This result is supported the study by Issifu et al., (2022) who found that sensitivity of farmer herder activities to climate variabilities increase their competition which leads to confrontation. The effect of exposure and sensitivity component on farmer herder conflict suggest that when elaborating climate policies to combat farmer-herder conflict that has very popular should be oriented toward the mitigation of climate change effect.

In addition, our studies show that revenue has a strong and positive effect on farmer-herder conflict. Indeed, an increase in farmer-herder revenue, increase farmer-herder conflict. This trend means that user are become rich, they do not tolerate crop damage or wealthier herders invest more in defending cattle and retaliating(Böhmelt & Bohnet, 2021).

Our result shows that the existence of local institutions to manage and prevent conflict affect negatively the incidence of farmer herder conflict. This means that the villages or communities that benefit local institution have a decrease in conflict level of 0.1328 unit than the communities that are not. This can be justified by the fact that when people in the community are aware of the existence of peaceful manners to resolve conflict prefer it instead of engaging in conflict. This result supports findings of studies that reveal that the communities which have conflict management tools are a smaller number of conflict including conflict impact compared to those which are not and support the studies that argues that local tools are suitable for natural resources management and resolution (Abroulaye & Abalo, 2015; Maiga, 2007b; Ofuoku & Isife, 2009). In the same line some studies show that when farmer or herder are far from institution that manage conflict, for instance police station, increase the number of conflicts incidence(Nnaji et al., 2022). This result also is in line with previous studies indicate that previous local institution can mitigate conflict(Homer-Dixon Thomas., 1999). Our result suggests that strong local institution and increase their capacities for resources management and conflict resolution reduce conflict in the area with both higher vulnerability to climate change and high ethnic fractionalization permit to mitigate the occurrence of conflict.

Table 4: effect of farmer-herder vulnerability on conflict

VARIABLES	First regression Farmer-herder conflict				Second regression Farmer-herder conflict			
	Estimate	Standard Error	t value	Pr(>|t|)	Estimate	Standard Error	t value	Pr(>|t|)
Intercept	0.526678	0.265330	-1.985	0.0478**	-0.542783	0.266860	2.011	0.04288*
Age	-0.001741	0.001475	-1.180	0.23855	-0.001673	0.001490	-1.115	0.26267
Gender	0.112764	0.064568	-1.746	0.08146.	0.114295	0.064604	1.805	0.07831 .
Local institution	- 0.132882	0.040295	-3.298	0.0010**	-0.131413	0.0.040123	-3.194	0.00127**
Road quality	- 0.013787	0.039904	-0.346	0.72988	-0.015697	0.039957	-0.470	0.069716
Log(Time taken)	- 0.044214	0.022403	-1.974	0.04908*	-0.045297	0.022456	-2.039	0.04204*
Migrant	- 0.034336	0.057065	-0.602	0.54769	-0.034869	0.057263	-0.609	0.54290
Log (revenue)	0.044624	0.019298	2.312	0.02123*	0.042206	0.019500	2.161	0.03123*
Vulnerability index	0.065032	0.032405	2.007	0.04540*				
Sensitivity index					0.026533	0.012268	2.162	0.03022.
Adaptative index					0.029905	0.026676	1.121	0.26290
Exposition index					0.011199	0.006346	1.764	0.06953 *

Source: authors based on field work data Signif. codes: 0 '***' 0.001 '**' 0.01 *' 0.05 '.' 0.1 ' ' 1

4.2 Qualitative results

During the focus group discussion both farmers and herders reveal that crop destruction is the first and foremost factor in escalating tension. Farmers, on average have 22 years of experiences in farming activities, emphasized that crop destruction by herdsmen animals is a root cause of clashes, confrontation. In their defense herdsmen, on average have 21years of experiences, reveal that crops destruction often occurs because of occupation of areas around water points and obstruction of pastoral and they don't do it deliberately. According to them, farmers plants crop around the pastoral routes. This behavior, by limiting space available for livestock to navigate and access grazing areas, is responsible for encroachment. Farmers neither denied nor confirmed this accusation against them, but some farmers argued that pastoral lands belong to them and highlighted the important number of animals per herder during grazing period as a crucial factor contributing to crops destruction. Farmer-herdsmen reveal that in their communities' conflict typically occurs at the start of rain season and few in dry season. Farmer-herdsmen live in mixed area, as the household sizes grow and land becomes degraded, competition for space intensify. With increasing populations both human and livestock, farmer expanded into new area for cultivation while herdsmen seek for new grazing land. As result, the competing activities have encroached on one another, leading to several consequences including the destruction, crops, injuries, poisoning of livestock and the potential confrontation between the two parties involved.

The conflict during the dry seasons arises from competition over the reaming resources. As highlighted during an interview with a RECOPA[14] agent, the prolonged dry season and the reduction water, caused by climate change have led decision-makers to advise farmers to engage in off-season cultivation. As consequence, farmers have turned to the lowland areas, which are more suitable for dry season farming. However, the same lowlands are critical for herdsmen, who rely on them as refuse zones to water their animals and graze on the few green plants that survive near these areas during the drought. As result, the obstruction of pastoral routes by farmers, reduced access to water for livestock, and the difficulty of moving animals to water points have become significant challenges. Grazing areas are shrinking, leading to animals trampling crops as they attempt to reach water sources, or even the

[14] Communication Network on Pastoralism(Réseau de Communication sur le Pastoralism)

destruction of crops as an alternative due to the disappearance of green vegetations around waters. All these factors escalate tensions, pushing actors towards violence. A discussion with local leaders and actives members involved in conflict resolution revealed climate change disrupts pastoral resources such grazing areas, water, salt licks, and causing low agricultural yields to contribute to the escalation of tensions. That confrontations could be reduced if pasture zone were demarcated and policies that clearly limited the expansion of agricultural expansion frontiers. In addition, the interview with agents from the Ministry of Agriculture and Livestock reveal that climate change by acting on the disruption of pastoral resources such as pastures, water, salt cures and low agricultural yields contributes to farmer herdsmen conflict. However, the conversation with the officials from the departmental court that during the process in conflict resolution, they often discover a latent or existing conflicts between actors. Then, the destruction of crops, poisoning of animals or injuries are usually just the final straw that triggers violent confrontation, serving as the tipping point for deeper unresolved tensions between parties.

But when the destruction of crops is carried out, the preferred method is the amicable settlement when the Farmers do not exaggerate the value of the damage. Indeed, traditional leaders often note that farmers exaggerate the value of the compensation, but a consensus is generally found when the conflict is brought to their level.

Perception of farmer-herders on the link between their vulnerability and conflict

During the discussion farmers highlighted water shortage, land degradation, drought is the majors' threat for their agricultural production and this trend increases their vulnerability or insecurity. They agree that phenomenon derives from climate variability can exacerbate their agricultural production risk and as among others factors the recurrent cause of disputes. Other factors consider as a threat to agriculture production in the community surveyed are famine, conflict, financial problems, lack of arable land, crop disease, climate variability and change, ethnic violence, and lack of agricultural technical training. For example, climate change contributes to reducing crop yield, food supply, reducing labour productivity and reducing per-capita output growth(Chen et al., 2016; Dasgupta et al., 2021; Kahn et al., 2021).

When their facing to the threats poses to the environmental challenge, farmers use various techniques to adapt including irrigation, half-moon, pray God, crop rotation, improve seeds, perrous cord, organic manure, invoke the ancestors, look for new farm area or migrate and diversify by doing

livestock farming (for instance, farmers have on average eight animals small and/or big ruminant). Farmers argue their vulnerabilities (water scarcity, drought, land degradation) themselves don't put them directly in the hands of violence but the degree to which their vulnerable influence conflict. Then, climate change with negative ramification in economic activities can disrupt agriculture production and contribute to violent conflict(Eastin, 2018; Iyke, 2024).

Herdsmen identify pests, water scarcity, drought, lack of grassland, pastoral routes for animals' mobility, animals' diseases or degradation of animal's heath a threat of their livestock activities and increase their vulnerability. Indeed, they argue that environmental stress contributes to the exacerbation of this vulnerability. To face the climate variability challenge, some of herdsmen reveal that they use to do seasonal migration or transhumance in Togo, Ghana and within Burkina Faso, reduce the number of animals by selling them, storing straw or buying agricultural residues or involve in agriculture farming. Their arguments that environmental stress perse don't create violence but it the behavior that they adopted(farmer-herder) when their vulnerability increasing regarding the control of natural resources influencing conflict because of conflicting resources needs.

The study also reveals that non climatic factors contribute to exacerbating conflict. Indeed, the insecurity caused by terrorism disrupts the traditional practices of herdsmen, such as transhumance, which is an essential adaptation strategy to climate change. Herdsmen who rely on mobility to find pasture and water for their livestock are suspended due to security risks and increase the vulnerability of pastoral communities. Under these circumstances, the new grazing space is very close to farmlands, leading to a range of consequences.

The second factor is the growing number of farmers and livestock. The increase in farmers requires the cultivation of the new land contributing to the expansion of the agricultural frontiers. At the same time, the augmentation of the numbers of animals demands more grazing area. Another factor is the tolerance for government policy of natural resources in response to climate change. To combat desertification, government policies have encouraged villagers to build villages forests, climate smart villages further reducing per capita availability of land for both farmers and herdsmen

4.3 Integrated result

Both quantitative and qualitative results support each other in some cases and diverge in other cases.

Convergence result in the two datasets

Quantitatively, the research shows that increased climate change vulnerability is linked to a rise in farmer-herders conflict. This increase in vulnerability is due to exposure and sensitivity component intensifies competition over controlling scarce resources. Qualitative findings reinforce this pattern. Indeed, farmer-herder during the focus group highlighted how those resources scarcity escalates tensions. If farmers indicated that crop destruction or damage is responsible to conflict onset, herdsmen argues that such destruction or damage often results due to restricted access to water points and pastoral routes. In addition, another notable pattern is ethnic fractionalization. We find a strong positive link between ethnic diversity and conflict, that supports the eco-scarcity theory in which environmental stress combined with social factors including ethnic diversity, increase the risk of violence. The qualitative data emphasizes that in social difference communities tension a rise because of conflicting resource need; farmer herder needs water, land paster that often disrupts agriculture and livestock activities and sources of resentment fuels. This confirms the quantitative analysis that indicates ethnic diversity influences farmer-herders conflict. In addition, the two datasets confirm the important role of local institutions in mitigating conflict. The statistical analysis shows that communities in which there are local conflict management and resolution institutions experience lower levels of conflict. The qualitative findings support this finding. Indeed, traditional leaders and officials reveal that amicable settlement processes prevent incidents, for example crop destruction, from escalating. Both Farmer and herder argue that when peaceful institutions for managing disputes exist and are accessible, they use it instead of engaging in conflict. Then, the two datasets show that the existence of local institutions has a strong effect from escalating. In another perspective, climate variability and adaptive behaviors confirm a strong pattern between the two data. Indeed, quantitative analysis indicates that exposure and sensitivity affect the likelihood of conflict; in the same lign qualitative accounts that farmer and herder adopt various adaptive strategies such as convergence to each other's activities, seasonal migration, irrigation, off season cultivation; these adaptations lead often to a new tension because intensifies competition for limited resources. Finally, the effects of non-climatic factors, such as security issue(terrorism) adds another layer of understanding conflict drivers in qualitative analysis whatever the quantitative does not directly quantify it. In fact, qualitative results highlight that terrorism disrupt traditional herding practices such as transhumance, herdsmen are restricted their mobility and must graze their animals in the same area as farmers raising the potential for violence onset. These qualitative findings suggest that non-climatic factors exacerbate climate-driven vulnerabilities.

Divergence finding in the two datasets

The conflicting findings in the two datasets are linked to vulnerability to climate change and it direct link. Quantitatively, the result indicates a strong relationship between vulnerability to climate change and variation of farmer herder conflict. However, farmers-herdsmen environmental stress creates and increases challenge, and it does not lead directly to conflict. They argue that violence only ensues when coping mechanisms fail, or when people adopt behaviors that heighten competition over resources. For example, some herders noted that they are compelled to move closer to farmlands only when they lack alternative pastures, suggesting that conflict may be less about climate change directly and more about the absence of sufficient adaptive support or infrastructure. This suggests that the quantitative approach might overstate the direct role of environmental vulnerability in causing conflict, as qualitative insights emphasize the importance of intermediary factors, such as behavioral adaptation and resource governance.

In addition, another little divergence is about the effectiveness of local institutions. Quantitative analysis finds that communities with local institutions experience lower levels of conflict. This suggests the strong protective role of local institutions. However, some farmers and herdsmen express frustration local institution mechanisms where the local institution members are unable to resolve conflict or were they perceived bias. They reveal that traditional leaders may favor one group (farmer or herder) over another group (farmer or herder). This situation led to dissatisfaction and sometimes lead to exacerbating tensions. Then, if the presence of local institution is statistically associated with reduction of conflict, alors qualitative result reveals that the effectiveness can vary widely, and depend on important factor such as fairness

These divergences between the two datasets results emphasize explain the complexities of farmer-herder conflict and highlight the limitation to focus on only one method. The statistical relationship provides a broad statistical trend; qualitative data captures local perspective and contextual nuances that offer deeper understanding of underlying tension.

5. Conclusion

In a context marked by a persistence conflict between farmer-herder and the intensification of climate change effect, this chapter aims to analyses the effects of farmer-herder vulnerability to climate change

and conflict. For that purpose, we conducted a survey in two regions of Burkina Faso during the period from November to December 2023. We combine quantitative analysis by using linear regression analysis and qualitative data description. Quantitively, the result shows that farmer-herder vulnerability to climate change influences positively their conflict. The vulnerability to climate change includes its composites such exposure, sensitivity and adaptation. The study finds also, the exposure and sensitivity components affect positively conflict while the adaptive component does not a predictor of conflict. Beyond these key variables, the study finds that ethnic fractionalization increases local conflict while local institutions for conflict management reduce the incidence of conflict. qualitatively, the discussion reveals that vulnerability to climate change influence conflict because it explains that the degree to which they are vulnerable explain violence. In the same analysis, respondents reveal that when local institution is their own communities, they prefer it instead of engaging in conflict.

In the context that farmer-herder conflict is widely expanded in Burkina Faso, our result proposes new approaches to combat the occurrence of farmer-herder conflict. As it seems practically impossible to combat climate change since it is exogenous to the country and to the study area in particular, the research proposes to encourage policy that can mitigate its effects and increase the resilience of farmer-herders. This previous measure will be insufficient since some factors, such as ethnicity diversity and local institutions for conflict management, affect conflict. Therefore, it's become very crucial when elaborating policies to mitigate climate change effect and resilience measures be accompanied with a fairness and equitable local institution for conflict prevention and management, and programs or activities aimed at fostering the tolerance for social difference(inter-ethnic) and dialogue in communities.

Concretely, policies that aimed to reduce farmers-herdsmen vulnerabilities to climate change. For instance, promotion of climate smart practices and facilitation of development of water infrastructure and grazing reserves. In addition, traditional leaders and the members that intervene in conflict management should be supported with training, financial and other resources to mediate conflict with fairness and effectiveness. Also, decision makers should imply both farmers and herdsmen during the decision processes to improve equitable allocation, resource demarcation to reduce competition around water and land, can be crucial to mitigate conflict.

CHAPTER 3: EFFECT OF VULNERABILITY TO CLIMATE CHANGE ON INTERNAL CONFLICT VIA MIGRATION IN THE SAHEL.

Abstract

In the relevant literature, Policymakers, researchers and scholars evidence warned that vulnerability to climate change countries can be affected by human conflict through agropastoral, infrastructure and migration channel. Few have investigated migration channel and found evidence, but findings were inconsistent across location. This paper focuses on a single area such as sahel to study the effect of vulnerability to climate change on conflict via migration channel. By using a structural equation modelling on a sample of nine Sahelian countries. We find that vulnerability to climate change has a direct positive effect on internal conflict in the sahel. We also, indirectly vulnerability to climate change affects positively internal conflict through migration channel in the Sahel. Then, on the one hand the study calls to support more vulnerable states to climate change vulnerability because failing to act may result in far reaching consequences that would go beyond environmental and economic losses to include internal violence. In the second hand, calls for integrating policies to simultaneously manage migration and conflict prevention.

Keywords: vulnerability to climate change, Migration, internal conflict, Sahel

some initial studies will impact on countries a relationship between climate change as well climate change vulnerability and conflict

1. Introduction

Climate change is considered one of the urgent environmental challenges, according to (IPCC, 2001). Africa is among others, the most vulnerable continent to climate change impacts(IPCC, 2014). At regional level, the Sahelian countries emerging have a critical case due to their geographical location experiencing increasing frequence and intense extreme events resulting from global climate change , (IPCC, 2022). These events are marked by the highly variable rainfall patterns, extreme temperatures and prolonged drought; cause production stability disruption due to the highly dependent climate sensitive sectors, undermine the livelihoods of large segments population who base their

income and food supply on rain-fed agriculture, change resources relocation and push people to migrate from most impacted areas to less impacted zones.

Migration in the Sahel is marked by increasing trend of both internal and cross border migration, described often in the literature as a coping mechanism to climate variability and economic stress (Issifu et al., 2022; V. Mueller et al., 2020). Seasonal or permanent migration has demographic pressures on degraded ecosystem and source of tension over access to natural resources(land and water) in host communities. This situation contributes to the rise of violent conflicts, according to Koubi (2017) and Raleigh et al. (2014).

Violent conflict in Africa and Sahel is marked by the increasing trend of internal armed and unarmed conflict (Bedasa & Deksisa, 2024; Ongo Nkoa et al., 2024; Siri, 2024). The conflict in the sahel is characterized by terrorism movement involving state and non-state actors, coups, community conflict and environmental conflict (Emeka et al., 2024; Ezeoha et al., 2023; Fang et al., 2020; Percival & Homer-Dixon, 1996a; Siri, 2024). These conflicts have exacerbated the pre-existent challenges faced by Sahelian including structural vulnerabilities, humanitarian crises. Economic literature documented the far-reaching conflict impact of conflict on fragile economies(Collier & Hoeffler, 2004; Emeka et al., 2024; Ezeoha et al., 2023; Fang et al., 2020). These effects manifest in multiple. Armed violence results in significant loss of human life, mass displacement, which in turn disrupts labor markets and undermines productive capacity. In addition, conflict impact includes the destruction of large scale and long-term degradation of socio-economic infrastructure, including schools, health facilities, markets, roads. Then, conflicts are a threat to both public and private sector development and reinforce the existing socio-economic inequalities (Abadie, 2006; Orosz, 2021; Baah & Lakner, 2023; Collier & Hoeffler, 2007; Emeka et al., 2024).

From all above, the Sahelian region is experiencing convergence vulnerability to climate change demographic pressures and escalating insecurity issues. The interaction between vulnerability to climate change, migration and conflict forms a vicious cycle, particularly where the state presence is weak(Cattaneo et al., 2019). The literature explored in isolation the relationship between climate change and migration, as well climate change and conflict or migration and conflict (Burke et al., 2009b; Rigaud et al., 2021; Schutte et al., 2021) Despite the increase relation recognition in the literature, fewer researches explored the triple links between climate change, migration and conflict simultaneously , particularly in the vulnerable area such Sahel where the dynamic seem to be acute (Boas et al., 2019; Ide et al., 2020). The limited integration of the three dimensions in literature

represents a critical gap and address is essential for both climate adaptation and conflict prevention strategies in vulnerable areas.

The aim of this chapter is to fill this gap by assessing the interconnected effect of climate change on migration and conflict in the Sahel. By focusing on the triangular relationship, this study avoids fragmentation or partial findings in the literature on climate change, migration and conflict in isolation.

The empirical analysis used panel data of nine Sahelian countries from the period 1997-2021 and simultaneous equation models are applied on the variables such as vulnerability to climate change index, UCDP conflict data, net stock migration, and other controls variables. Our preliminary results show that vulnerability to climate change influence migration that in turn influence conflict

The rest of this chapter is organized as follows. The rest of the paper follows this structure: the next section is focused on the literature review. The third is concentrated on methodology. Section four, results and discussion. And the chapter will end with conclusion.

2. Literature review

Climate change and conflict in the relevant literature is organized traditionally around five dimensions such as the type of conflict, the climate variable used, the theoretical pathway, empirical strategies and the geographical region used. Within this multidimensional framework, the literature distinguishes two branches, direct and indirect effect of climate change on conflict.

2.1 Related literature on the direct relationship between climate change and conflict

Scholars advanced in literature theories in the causal mechanisms on climate change, security and conflict. Arnall (2023) regrouped the causal mechanism in three main categories. The first categories highlight that political and governance factor. Indeed, according to Barnett, (2001), national or local governance, stability (nature of governance), and the resource scarcity or abundance influence on the likelihood of conflict emerging resulting from climate change. The second categories of studies lead by Seter, (2016) identified other factors such as economic and migration factors. According to the previous author, economic hardship due to climate change, resource availability or depletion, and migration resulting from climate due to economic change attach the link between climate change and conflict. Another suggestion in the literature is from Bretthauer, (2015). Indeed, the author suggested

areas with agriculture dependance coupled with low levels of education are more likely to experience or increase the likelihood of armed conflict due to the global warming.

The direct link between climate change and conflict is clearly established, according to IPCC, (2014). Building on this evidence, Koubi (2019) identified two types of conflict that can be directly affected by climate change: intragroup violence and interpersonal violence. The author argued that resource scarcity is pathway through which climate change affects the likelihood of intergroup violence. Indeed, falling within the logic of neo-Malthusian argumentation that assumed that extreme climate condition combined with overpopulation creates pressure on resources, reduces its availability to sustain human communities' livelihoods. As consequence, the competition of remaining resources increases and leads to conflict, according to Homer-Dixon (1999) and Dalby, (2002). And the other hand, some authors argue that nonsocial aversive such as extreme weather creates an environment of discomfort, changes the behavior of peoples and increases aggression, violence. That this the physiological/psychological effect of climate change(C. Anderson & Bushman, 2002; Koubi, 2019a).

From empirical point of view, there are plenty of researchers who worked on a direct link between climate change and conflicts (Adano et al., 2012; Bedasa & Deksisa, 2024; Cappelli et al., 2023; Urdal, 2005; van Weezel, 2020). This research generally focused on examining how long-term trends in climate parameters such as extreme events, temperature and precipitation influence the occurrence and intensity of conflicts. Weezel, (2020) argues that climate change exerts power on the continuation on the previous conflict. But he doubts the fact that climate change can cause the new conflict. Based on these previous findings, one can conclude that climate-conflict nexus may occur only in areas vulnerable to climate change. Buhaug & Von Uexkull, (2021) argue in countries such as Yemen and Afghanistan territorial vulnerability amplifies the effects of climate change, fueling a self-perpetuating cycle where vulnerability, conflict, and climate impacts continuously intensify. Cardwell (2018) adds that vulnerability to climate change plays a critical role in conflict resolution. When it may not be capable to prevent new conflicts from arising, it can aid in addressing ongoing ones by highlighting the underlying values that shape conflicts. Recognizing and understanding these values is essential for advancing negotiations and finding resolutions.

Using climate variability as a proxy of climate change, they find that climate change increases the risk of community conflict rather than civil war(Crost et al., 2018b; Fjelde & von Uexkull, 2012; Raleigh et al., 2014). Indeed, community conflict is likely to occur in dry season; rainfall variation decreases water and arable availability and could push violent entrepreneurial against other

communities to secure the remaining of scarce resources. Burke et al., (2009a) investigated the potential impact of global climate change on armed conflict in sub-Saharan Africa. By linking civil war to various measures of historical climate, they find a strong link between climate change and civil wars. Indeed, a 1 °C increase in temperature in their preferred specification leading to a 4.5% increase in civil war in the same year and a 0.9% increase in conflict incidence in the following year. In the same line, O'Loughlin et al., (2014), by applying multilevel modeling technique on database of conflict events and climatological data between 1980–2012, conclude that globally, high temperature extremes are associated with more conflict; however, the relation become not consistent at subregion level and for different types of conflict. In contrast, Buhaug & Theisen (2012) found that within contexts presumed most conducive to violence. Raleigh et al., (2014) argue that people directly respond to increased temperature by attacking their neighbors. Drought induced price shocks lead to more conflict (Maystadt & Ecker, 2014) .

Other range of studies found not yet significant statistically relationship between climate change and conflict. Others failed to find a significant relationship between conflict and climate variability in Africa from 1991 to 2009 by using simple generalized linear model (GLM). Authors find that one standard deviation that increases drought intensity and length raises the likelihood of conflict is absence of evidence in short-term relationship between drought and civil war onset, even by 62% (O'Loughlin et al., 2012).

One can conclude that Despite suggestions from theoretical propositions about the link between climate change and conflict, the empirical evidence for the link has been challenged. The contradictory result in empirical studies is due to the choices of conflict measure of conflict and the modelling design.

2.2 Related literature of indirect climate change on conflict

The indirect effect of climate change on conflict refers to the mechanism through which climate change does not cause directly violence but influences other variables (socioeconomics or political factors) that in in turn increase the risk of violence. One of the most critical channels identified in the literature is migration pressures. Following this channel, the literature is divided into two parts, the effect of climate change on migration on the one hand and the other hand, the effects of migration on conflict.

2.2.1 Climate change and migration

In the literature, the pathway connecting climate change to migration is complex and is far from understood (Abel et al., 2019) because the decision for agent, individual or household to leave or move from his own or current community to another one is made by considering multiple factors such as environment, socio-economic and demographic (Black et al., 2011; Boas et al., 2019; Horton et al., 2021). Then, when investigating the effect of climate change on migration, researchers highlighted strong context dependency in climate activities and climate type and the profile of affected population for the potential climate-migration links. Studies largely agreed that higher temperature and changed rainfall patterns resulting from direct manifestation of climate change leads to agropastoral production disruption, rural food production and livelihood system for low- and middle-income countries (FAO, 2017; IPCC, 2022; Lenshie et al., 2021; Tuholske et al., 2024). This situation pushes people to move from vulnerable areas to less vulnerable areas or encourage exode from rural to urban area where employment as less related or less sensitive to climate change. For instance, Africa has the specificity of having agricultural workers or labor around 50% of the population, according to (FAO, 2022). In view of this FAO report, persistent extreme climate events in the first-time will cause damage to rural livelihoods and worsen food insecurity and in second time accelerate the rural out- internal migration (to urban) or international migration. In the same perspective, Rostow (1960), in his theory of development argues when countries are making progress in terms of development, technology and capital are improved that help agriculture improvement and require less agriculture workers, in particular rural labor demand. Under such circumstances, according to Rostow, the excess rural workers will migrate to urban areas to look for jobs in manufacturing and services and look for better wages. Nowadays, people can migrate from rural areas to urban areas or others form of internal (or international) migration not for looking higher wages but for agrarian or livestock distress. For instance, in Burkina Faso livestock and agrarian distress due to environmental stress is among others the main raison for people movement to internal and international destinations(INSD, 2019; USAID, 2014a). Mueller et al.,(2020) argue that extreme events deriving from climate change such as floods destroys house and infrastructure and oblige people to move for seeking a safely area to install. Hendrix, (2004) find that in Burkina Faso, a rainfall deficit encourages long-term migration to nearby rural areas, while it decreases short-term migration to distant or international destination's locations. In Ethiopia, extremes events such as flooding increase male migration for job reason and discourage female migration for marriage; the climate variability encourage migration in Botswana and Keneya while it reduces migration in Zambia(Mueller et al., 2020). These conflicting results can be explained

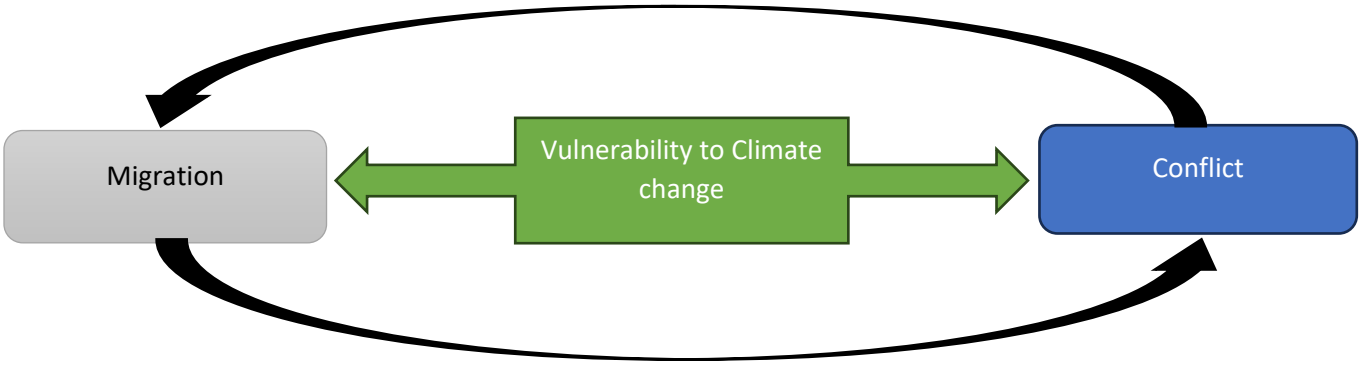
by the resilience of population over another population. That' why it is important to consider non climatic factors that may explain the level of adaptation of population to climate change. Climate vulnerability is likely to intensify the negative impacts of climate change in the most at-risk regions, leading to increased emigration and reduced immigration.

2.2.2 Migration and conflict

The economic literature of factors affecting migration are abundant and can be divided in two branches, according to Simpson, (2017). The first categories are economic factors such as over density, low income or salary, exorbitant taxes and jobless or severe unemployment. The second branch, non-economic factors include conflict, discrimination, poor healthcare, crime, natural disaster, corruption and famine and climate stress or change. Link to conflict, Freeman (2017) provides a thorough literature review on the relationship between climate-driven migration and conflict, noting that while research has identified migration as a potential cause of conflict, it often lacks an exploration of the underlying mechanisms(Kelley et al., 2015) . Freeman's study suggests that climate migration is generally active and intentional; rather than passively relocating, migrants often seek territories that offer natural resource wealth. This pursuit of resource-rich areas can limit access to social and economic opportunities for local populations, heightening competition and potentially fueling tensions and conflict between migrants and indigenous communities(Das, 2013). In the same line, somes authors find that climate migration reduces conflict in Africa because the net stock of migrants increase conflict(Tsomb et al., 2023)

However, Ide (2017b); Issifu et al.,(2022) add nuance to this view by showing that conflict is not an inevitable outcome of climate migration. They find that when migrants share socio-cultural similarities with local populations, a sense of mutual understanding and harmony may develop, reducing the likelihood of direct conflict. In such cases, rather than clashes between migrant and local groups, conflict may instead arise as collective demands directed at government policies, especially if both groups feel underserved or marginalized by state actions. This perspective highlights that the dynamics of migration-related conflict are complex and can vary significantly depending on the social and cultural context of migration. The mechanisms through which climate migration will affect conflict are inequality, poverty, state capacity and natural resources channels Issifu et al., (2022).

From our literature review we propose a graph that show the relation between climate change vulnerability, migration and conflict



According to this graph, vulnerability to climate change affects both migration and conflict and conflict has direct effect on migration and migration also affect conflict.

3. Methodology

3.1 Econometric model

The literature offers many models to analyze the effect of climate on conflict including Agent based modelling (of environmental conflict), Bayesians analysis, logistic regressions, linear regression, multiple regressions and structural equation modelling(Maystadt & Ecker, 2014; Tsomb et al., 2023; van Weezel, 2020). The choice of one model over another model is due to nature of conflict variables (dichotomous or continuous) and the objective of the study. In this chapter we are going to use structural equation modelling. Structural Equation Modeling (SEM) offers several advantages, particularly in handling complex relationships within multivariable datasets. One key benefit is SEM's ability to model both direct and indirect effects, allowing researchers to test hypothesized relationships between observed and latent variables simultaneously(Asamoah et al., 2019). Unlike traditional regression techniques, SEM can account for measurement errors, enhancing the accuracy of results. Additionally, SEM enables the testing of comprehensive theoretical models, assessing entire networks of relationships in one analysis rather than examining them in isolation. Structural Equation Modeling (SEM) offers the possibility to analyze complex causal systems by estimating several dependent relationships at the same time. When variables influence each other through both direct and indirect pathways, SEM is particularly suitable for disentangling these effects. In longitudinal applications, the approach makes it possible to incorporate both time-varying and time-invariant predictors. SEM has become widely used because it integrates confirmatory factor analysis with regression techniques, allowing researchers to model diverse economic, social, and behavioral processes within a single coherent framework.

The formula for analytical models is three equations. The first equation analyzes the effects of readiness on vulnerability to climate change. The second equation is a migration equation, and the third equation is a conflict equation

$$CCV_i = \alpha_1 + \alpha_2 Readness_i + \varepsilon_i \quad (1)$$

$$Migration_i = \alpha_1 + \alpha_2 VCC_i + \alpha_3 GDP_i + \alpha_4 conflict_i + \beta_5 Arable\_land_i + \varepsilon_i \quad (2)$$

$$Conflict_i = \beta_1 + \beta_2 VCC_i + \beta_3 migration_i + +\beta_5 education_i + Population + \varepsilon_i \quad (3)$$

CCV represents the Climate Change Vulnerability Index, while the readiness indicator reflects the impact of adaptation measures to climate change. Arable Land denotes the logarithm of arable land, and GDP serves as an indicator of generated wealth, measured by gross domestic product. Pop represents the total population expressed in logarithmic form, while Mig denotes the net migration stock, also presented in logarithmic form. The idea behind the variables in logarithm form is to eliminate the potential biased that can be introduced due the scale of measurement of variables

3.2 Empirical model

The estimation techniques that will be used is maximum likelihood, more appropriate to analyze our data using structural equation modelling. To counteract a potential endogeneity bias due to the two-way relationship between migration and conflict, we will use instrumental variable techniques. This technique consists of considering during the regression, the covariance between error term from migration equation and error term in conflict equation as a constant term to be estimated.

To know whether direct effect of vulnerability or indirect effect are more appropriate for the analyses we confront the direct model of vulnerability to climate change, to indirect effect of vulnerability to climate change on conflict through migration by following Singh et al., (1994) approach in the literature. Indeed, Singh and his colleagues propose an approach to test for intermediate variable effects when analyzing the relation between independent variable, mediator and dependent variables. The model with indirect effect through migration is chosen over direct if the following hypothesis are met:

- ✓ Increase percentage of variance

If we observed with the indirect model the higher percentage of variance explained in conflict due to vulnerability than the direct model, this indicate that the presence of migration variable provides more comprehensive understanding of the link between climate change vulnerability and conflict.

- ✓ Significant relationship between vulnerability to climate change and migration.

For the migration variable to be a mediator the sine qua non condition is that there must be a strong relation between vulnerability to climate change and migration. In other term, vulnerability to climate change must influence migration patterns, needed to consider it as a mediator

- ✓ Insignificant effect of vulnerability to climate change on conflict

The relationship between climate change and conflict must be insignificant that allow to support the presence of mediator variable because migration is capturing some effect of vulnerability to climate change on conflict.

- ✓ Significant relation between migration and conflict

This significant relationship is essential and solidifies migration as a mediator variable.

If these four conditions are met, then the role of migration as an intermediate mediator variable is supported.

3.3 Data analysis and study area

This chapter conducts an empirical analysis of the link between climate change vulnerability, conflict, and migration in the Sahel. Africa and Sahel in particulars was chosen for this study due to the increase trends in armed conflicts (ND-GAIN, 2024; Ongo Nkoa et al., 2024; Siri, 2024). Our study area covers 9 Sahelian countries (Burkina Faso, Chad, Cameroon, Guinea, Mali, Mauritania, Niger, Nigeria and Senegal) define as a political region of the sahel by UNISS (united nation strategy for the Sahel). The regions faced many challenges such climate stress and political instability. The study period go from 1998 to 2021. This timeframe was chosen because climate change vulnerability (CCV) became available starting in 1995 and due to the attention pay to climate change issue since the Earth Summit since 1992. The study period concludes in 2021 due to the lack of data on main variables beyond 2021. Data for this chapter come from various sources: conflict data(internal conflicts) are drawn from the PRIO/Uppsala database, vulnerability to climate change index and readiness data are from (ND-GAIN, 2024), and migration data are provided by the United Nations website (2024).

The table below provides the descriptive statistics of selected variables in our study. The vulnerability variable is a continuous variable, its value range between 0.464 and 0.660 with the mean of 0.564. This means that on average Sahelian countries are highly vulnerable to climate change (0.564) following the classification of ND-GAIN (Notre Dame Global Adaptation Initiative). Internal violent conflict is a binary variable that takes zero for no conflict and one for conflict. In addition, 34.72% of observations present an episode of conflict that led to at least 25 battle related deaths. On average the decrease of the net stock of migration by 2.35%. This mean in the sahel on average we observe more emigration than immigration with 3.56 as a standard deviation explaining heterogeneity between countries. Some control variables (such as education sd=1.26, GDP=0.661 and Population sd=1.34) reveal disparities between countries.

Table 5:Descriptive statistics of variables

Variables	Observations	mean	Standard deviation	Minimum	Maximum
VCC	216	.564485	.0562946	.4642001	.6605521
Log (Migration)	216	-2.352016	3.559394	-5.191104	5.042918
Conflict	216	.3472222	.477193	0	1
Readiness	216	.2882152	.0482439	.1611884	.4223972
Log(Arable land)	216	12.50593	11.31637	.4365965	40.48443
Log (GDP)	216	23.36667	1.257229	21.86529	26.97416
Log (Population)	216	16.16325	.6615352	14.7518	17.11868
Log (Education)	216	14.54282	1.339292	11.66928	16.47824
Capacity	216	.7922258	.0671801	.6492382	.9195344
Sensitivity	216	.4415884	.0824066	.3065042	.6478567
Exposure	216	.5095505	.0592009	.4355588	.6326968

Source: authors based on various secondary sources

VCC: vulnerability to climate change, Migration: immigration minus emigration. Readiness: measures a country's ability to leverage investments and convert them to adaptation actions. variables are sourced from the World Bank's World Development Indicators (WDI, 2023).

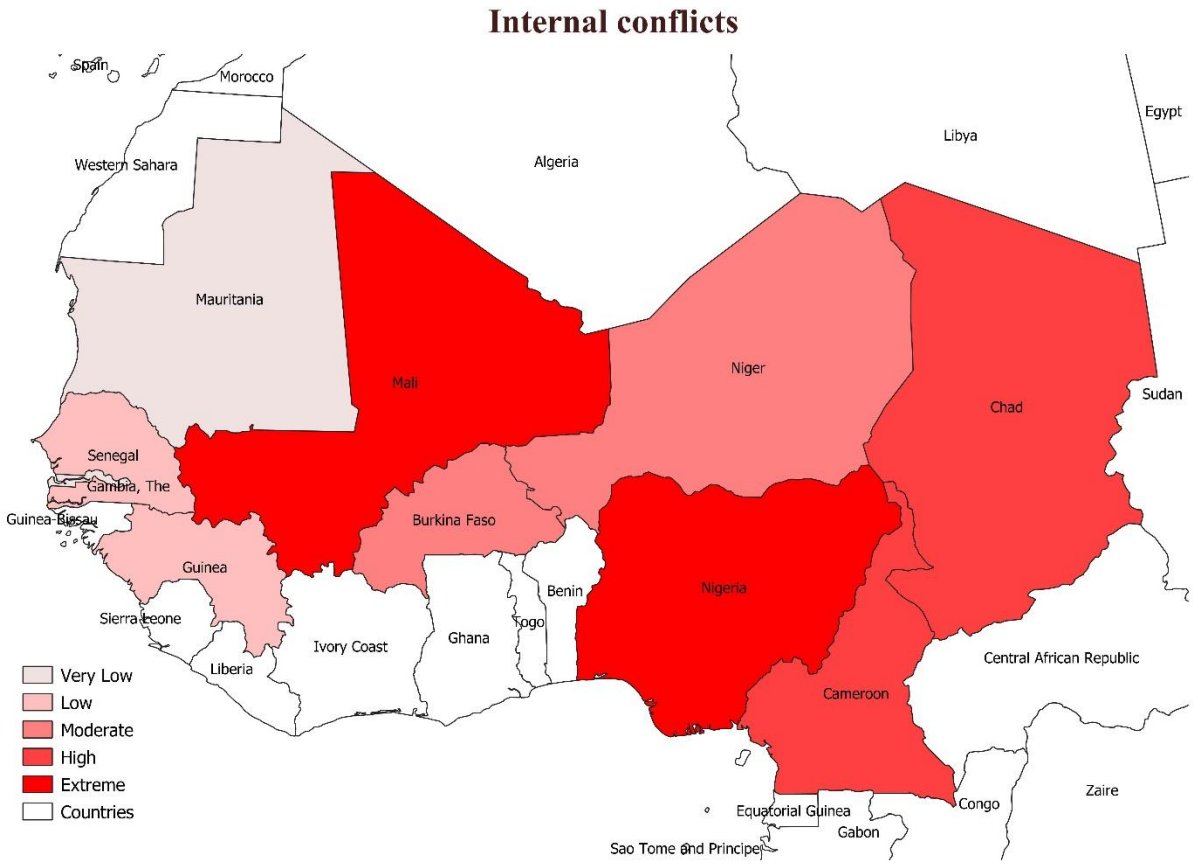


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Figure 11: Geographical distribution of internal conflict in the Sahel
Source: Authors based on PRIO/Uppsala conflict database (2021)

The map above presents the geographical distribution of internal conflict in the Sahelian countries of Africa, ranging from very low to extreme level of violence. While Cameroon Chad, Nigeria and Mali experienced more occurrence of internal violent conflict others such as Guinea and Senegal recorded a very low level of violence. Except Nigeria, the Coastal countries in Sahel have low level of conflict from 1998 to 2021 compared to non-coastal countries.

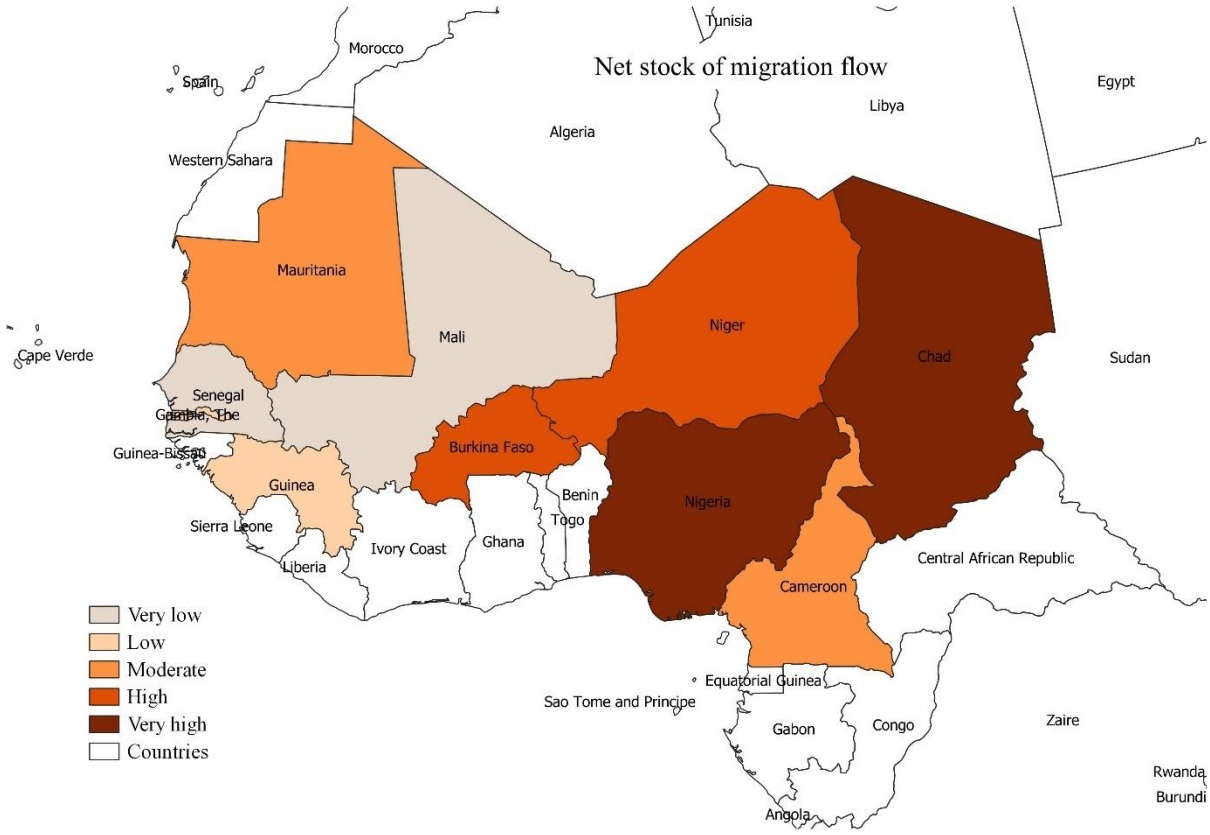

Figure 12: Geographical distribution net stock migration in the sahel
Source: Authors: United Nation(2024)

On average some countries such as Mali, Senegal, Guinea, Gambia are more level of net stock migration, implying there are more emigrants than immigrants. In contrast, Nigeria and Chad have very low level of net stock migration. Theses have little stock of net migration or more immigrant than emigrants.

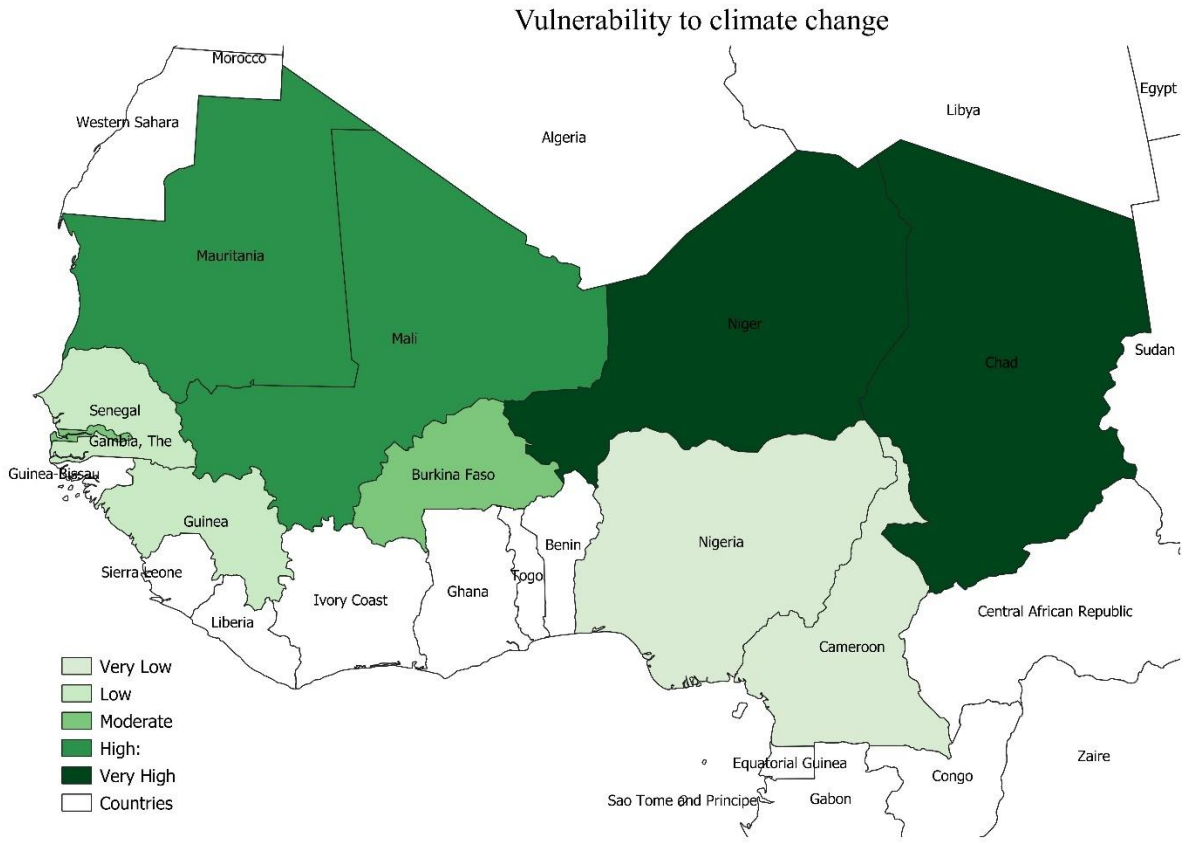

Figure 13: Geographical distribution of vulnerability to climate change across Sahelian countries
Source: authors based on Notre Dame Global Adaptation Initiative database(2021)

The map shows asymmetric distribution of climate change vulnerability across Sahelian countries and emphasizing the heterogeneity of our study area regarding the risk to climate change. Indeed, some countries are more vulnerable than others. For instance, on average, landlock countries of the sahel are more vulnerable to climate change than Sahelian countries.

Regarding the three figures, some keys points need to be mentioned. Landlock Sahelian countries are more vulnerable to climate change (ranging from moderate to very high level) experiencing more violent conflict combined with net stock migration that ranges from very low to moderate level. Between countries that have very low or low level of vulnerability to climate change there are in the first time those that experienced less violent conflict (Gambia, Guinea and Senegal) than others and in the second those that are very low level of net stock migration(Nigeria).

Statistics descriptives

In the table below, we give the definition of variables, their sources and their measurement. According to the table

Table 6: Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) VCC	1.000									
(2) Migration	0.247	1.000								
(3) Conflict	0.127	-0.027	1.000							
(4) Readiness	-0.192	-0.351	-0.194	1.000						
(5) ln_POP	-0.306	-0.037	0.279	-0.447	1.000					
(6) ln_GDP	-0.668	-0.076	0.241	-0.018	0.355	1.000				
(7) ln_EDUC	-0.315	0.065	0.348	-0.287	0.662	0.567	1.000			
(8) Exposure	0.581	0.210	0.018	0.198	-0.559	-0.406	-0.272	1.000		
(9) Sensitivity	-0.127	-0.136	0.078	0.193	-0.069	0.417	-0.115	-0.337	1.000	
(10) Capacity	0.178	0.204	0.120	-0.563	0.368	0.059	0.176	-0.394	0.193	1.000

Source: authors based on various secondary sources

The table of Matrix presents the correlations between the selected variables, climate change vulnerability, stocks of migration, conflict and socio-economics factors in Sahelian countries. Also, the table gives details on the relation between the three equations of the model. Firstly, The relation between vulnerability to climate change (VCC) and readiness (-0.192) is negative and indicates that Sahelian countries that are less prepared for climate change tend to be more vulnerable. In addition, the relation between conflict and readiness is negative and implies that countries more prepared for climate change reduce the risk of recording violent conflict in their territory. The direct link between vulnerability to climate change and conflict is positive. This means that the increase of the Sahelian countries' vulnerability to climate change increases their risk of internal violence. This correlation seems to imply that to reduce the risk of violence in this part of Africa effort should be oriented toward action that can help them to be more prepared to face the effects of climate change.

4. Results and discussion

According to table 6, our results show that there is a negative relationship between vulnerability to climate change and readiness in Sahel countries. Statistically, the coefficient of -0.19 between Vulnerability to climate change and readiness means that when Sahelian countries' readiness increase by 1 units, vulnerability to climate change is expected to decrease by 0.19, Ceteris paribus. This implies that countries that are better prepared economically, institutionally and socially (high readiness) are less vulnerable to climate change impacts. This result supports the literature on adaptive capacity and resilience that emphasize the role of social, institutional and factors to reducing the impact of climate shocks(Adger et al., 2009; Füssel & Klein, 2006; Wheeler, 2003). In addition, according to the ND-GAIN framework, the improvements in economic, governance and social readiness enhance country's ability to reduce vulnerability to climate risk (Chen et al., 2015). Recent economic studies reinforce this parterns.

The relation between vulnerability to climate change and migration is positive 36.31 and statistically significative. This means that higher vulnerability is associated with a net increase of population through migration inflows. This counterintuitive finding challenges the common expectation in climate change and migration literature that posit in the situation of climate shock such as drought and land degradation, people migrate in searching area with more secure livelihood (Abel et al., 2019; Beine & Parsons, 2017; OIM, 2024). In other terms, these findings challenge the assumptions that climate change will always trigger large migration. But this result is consistent with the ''climate immobility paradox''(Beine & Parsons, 2017). The climate immobility paradox describes a situation where people should force to move, due to severe land degradation, drought resulting from climate change impact but are not able to do so. This constraint happens due to the diminishing resource for migration, lack of financial resources and lack of access to transportation. In low-income countries such as Sahelian countries, agrarian households are those who the least capacity to migrate or lack assets to finance migration and become "trapped in place" even if in the situation of climate risk (Gray & Mueller, 2012).

The effect of vulnerability to climate change on conflict is positive and statistically significant (coefficient = 3.526, $p < 0.05$). This indicates that higher vulnerability to climate change increases the risk of internal conflict in the Sahel. Our result supports the hypothesis ''threat multiplier' that

describes a situation where the violence or security risk are influence by how climate change effect interact with and can potentially exacerbate the existing economic, social and political tensions and others sources of instability(Goodman & Baudu, 2023). Our finding corroborates with Von Uexkull et al. (2016) find that drought resulting from climate change in least developed countries increase the risk of internal conflict. In supporting line, the study by Buhaug, (2015) and Koubi, (2019b) indicate the strong role of weak institution capacity and lack of population adaptive capacity in climate conflict nexus.

The effect of net migration on conflict is positive (0.269) and statistically significant ($p<0.01$). These findings mean that when immigration is increasing than emigration there is a 0.269-fold chance of internal conflicts. Our results support previous studies, those of Issifu et al. (2022) and (Koubi, 2017, 2019b). They find and argue that migration induced by climate change increases the risk of internal violence in the host area. This result can be explained by the fact that the positive net stock migration reduces per capita resource availability, increases the disparities of ethnicity, religion, culture and reduces access to basic goods that are needed for both individual and group fulfillment and cause conflict.

Other factors influence our keys variables. For the countries that are vulnerable to climate change and have an increasing trend of migration, the increasing trend of education is suggested to limit the risk of internal conflict. Indeed, we find that when the number of educated people is increasing, this reduces the risk of internal conflict in Sahelian countries. This support previous study of (Ateba & Ongo Nkoa, 2024) reinforces stability of states. Educated population are more like to look for opportunities or job in legal and regular activities rather than join illegal armed group. In addition to this factor, we find that GDP influence positively migration. This means when countries are recording an increasing trend of GDP, this encourages more immigration than emigration in our study area.

Table 7:Effect of vulnerability to climate change on conflict

	(1)	(2)	(3)	(4)	(5)	(6)
	Direct effect			Indirect effect via migration		
VARIABLES	VCC	Migration1	Conflict	VCC	Migration	Conflict
VCC		36.31***	3.526**		-	9.758***
		(5.033)	(1.372)			(1.297)
Arable land		-0.154			-	-0.414
		(0.210)				(0.056)
Log (GDP)		0.539**			-	0.145***
		(0.215)				(0.055)
Conflict		1.822***			-	0.490***
		(0.328)				(0.092)
Readiness	-0.190**			-		
	(0.0804)					
Log (Net migration)			0.269***			-
			(0.0185)			
Log (Education)			-0.116***			-
			(0.0324)			
Log (Population)			0.00828			-
			(0.154)			
Constant	0.619***	-35.77***	0.143	-	-	-
	(0.0236)	(6.807)	(2.651)			
Observations	216	216	216	216	216	216

Source: Authors Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In table 6, we perform an indirect analysis to assess the role of migration induced by vulnerability of climate change on conflict. To estimate the indirect effect of climate change vulnerability on conflict, we estimate nonlinear combinations of parameters. This approach uses the product-of-coefficients of migration on conflicts. This allows us to isolate and quantify transmission mechanisms consistent with mediation analysis advice in literature(Dell et al., 2014).

We find that vulnerability to climate change has an indirect positive effect on conflict through migration (coefficient = 9.76; p< 0.001) channel in the Sahel, suggesting climate-migration-conflict nexus in the sahel. This result support previous studies that conclude migration resulting from climate change increases the risk of violent conflict in weak state(Koubi, 2019b), a security risk multiplier(IPCC, 2022). In addition, we find that GDP influence migration that causes it to have indirect positive effects on conflict. Then, high GDP increases conflict via its positives influence on migration. This result implies economic opportunities induced migration can increase conflict risk in

the host area.The feedback effet of conflict on itself via migration is positive and significant (coefficient =0.49; $p<0.01$) and indicate circular dynamics in conflict exposed region or area with high migration. This result supports conflict trap models where both past and present conflicts provoke people movement that in turn aggrave conflict in both or host zone (Collier et al., 2003) and study find that migration from conflict affected region often intensifies group competition and undermine trust where state is weak.

Our result partial supports the role of migration as a mediator between climate change and internal conflict in the Sahel. The large and significant indirect effect (coefficient = 9.76 and $p<0.01$) confirms that migration is a pathway, but the remaining direct effect (coefficient = 3.526 and $p<0.05$) indicates that vulnerability to climate change influences conflict through other channels. Then, migration is a key channel but not exclusive via which climate change vulnerability increases the risk of conflict in the Sahel.

Table 8: Effect of climate change vulnerability componets on conflict

	Exposure		Sensitivity		Adaptative	
VARIABLES	Migration	Conflict	Migration	Conflict	Migration	Conflict
Capacity	18.54	-6.939	28.62***	28.62***	23.54	-5.362
	(0)	(0)	(3.471)	(1.429)	(0)	(0)
Sensitivity	-0.153	2.518	8.261***	4.730***	2.728	2.641
	(3.969)	(0)	(3.021)	(0.919)	(0)	(0)
Exposure	27.45***	11.16***	20.72***	-5.295***	12.76	1.06
	(4.125)	(1.512)	(4.07)	(1.359)	(0)	(0)
Log(Arable)	-0.390***		0.00516		-0.565***	
	(0.026)		(0.124)		(0.00744)	
Log(GDP)	0.344*		0.381***		0.426	
	-0.199		-0.123		0	
Conflict	3.189***		1.190***		2.985***	
	(0.194)		(0.324)		(0.0186)	
Readiness						
Log(Migration)		0.334***		0.311***		0.319***
		(0.016)		(0.0143)		(0.00353)
Log(Education)		-0.112		-0.0847***		-0.104
		(0.125)		(0.0251)		(0)
Log(Population)		0.918***		0.210**		0.662***
		(0.0825)		(0.0997)		(0.000361)
Constant	-39.32***	-13.91	-48.55***	6.256***	-38.57	-6.183
					(0)	(0)
Observations	216	216	216	216	216	216

Source: authors

Standard errors in parentheses

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

The table shows in the three specifications; the coefficients of migration are positive and statistically significant at 1%. This implies that migration increases the risk of conflict in Sahelian in all three specifications. This result supports previous studies that are source of tension in receiving host where there are weak institutions and poor governance(Abel et al., 2019; Ide, 2017b; Issifu et al., 2022). In addition, we find that Sahelian countries are vulnerable to climate change regarding their sensitivity, an increase in education decreases the risk of conflict. This indicates more educated people are less prompt to engage in violent conflict. The study finds that an increase in GDP has a positive

and significant effect on migration. When GDP has an increasing trend, there is more immigration than emigration. This supports the study by Cattaneo et al. (2019; Simpson, (2017) that argue migrant move from more vulnerable countries and poor countries to rich and less vulnerable countries to climate change impact.

5. Conclusion

In the region marked by the increasing trend of violence and one of the most vulnerable parts of Africa to climate change, the aim of this study is to assess the role of migration in transmission of violence between climate change vulnerability and internal conflict. In a panel of nine Sahel countries, over the period of 1998-2021 and structural equation modelling, we find two pathways influencing conflict with migration playing a partial mediated role on conflict via vulnerability to climate change. We find that vulnerability to climate has a strong and significant effect on internal conflict in the sahel. This finding has important police implication since the link between vulnerability to climate change and internal conflicts need that policies and investment for climate change impact mitigation and building resilience are critical for climate change adaptation and conflict prevention in the Sahel. Priority should be given to support more vulnerable states to climate change vulnerability. Fail to act may result in far reaching consequences that would go beyond environmental and economic losses to include internal violence. The second key finding is that migration is a major but not exclusive channel through which climate vulnerability to climate change increases the risk of internal armed violence in the sahel. This finding calls for integrated policies to simultaneously manage migration and conflict prevention. Investments should orient in the migration receiving area and ensure that institutions are strong and equipped to manage resources pressures and social tensions. Failing to act this pathway may undermine stability and increase the risk of instability in this fragile part of Africa.

GENERAL CONCLUSION

In the context where the world is shaken by armed and unarmed conflicts and where climate change is identified as most environmental challenges of the century, the objective of this thesis is to assess the effects of climate change on conflict in Africa. We find that vulnerability to climate change influence directly conflict in the Sahel part of Africa and indirectly via migration channels. This finding calls for integrated policy to response that simultaneously increase resilience, support safe and inclusive migration and address conflict risks. This implies that investment should focus on vulnerability area and migration host area and increase the power of institution to well manage resources pressures and violent or non-violent conflict. We find also the feedback effect of conflict via migration. This feedback effect highlights the importance of considering the indirect cause of conflict that can reinforce it over time. Then, this finding calls for integrated policy building responses integrated peacebuilding, mobility management and adaptation to limit this vicious circle.

In the second chapter, we assess the effect of farmer-herder vulnerability to their local conflict. Quantitively, we find that farmer-herder vulnerability influence conflict. This pattern is confirmed during focus group discussion with farmer-herder. Beyond this key finding, the studies find also that the increase in ethnic fractionalization increases conflict while the presence of conflict local institutions to manage conflict reduces it. This qualitative result confirms the quantitative findings. Indeed, farmer-herder reveals during the focus discussion the degree to which they vulnerable to climate change influence their conflict or dispute. In addition, in the presence of trust local fair institutions to manage disputes, they prefer to bring their dispute there instead of engaging in conflict where their family can be involved. This convergence of both quantitative and qualitative findings indicate that it is not statistically significant but it also consistent with farmer-herder and stakeholders experiences. Then elaborating policies to reduce farmer-herder conflict, effort should be focused on increasing farmer-herder resilience via-a-visa of climate change effect and mitigate climate change effect, promote tolerance for social diversity, and support stakeholders (who intervene in conflict management) and traditional dispute resolution mechanisms with training, financial and legality to improve their inclusive and equitable.

The chapter provides a little evidence that phenomenon resulting from climate change (water scarcity, land degradation, internal migration, etc.) acts as threat multipliers of community conflicts (in particular, land use dispute and farmer-herders conflict) in Burkina. In addition, structural socio-economic vulnerability such as inability to secure rural households to secure formal land titles. Then, policy response must account for both climate change stressor by building resilience through local investment, and socio-economic inequities including promotion job creation, investment drought-resistant agriculture, pasture rehabilitation, secure transhumance corridors and grazing reserves to reduce friction with farmers.

Several research gaps have been identified. Despite the recurrence and geographic spread of community conflicts in Burkina, particularly those involving land use disputes and farmer-herders violence studies have not received much attention or scholars' attention remains limited. Future research on conflict should be conducted on disaggregated analysis of community conflicts across regions to uncover local drivers. Another limitation in these studies is the type of migration data employed. In the relevant literature, climate change predominantly drives internal migration rather than international migration. The choice of international migration is justified by the lack of internal migration data in the study area. For instance, the case of Burkina Faso, the only available national data on internal migration dates to 2006 and 2019. This data gap limits the precision of policy recommendation. To address this gap, it requires decision makers to invest in longitudinal and household level surveys to collect internal mobility over time. This will allow future studies to accurately provide evidence for national adaptation and conflict prevention strategies.

REFERENCE

Abadie, A. (2006). Poverty, Political Freedom, and the Roots of Terrorism. *American Economic Review*, *66*(2), 50–56. https://doi.org/DOI: 10.1257/000282806777211847

Abel, G. J., Brottrager, M., Crespo Cuaresma, J., & Muttarak, R. (2019). Climate, conflict and forced migration. *Global Environmental Change*, *54*, 239–249. https://doi.org/10.1016/j.gloenvcha.2018.12.003

Abidoye, B. O., & Odusola, A. F. (2015). Climate change and economic growth in Africa: An econometric analysis. *Journal of African Economies*, *24*(2), 277–301. https://doi.org/10.1093/jae/eju033

Abroulaye, S., & Abalo, K. E. (2015). Climate Change: A Driver of Crop Farmers-Agro Pastoralists Conflicts in Burkina Faso IUCN (International Union for the Conservation of Nature) Program of Burkina Faso. In *International Journal of Applied Science and Technology* (Vol. 5, Issue 3). www.ijastnet.com

Adano, W. R., Dietz, T., Witsenburg, K., & Zaal, F. (2012). Climate change, violent conflict and local institutions in kenya's drylands. *Journal of Peace Research*, *49*(1), 65–80. https://doi.org/10.1177/0022343311427344

Adele Orosz. (2021). How Did Extremism and Violence Become a Dangerous Reality in Burkina Faso? *International Peace Institute*.

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., Naess, L. O., Wolf, J., & Wreford, A. (2009). Are there social limits to adaptation to climate change? In *Climatic Change* (Vol. 93, Issues 3–4, pp. 335–354). https://doi.org/10.1007/s10584-008-9520-z

Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockström, J. (2005). Social-ecological resilience to coastal disasters. In *Science* (Vol. 309, Issue 5737, pp. 1036–1039). https://doi.org/10.1126/science.1112122

Afane, A., & Gagnol, L. (2014). Convoitises et conflits entre ressources pastorales et extractives au Nord-Niger Verts pâturages et yellow cake chez les « hommes bleus ». *Afrique Contemporaine*, *249*(1), 53–68. https://doi.org/10.3917/afco.249.0053

Ahmadou Aly Mbaye, & Landry Signé. (2022). *Climate change, development, and conflict-fragility nexus in the Sahel*.

Amole, T., Augustine, A., Balehegn, M., & Adesogoan, A. T. (2022). Livestock feed resources in the West African Sahel. *Agronomy Journal*, *114*(1), 26–45. https://doi.org/10.1002/agj2.20955

Anderson, C., & Bushman, J. B. (2002). Human aggression. *Annu. Rev. Psychol*, *53*, 27–51.

Anderson, G., Basist, A., Hellmuth, M., Jaglom, W., Kim, Y., Letelier, V., Miller, R., Njinga, J.-L., Phung, T., Schultz, P., Sharma, M., Snow, C., Tarrant, J., Van Mossel, J., & Wong, A. (2012). *CLIMATE VULNERABILITIES AND DEVELOPMENT IN BURKINA FASO AND NIGER i CONTENTS*.

Arnall, A. (2023). Climate change and security research: Conflict, securitisation and human agency. *PLOS Climate*, *2*(3), e0000072. https://doi.org/10.1371/journal.pclm.0000072

Asamoah, L. A., Mensah, K. E., & Bondzie, A. E. (2019). Trade Openness, FDI and Economic Growth in Sub-Saharan Africa: Do Institutions Matter? *Transnational Corporations Review*, 65–79.

Ateba, B. H. A., & Ongo Nkoa, B. E. (2024). Climate change and political stability in African states: the role of agricultural food price volatility. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-024-05358-y

Baah, S. K. T., & Lakner, C. (2023). Fragilité et pauvreté en Afrique subsaharienne : les deux faces d'une même médaille. In *word Bank*.

Baarsch, F., Granadillos, J. R., Hare, W., Knaus, M., Krapp, M., Schaeffer, M., & Lotze-Campen, H. (2020a). The impact of climate change on incomes and convergence in Africa. *World Development*, *126*. https://doi.org/10.1016/j.worlddev.2019.104699

Baarsch, F., Granadillos, J. R., Hare, W., Knaus, M., Krapp, M., Schaeffer, M., & Lotze-Campen, H. (2020b). The impact of climate change on incomes and convergence in Africa. *World Development*, *126*. https://doi.org/10.1016/j.worlddev.2019.104699

Barnett, J. (2001). *The Meaning of Environmental Security: Ecological Politics and Policy in the New Security Era. Zed Books, 2001.*

Barnett, J., & Adger, W. N. (2007a). Climate change, human security and violent conflict. *Political Geography*, *26*(6), 639–655. https://doi.org/10.1016/j.polgeo.2007.03.003

Barnett, J., & Adger, W. N. (2007b). Climate change, human security and violent conflict. *Political Geography*, *26*(6), 639–655. https://doi.org/10.1016/j.polgeo.2007.03.003

Becker, G. S. (1968). Crime and Punishment: An Economic Approach. In *The Journal of Political Economy* (Vol. 76). http://www.jstor.org/about/terms.html.

Bedasa, Y., & Deksisa, K. (2024). Food insecurity in East Africa: An integrated strategy to address climate change impact and violence conflict. In *Journal of Agriculture and Food Research* (Vol. 15). Elsevier B.V. https://doi.org/10.1016/j.jafr.2024.100978

Beine, M., & Parsons, C. R. (2017). Climatic factors as determinants of international migration: Redux. *CESifo Economic Studies*, *63*(4), 386–402. https://doi.org/10.1093/cesifo/ifx017

Benjaminsen, T. A., Alinon, K., Buhaug, H., & Buseth, J. T. (2012). Does climate change drive land-use conflicts in the sahel? *Journal of Peace Research*, *49*(1), 97–111. https://doi.org/10.1177/0022343311427343

Blattman, C., Hartman, A. C., & Blair, R. A. (2014). How to promote order and property rights under weak rule of Law? An experiment in changing dispute resolution behavior through Community Education. *American Political Science Review*, *108*(1), 100–120. https://doi.org/10.1017/S0003055413000543

Boas, I., Farbotko, C., Adams, H., Sterly, H., Bush, S., van der Geest, K., Wiegel, H., Ashraf, H., Baldwin, A., Bettini, G., Blondin, S., de Bruijn, M., Durand-Delacre, D., Fröhlich, C., Gioli, G., Guaita, L., Hut, E., Jarawura, F. X., Lamers, M., … Hulme, M. (2019). Climate migration myths. In *Nature Climate*

Change (Vol. 9, Issue 12, pp. 901–903). Nature Research. https://doi.org/10.1038/s41558-019-0633-3

Böhmelt, T., & Bohnet, H. (2021). *Resource Wealth and Pastoral Violence*.

Bretthauer, J. M. (2015). Conditions for Peace and Conflict: Applying a Fuzzy-Set Qualitative Comparative Analysis to Cases of Resource Scarcity. *Journal of Conflict Resolution*, *59*(4), 593–616. https://doi.org/10.1177/0022002713516841

Buhaug, H. (2015). Climate-conflict research: Some reflections on the way forward. *Wiley Interdisciplinary Reviews: Climate Change*, *6*(3), 269–275. https://doi.org/10.1002/wcc.336

Buhaug, H. (2016). Climate change and conflict: Taking stock. *Peace Economics, Peace Science and Public Policy*, *22*(4), 331–338. https://doi.org/10.1515/peps-2016-0034

Buhaug, H., & Von Uexkull, N. (2021). *Annual Review of Environment and Resources Vicious Circles: Violence, Vulnerability, and Climate Change*. https://doi.org/10.1146/annurev-environ-012220

Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A., & Lobell, D. B. (2009a). Warming increases the risk of civil war in Africa. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(49), 20670–20674. https://doi.org/10.1073/pnas.0907998106

Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A., & Lobell, D. B. (2009b). Warming increases the risk of civil war in Africa. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(49), 20670–20674. https://doi.org/10.1073/PNAS.0907998106

Burkina Faso. (2018). *Rapport sur l'etat des lieux des conflits communautaires au Burkina Faso*.

Burkina Faso. (2021). *BURKINA FASO CONTRIBUTION DETERMINEE AU NIVEAU NATIONAL (CDN) DU BURKINA FASO 2021-2025*.

Cabot, C. (2017a). *Climate Change and Farmer–Herder Conflicts in West Africa* (pp. 11–44). https://doi.org/10.1007/978-3-642-29237-8_2

Cabot, C. (2017b). *Climate change, security risks and conflict reduction in Africa. Hexagon Series on Human and Environmental Security and Peace 12.* http://dx.doi.org/10.1007/978-3-642-29237-8

Callendar, G. S. (1938). The artificial production of carbon dioxide and its influence on temperature. *Quarterly Journal of the Royal Meteorological Society*, *64*(275), 223–240.

Cappelli, F., Conigliani, · Caterina, Consoli, D., Valeria Costantini, ·, Paglialunga, E., & Conigliani, C. (2023). Climate change and armed conflicts in Africa: temporal persistence, non-linear climate impact and geographical spillovers 1 3 JEL Classification D74 · O13 · O55 · Q54. *Economia Politica*, *40*, 517–560. https://doi.org/10.1007/s40888-022-00271-x

Cardwell, R. (2018). *The Power of Vulnerability in Conflict Resolution | S.J. Quinney College of Law*. University of Utah. https://law.utah.edu/the-power-of-vulnerability-in-conflict-resolution/

Cattaneo, C., Beine, M., Fröhlich, C. J., Kniveton, D., Martinez-Zarzoso, I., Mastrorillo, M., Millock, K., Piguet, E., & Katrin Millock, F. (2019). Human Migration in the Era of Climate Change "Human

Migration in the Era of Climate Change." *Review of Environmental Economics and Policy*, *13*(2), 189–206.

CEA. (2023). *Rapport économique sur l'afrique 2023: renforcer la résilience de l'Afrique face aux chocs économiques mondiaux*. https://hdl.handle.net/10855/50023

Chen, J., McCarl, B. A., Price, E. C., Wu, X., Bessler, D. A., & Junyi Chen, by. (2016). *CLIMATE AS A CAUSE OF CONFLICT: AN ECONOMETRIC ANALYSIS*.

Chen;, Noble, I., Coffee, J. ;, Murillo, M., & Chawla, N. (2015). *University of Notre Dame Global Adaptation Index Country Index Technical Report*. http://index.gain.org/about/reference.

Clanet, J. C., & Ogilvie, A. (2009). Farmer-herder conflicts and water governance in a semi-arid region of Africa. *Water International*, *34*(1), 30–46. https://doi.org/10.1080/02508060802677853

Collier, P., & Hoeffler, A. (2004). Greed and Grievance in Civil War. *Oxford Economic Papers*, *56*(4), 563–595. https://doi.org/10.1093/oep/gpf064

Collier, P., & Hoeffler, A. (2007). Civil war. *Handbook of Defense Economics*, *2*, 711–739.

Collier, P., Lani Elliott, Håvard Hegre, Anke Hoeffler, Marta Reynal-Querol, & Nicholas Sambanis. (2003). *Breaking the Conflict Trap: Civil War and Development Policy*.

Crawford, A., Price-Kelly, H., Terton, A., & Echeverría, D. (2016). *Review of Current and Planned Adaptation Action in Burkina Faso*. www.idrc.ca/cariaa.

Crost, B., Duquennois, C., Felter, J. H., & Rees, D. I. (2018a). Climate change, agricultural production and civil conflict: Evidence from the Philippines. *Journal of Environmental Economics and Management*, *88*, 379–395. https://doi.org/10.1016/j.jeem.2018.01.005

Crost, B., Duquennois, C., Felter, J. H., & Rees, D. I. (2018b). Climate change, agricultural production and civil conflict: Evidence from the Philippines. *Journal of Environmental Economics and Management*, *88*, 379–395. https://doi.org/10.1016/j.jeem.2018.01.005

Dalby, S. (2002). *Environment, Scarcity and Violence*. https://www.researchgate.net/publication/24089766

Dang, H.-A. H., & Trinh, T.-A. (2022). Does Hotter Temperature Increase Poverty? Global Evidence from Subnational Data Analysis. *IZA Institute for Labor Economic. Discussion Papaer No. 15326*. www.iza.org

Das, Onita. (2013). *Environmental protection, security and armed conflict : a sustainable development perspective*. Edward Elgar Pub.

Dasgupta, S., van Maanen, N., Gosling, S. N., Piontek, F., Otto, C., & Schleussner, C. F. (2021). Effects of climate change on combined labour productivity and supply: an empirical, multi-model study. *The Lancet Planetary Health*, *5*(7), e455–e465. https://doi.org/10.1016/S2542-5196(21)00170-4

Day, A., & Caus, J. (2020). Conflict Prevention in the Era of Climate Change: Adapting the UN to Climate-Security Risks. In *United Nations University*.

Dell, M., Jones, B. F., & Olken, B. A. (2014). What do we learn from the weather? The new climate-economy literature. In *Journal of Economic Literature* (Vol. 52, Issue 3, pp. 740–798). American Economic Association. https://doi.org/10.1257/jel.52.3.740

D'errico, M., Bori, A., & Campos, A. P. de la O. (2021). Resilience and conflict: Evidence from mali. *Sustainability (Switzerland)*, *13*(18). https://doi.org/10.3390/su131810444

Dimelu, M. U., Salifu, E. D., Chah, J. M., Enwelu, I. A., & Igbokwe, E. M. (2017). Livelihood issues in herdsmen-farmers conflict among farming communities in Kogi State, Nigeria. *African Journal of Agricultural Research*, *12*(24), 2105–2115. https://doi.org/10.5897/ajar2017.12319

Donald, M. N. (n.d.). *IMPLICATIONS OF NONRESPONSE FOR THE INTERPRETATION OF MAIL QUESTIONNAIRE DATA*. http://poq.oxfordjournals.org/

Drechsel, F. ;, Engels, B. ;, & Schäfer, M. (2018). « Les mines nous rendent pauvres » : L'exploitation minière industrielle au Burkina Faso. In *GLOCON Country Report No. 2 (FR).Berlin: Freie Universität Berlin, Junior Research Group "Global Change – Local Conflicts?", 2018*. https://doi.org/10.17169/refubium-2896

Dube, O., & Vargas, J. F. (2013). Commodity Price Shocks and Civil Conflict: Evidence from Colombia. *Review of Economic Studies*, *80*, 1384–1421. https://doi.org/10.1093/restud/rdt009

Eastin, J. (2018). Hell and high water: Precipitation shocks and conflict violence in the Philippines. *Political Geography*, *63*, 116–134. https://doi.org/10.1016/j.polgeo.2016.12.001

Eberle, U. J., Rohner, D., & Thoenig, M. (2020). *ESOC Working Paper No. 22 HEAT AND HATE Climate Security and Farmer-Herder Conflicts in Africa*. http://esoc.princeton.edu/wp22.

Emeka, E. T. G., Ogbuabor, J. E., & Ekeocha, D. O. (2024). Terrorism and economic complexity in Africa: The unconditional impact of military expenditure. *African Development Review*, *36*(1), 139–152.

Engels, B. (2020). Gold is not for eating. *Commodity Frontiers*, *1*, 1–6. https://doi.org/10.18174/cf.2020a17960

Ezeoha, A., Igwe, A., Okoyeuzu, C., & Uche, C. (2023). The fiscal effects of armed conflicts in Africa. *African Development Review*, *35*(4), 444–456.

Fang, X., Kothari, S., Mcloughlin, C., & Yenice, M. (2020). *The Economic Consequences of Conflict in Sub-Saharan Africa Prepared by Xiangming Fang*.

FAO. (2017). *La situation mondiale de l'alimentation et de l'agriculture 2017: Mettre les systèmes alimentaires au service d'une transformation rurale inclusive*.

FAO. (2021). *Burkina Faso – Analyse des conflits liés à l'exploitation des ressources naturelles: Note de synthèse*.

Fjelde, H., & von Uexkull, N. (2012). Climate triggers: Rainfall anomalies, vulnerability and communal conflict in Sub-Saharan Africa. *Political Geography*, *31*(7), 444–453. https://doi.org/10.1016/j.polgeo.2012.08.004

Füssel, H. M., & Klein, R. J. T. (2006). Climate change vulnerability assessments: An evolution of conceptual thinking. In *Climatic Change* (Vol. 75, Issue 3, pp. 301–329). https://doi.org/10.1007/s10584-006-0329-3

George, J., Adelaja, A., & Weatherspoon, D. (2020). Armed Conflicts and Food Insecurity: Evidence from Boko Haram's Attacks. *American Journal of Agricultural Economics*, *102*(1), 114–131. https://doi.org/10.1093/ajae/aaz039

Gleditsch, N. F. (1997). *Conflict and the Environment* (N. F. Gleditsch, Ed.; Vol. 33). Springer.

Gleditsch, N. P., & Nordås, R. (2009). *Climate Change and Conflict: A Critical Overview* (Vol. 84, Issue 2). Klimawandel und Gewaltkonflikte. https://www.jstor.org/stable/23773880

Goodman, S., & Baudu, P. (2023). Climate Change as a "'threat multiplier'": History, uses and future of the concept. *Climate Change and Security*, *748*. https://doi.org/10.1016/j.scitotenv.2020.141346

Gray, C., & Mueller, V. (2012). Drought and Population Mobility in Rural Ethiopia. *World Development*, *40*(1), 134–145. https://doi.org/10.1016/j.worlddev.2011.05.023

Gurr, T. (1970). Why Men Rebel. *Princeton University Press*.

Hagberg, S. (2007). Traditional Chieftaincy, Party Politics, and Political Violence in Burkina Faso. In *State Recognition and Democratization in Sub-Saharan Africa* (pp. 131–153). Palgrave Macmillan US. https://doi.org/10.1057/9780230609716_6

Hagburgt, E. C. (n.d.). *VALIDITY OF QUESTIONNAIRE DATA: REPORTED AND OBSERVED ATTENDANCE IN AN ADULT EDUCATION PROGRAM**. http://poq.oxfordjournals.org/

Hardin, G. (1968). The Tragedy of the Commons. In *New Series* (Vol. 13, Issue 3859).

Hendrix, C. S. (2018). Searching for climate-conflict links /706/689/454 /704/844/2739 news-and-views. In *Nature Climate Change* (Vol. 8, Issue 3, pp. 190–191). Nature Publishing Group. https://doi.org/10.1038/s41558-018-0083-3

Homer-Dixon, T. F. (1994). Environmental-Scarcities-and-Violent-Conflict-Evidence-from-Cases. *International Security*, 5–40.

Homer-Dixon, T. F. (1999). *Environment, scarcity, and violence* (136053182nd ed.). Princeton University Press City: Princeton, N.J.

Homer-Dixon Thomas. (1999). Environmental-Scarcities-and-Violent-Conflict-Evidence-from-Cases. *Princeton University Press*.

Ide, T. (2017a). Research methods for exploring the links between climate change and conflict. In *Wiley Interdisciplinary Reviews: Climate Change* (Vol. 8, Issue 3). Wiley-Blackwell. https://doi.org/10.1002/wcc.456

Ide, T. (2017b). Research methods for exploring the links between climate change and conflict. In *Wiley Interdisciplinary Reviews: Climate Change* (Vol. 8, Issue 3). Wiley-Blackwell. https://doi.org/10.1002/wcc.456

Ide, T., Brzoska, M., Donges, J. F., & Schleussner, C. F. (2020). Multi-method evidence for when and how climate-related disasters contribute to armed conflict risk. *Global Environmental Change*, *62*. https://doi.org/10.1016/j.gloenvcha.2020.102063

INSD. (2019). *ANALYSES COMPLEMENTAIRES DU RECENCEMENT GENERAL DE LA POPULATION ET DE L'HABITATION-V*.

INSD. (2022). *Tableau de bord démographique: Décembre 2022.*

IPCC. (1990). *First Assessment Report. Intergovernmental Panel on Climate Change*.

IPCC. (2001). *CLIMATE CHANGE 2001: IMPACTS, ADAPTATION, AND VULNERABILITY,Contribution of working group II to the fourth assessment report of the third intergovernmental panel on climate change*.

IPCC. (2014). *Climate Change 2014 Impacts, Adaptation, and Vulnerability Part A: Global and Sectoral Aspects. In field, C.B., Barros, V.R, Dokken, D.J., K.J.,Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O.,Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R, White, L.L.(Eds), Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York*.

IPCC. (2021). *Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change Edited by*. www.ipcc.ch

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)*.

Issifu, A. K., Darko, F. D., & Paalo, S. A. (2022). Climate change, migration and farmer–herder conflict in Ghana. *Conflict Resolution Quarterly*, *39*(4), 421–439. https://doi.org/10.1002/crq.21346

Iyke, B. N. (2024). Climate change, energy security risk, and clean energy investment. *Energy Economics*, *129*. https://doi.org/10.1016/j.eneco.2023.107225

Johnson, P. O. (1959). Development of the Sample Survey as a Scientific Methodology. *Journal of Experimental Education*, *27*(3), 167–176. https://doi.org/10.1080/00220973.1959.11010620

Kahn, M. E., Mohaddes, K., Ng, R. N. C., Hashem Pesaran, M., Raissi, M., & Yang, J.-C. (2021). *Long-term macroeconomic effects of climate change: A cross-country analysis ☆*. https://doi.org/10.17632/hytzz

Kelley, C. P., Mohtadi, S., Cane, M. A., Seager, R., & Kushnir, Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(11), 3241–3246. https://doi.org/10.1073/pnas.1421533112

Konrad Adenauer. (2018). *ETUDE SUR LES CONFLITS FONCIERS EN MILIEU RURAL AU BURKINA FASO Rapport final*.

Koubi, V. (2017). Climate Change, the Economy, and Conflict. In *Current Climate Change Reports* (Vol. 3, Issue 4, pp. 200–209). Springer. https://doi.org/10.1007/s40641-017-0074-x

Koubi, V. (2019a). *Climate Change and Conflict*. https://doi.org/10.1146/annurev-polisci-050317

Koubi, V. (2019b). *Climate Change and Conflict*. https://doi.org/10.1146/annurev-polisci-050317

Kugbega, S. K., & Aboagye, P. Y. (2021). Farmer-herder conflicts, tenure insecurity and farmer's investment decisions in Agogo, Ghana. *Agricultural and Food Economics*, *9*(1). https://doi.org/10.1186/s40100-021-00186-4

Lenshie, N. E., Okengwu, K., Ogbonna, C. N., & Ezeibe, C. (2021). Desertification, migration, and herder-farmer conflicts in Nigeria: rethinking the ungoverned spaces thesis. *Small Wars and Insurgencies*, *32*(8), 1221–1251. https://doi.org/10.1080/09592318.2020.1811602

Maiga, A. (2007a). Approche sociologique de l'émergence des conflits et des instances locales de régulation dans les usages des ressources naturelles dans le Noumbiel (Burkina Faso). *Revue de l'Université de Moncton*, *37*(1), 267–294. https://doi.org/10.7202/016723ar

Maiga, A. (2007b). Approche sociologique de l'émergence des conflits et des instances locales de régulation dans les usages des ressources naturelles dans le Noumbiel (Burkina Faso). *Revue de l'Université de Moncton*, *37*(1), 267–294. https://doi.org/10.7202/016723ar

Matthew, R. A., Gaulin, T., & Mcdonald, B. (2003). *Linking Environmental Change and Conflict*.

Maystadt, J. F., & Ecker, O. (2014). Extreme weather and civil war: Does drought fuel conflict in Somalia through livestock price shocks? *American Journal of Agricultural Economics*, *96*(4), 1157–1182. https://doi.org/10.1093/ajae/aau010

Meyer, M. (2017). Climate Change, Security Risks and Conflict Reduction in Africa: A Case Study of Farmer-Herder Conflicts over Natural Resources in Côte d'Ivoire, Ghana and Burkina Faso 1960–2000 . *Peace Review*, *29*(3), 420–423. https://doi.org/10.1080/10402659.2017.1344762

Mueller, H., & Tobias, J. (2016). *The cost of violence: Estimating the economic impact of conflict*.

Mueller, V., Gray, C., & Hopping, D. (2020). Climate-Induced migration and unemployment in middle-income Africa. *Global Environmental Change*, *65*. https://doi.org/10.1016/j.gloenvcha.2020.102183

Nagano, T., & Sekiyama, T. (2023). Review of Vulnerability Factors Linking Climate Change and Conflict. In *Climate* (Vol. 11, Issue 5). MDPI. https://doi.org/10.3390/cli11050104

NAP. (2015). *BURKINA FASO NATIONAL CLIMATE CHANGE ADAPTATION PLAN (NAP) Main volume Final version*.

ND-GAIN. (2024). *ND-GAIN Country Index*. University of Notre Dame.

Nnaji, A., Ma, W., Ratna, N., & Renwick, A. (2022). Farmer-herder conflicts and food insecurity: Evidence from rural Nigeria. *Agricultural and Resource Economics Review*, *51*(2), 391–421. https://doi.org/10.1017/age.2022.9

Nordås, R., & Gleditsch, N. P. (2007). Climate change and conflict. *Political Geography*, *26*(6). https://doi.org/10.1016/j.polgeo.2007.06.003

Odoh, S. I., Chilaka, &, & Chigozie, F. (2012). CLIMATE CHANGE AND CONFLICT IN NIGERIA: A THEORETICAL AND EMPIRICAL EXAMINATION OF THE WORSENING INCIDENCE OF CONFLICT BETWEEN FULANI HERDSMEN AND FARMERS IN NORTHERN NIGERIA. In *Arabian Journal of Business and Management Review (OMAN Chapter* (Vol. 2, Issue 1).

Ofuoku, A. U., & Isife, B. I. (2009). Causes, effects and resolution of farmers-nomadic cattle herders conflict in Delta state, Nigeria. In *International Journal of Sociology and Anthropology* (Vol. 1, Issue 2). http://www.academicjournals.org/ijsa

OIM. (2023). *PEACEFUL TRANSHUMANCE PROGRAMME IN WEST AND CENTRAL AFRICA*.

OIM. (2024). *changements climatiques et migrations en Afrique*. www.uneca.org

Ojo, J. S. (2020). Governing "Ungoverned Spaces" in the Foliage of Conspiracy: Toward (Re)ordering Terrorism, from Boko Haram Insurgency, Fulani Militancy to Banditry in Northern Nigeria. *African Security*, *13*(1), 77–110. https://doi.org/10.1080/19392206.2020.1731109

O'Loughlin, J., Linke, A. M., & Witmer, F. D. W. (2014). Effects of temperature and precipitation variability on the risk of violence in sub-Saharan Africa, 1980-2012. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(47), 16712–16717. https://doi.org/10.1073/pnas.1411899111

O'Loughlin, J., Witmer, F. D. W., Linke, A. M., Laing, A., Gettelman, A., & Dudhia, J. (2012). Climate variability and conflict risk in East Africa, 1990-2009. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(45), 18344–18349. https://doi.org/10.1073/pnas.1205130109

Ongo Nkoa, B. E., Ela Alene, L. J., & Djam'Angai, L. (2024). New wave of internal armed conflicts in developing countries: Does inequality of opportunity matter? *African Development Review*, *36*(1), 15–29. https://doi.org/10.1111/1467-8268.12738

Østby, G. (2007). Horizontal Inequalities, Political Environment, and Civil Conflict Evidence from 55 Developing Countries, 1986-2003*. In *World Bank Policy Research Working Paper 4193.* http://econ.worldbank.org/programs/conflict

Ouedraogo, M. (2012). Impact des changements climatiques sur les revenus agricoles au Burkina Faso. *Journal of Agriculture and Environment for International Development*. https://www.researchgate.net/publication/261004312

Percival, V., & Homer-Dixon, T. (1996). Environmental scarcity and violent conflict: The case of rwanda. *Journal of Environment and Development*, *5*(3), 270–291. https://doi.org/10.1177/107049659600500302

Raleigh, C., & Kniveton, D. (2012). Come rain or shine: An analysis of conflict and climate variability in East Africa. *Journal of Peace Research*, *49*(1), 51–64.

Raleigh, C., Linke, A., & O'loughlin, J. (2014). Extreme temperatures and violence. In *Nature Climate Change* (Vol. 4, Issue 2, pp. 76–77). https://doi.org/10.1038/nclimate2101

Rigaud, K. K., de Sherbinin, A., Jones, B., Adamo, S., Maleki, D., Abu-Ata, N. E., Casals Fernandez, A. T., Arora, A., Chai-Onn, T., & Mills, B. (2021). Groundswell Africa. In *Groundswell Africa*. World Bank. https://doi.org/10.1596/36404

Ruddiman, William. F. (2001). *Earth's Climate: Past and Future*. W. F. Freeman.

Salehyan, I., & Hendrix, C. S. (2014). Climate shocks and political violence. *Global Environmental Change*, *28*(1), 239–250. https://doi.org/10.1016/j.gloenvcha.2014.07.007

Salkind, N. J. (1997). *Exploring research*. Upper Saddle River, NJ: Prentice Hall.

Sawadogo, B. (2021). *Perspective genre de l'impact économique du changement climatique au Burkina Faso*. www.pep-net.org,

Schutte, S., Vestby, J., Carling, J., & Buhaug, H. (2021). Climatic conditions are weak predictors of asylum migration. *Nature Communications*, *12*(1). https://doi.org/10.1038/s41467-021-22255-4

Selby, J., Dahi, O. S., Fröhlich, C., & Hulme, M. (2017). Climate change and the Syrian civil war revisited. *Political Geography*, *60*, 232–244. https://doi.org/10.1016/j.polgeo.2017.05.007

Seter, H. (2016). Connecting climate variability and conflict: Implications for empirical testing. *Political Geography*, *53*, 1–9. https://doi.org/10.1016/j.polgeo.2016.01.002

Simpson, N. (2017). Demographic and economic determinants of migration. *IZA World of Labor*. https://doi.org/10.15185/izawol.373

Singh, J., Goolsby, J. R., & Rhoads, G. K. (1994). Behavioral and Psychological Consequences of Boundary Spanning Burnout for Customer Service Representatives. *Journal of Marketing Research*, *31*(4), 558. https://doi.org/10.2307/3151883

Siri, A. R. (2024). Conflict Trends: A Global Overview, 1946–2023. *Peace Research Institute Oslo*.

Solow, A. (2013). A call for peace on climate change and conflict. *Nature*, *497*, 179–180. https://doi.org/https://doi.org/10.1038/497179a

Spillmann, K. R. ., & Bächler, G. (1996). *Environmental degradation as a cause of war. ENCOP-Final Report, 1*. Center for Security Studies and Conflict Research, Swiss Federal Institute of Technology ; Swiss Peace Foundation.

Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: The Great Acceleration. *The Anthropocene Review*, *2*(1), 81–98.

Taherdoost, H. (2018). Determining Sample Size; How to Calculate Survey Sample Size. *International Journal of Economics and Management Systems*. http://www.iaras.org/iaras/journals/ijems

Theisen, O. M. (2012). Climate clashes? weather variability, land pressure, and organized violence in Kenya, 1989-2004. *Journal of Peace Research*, *49*(1), 81–96. https://doi.org/10.1177/0022343311425842

Tsomb, E. I. B. T., Nsoga, M. H. I. N., & Bitting, C. D. (2023). Climate change vulnerability and conflicts in Africa: evidence from the migrations channel. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-023-03417-4

Tuholske, C., Di Landro, M. A., Anderson, W., van Duijne, R. J., & de Sherbinin, A. (2024). A framework to link climate change, food security, and migration: unpacking the agricultural pathway. *Population and Environment*, *46*(1). https://doi.org/10.1007/s11111-024-00446-7

UNDP. (2021). *Effets de la crise Sécuritaire sur le Développement Humain au Burkina Faso*.

UNFCCC. (1992). *UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE*.

UNFCCC. (2016). *The Paris Agreement. United nations.* https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-

Urdal, H. (2005). People vs. Malthus: Population pressure, environmental degradation, and armed conflict revisited. In *Journal of Peace Research* (Vol. 42, Issue 4, pp. 417–434). https://doi.org/10.1177/0022343305054089

USAID. (2010). BURKINA FASO-PROPERTY RIGHTS AND RESOURCE GOVERNANCE PROFILE. In *United States Agency for International Development*. http://usaidlandtenure.net/burkina-faso

USAID. (2012). Famine Early Warning Systems Network-Informing Climate Change Adaptation Series. In *United States Agency for International Development*. https://www.cia.gov/library/

USAID. (2014a). CLIMATE CHANGE AND CONFLICT IN THE SAHEL: FINDINGS FROM NIGER AND BURKINA FASO. *United State Agency for International Development*.

USAID. (2014b). CLIMATE CHANGE AND CONFLICT IN THE SAHEL: FINDINGS FROM NIGER AND BURKINA FASO. *United State Agency for International Development*.

USAID. (2017). COUNTRY OVERVIEW. *United States Agency for International Development*.

van Weezel, S. (2020). Local warming and violent armed conflict in Africa. *World Development*, *126*. https://doi.org/10.1016/j.worlddev.2019.104708

Von Uexkull, N., Croicu, M., Fjelde, H., & Buhaug, H. (2016). Civil conflict sensitivity to growing-season drought. *Proceedings of the National Academy of Sciences of the United States of America*, *113*(44), 12391–12396. https://doi.org/10.1073/pnas.1607542113

Wheeler, D. (2003). *Quantifying Vulnerability to Climate Change: Implications for Adaptation Assistance Center for Global Development 1800 Massachusetts Ave*. http://ssrn.com/abstract=1824611http://www.cgdev.org/content/publications/detail/1424759www.cgdev.org

WMO. (2023). *State of the Global Climate 2023.World Meteorological Organization.*

Xu, X., Wang, L., Sun, M., Fu, C., Bai, Y., Li, C., & Zhang, L. (2020). Climate change vulnerability assessment for smallholder farmers in China: An extended framework. *Journal of Environmental Management*, *276*. https://doi.org/10.1016/j.jenvman.2020.111315

Zougmoré, R., Partey, S., Ouedraogo, M., Omitoyin, B., Thomas, T., Ayantunde, A., Ericksen, P., Said, M., & Jalloh, A. (2016). Toward climate-smart agriculture in West Africa: a review of climate change impacts, adaptation strategies and policy developments for the livestock, fishery and crop production sectors. *Agriculture & Food Security*, *5*.

ANNEXE

Table 9: List of the countries

List of the countries		
Burkina Faso	Cameroon	Chad
Guinea	Mali	Mauritania
Niger	Nigeria	Senegal

Table 10:Variance inflation factor or multicollinearity verification

	VIF	1/VIF
Log(population)	4.674	.214
Log(Education)	4.54	.22
Log(GDP)	3.906	.256
Sensitivity	3.386	.295
Log(Arable land)	3.135	.319
Exposure	2.901	.345
Capacity	2.539	.394
Readiness	2.019	.495
Log(Migration)	1.527	.655
Conflict	1.43	.699
Mean VIF	3.006	.

Table 11: Direct effect of VCC on Conflict

VARIABLES	(1) VCC	(2) Migration1	(3) Conflict	(4) lnsig_1	(5) lnsig_2	(6) atanhrho_12	(7) atanhrho_13	(8) atanhrho_23
VCC		36.31***	3.526**					
		(5.033)	(1.372)					
ln_Arable		-0.154						
		(0.210)						
ln_GDP		0.539**						
		(0.215)						
Conflict		1.822***						
		(0.328)						
Readiness	-0.190**							
	(0.0804)							

Migration1			0.269***					
			(0.0185)					
ln_EDUC			-0.116***					
			(0.0324)					
ln_POP			0.00828					
			(0.154)					
Constant	0.619***	-35.77***	0.143	-2.895***	1.233***	-0.305	-0.406	-1.014
	(0.0236)	(6.807)	(2.651)	(0.0478)	(0.0480)	(0)	(0)	(0)
Observations	216	216	216	216	216	216	216	216

Table 12: Direct effect of VCC on Conflict

```
Mixed-process regression                        Number of obs     =        216
                                                LR chi2(6)        =     300.46
Log likelihood = -244.18393                     Prob > chi2       =     0.0000

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
VCC          |
   Readiness |  -.1901161   .0804176    -2.36   0.018    -.3477317   -.0325004
       _cons |   .6192757    .023591    26.25   0.000     .5730382    .6655131
-------------+----------------------------------------------------------------
Migration1   |
         VCC |   36.30701   5.032865     7.21   0.000     26.44278    46.17124
   ln_Arable |  -.1541556   .2100801    -0.73   0.463    -.5659051    .2575939
      ln_GDP |    .539121   .2152081     2.51   0.012     .1173208    .9609212
    Conflict |   1.821552   .3280212     5.55   0.000     1.178643    2.464462
       _cons |  -35.77141   6.807369    -5.25   0.000    -49.11361   -22.42921
-------------+----------------------------------------------------------------
Conflict     |
         VCC |   3.526467   1.371671     2.57   0.010     .8380405    6.214893
  Migration1 |   .2687878   .0185419    14.50   0.000     .2324462    .3051293
     ln_EDUC |  -.1162717   .0323919    -3.59   0.000    -.1797587   -.0527846
      ln_POP |   .0082819   .1542738     0.05   0.957    -.2940891    .3106529
       _cons |   .1433552   2.651192     0.05   0.957    -5.052885    5.339596
-------------+----------------------------------------------------------------
    /lnsig_1 |  -2.895411   .0478184   -60.55   0.000    -2.989133   -2.801688
    /lnsig_2 |   1.232733   .0480498    25.66   0.000     1.138557    1.326909
/atanhrho_12 |  -.3051206          .        .       .            .           .
/atanhrho_13 |  -.4061647          .        .       .            .           .
/atanhrho_23 |  -1.014079          .        .       .            .           .
-------------+----------------------------------------------------------------
       sig_1 |   .0552763   .0026432                      .050331    .0607075
       sig_2 |   3.430592   .1648391                     3.12226    3.769372
      rho_12 |  -.2959917          .                          -1           1
      rho_13 |  -.3852113          .                          -1           1
      rho_23 |  -.7674439          .                          -1           1
------------------------------------------------------------------------------

.
end of do-file
```

Table 13 Indirect effect of VCC on conflict

```
. shellout using `"resultssamplVCC.doc"'

. do "C:\Users\DELL\AppData\Local\Temp\STD64b4_000000.tmp"

. *indirect_effects
. nlcom ///
>     (_b[Migration1:VCC] * _b[Conflict:Migration1]) ///
>     (_b[Migration1:ln_Arable] * _b[Conflict:Migration1]) ///
>     (_b[Migration1:ln_GDP] * _b[Conflict:Migration1]) ///
>     (_b[Migration1:Conflict] * _b[Conflict:Migration1])

       _nl_1:  _b[Migration1:VCC] * _b[Conflict:Migration1]
       _nl_2:  _b[Migration1:ln_Arable] * _b[Conflict:Migration1]
       _nl_3:  _b[Migration1:ln_GDP] * _b[Conflict:Migration1]
       _nl_4:  _b[Migration1:Conflict] * _b[Conflict:Migration1]
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_nl_1	9.75888	1.296989	7.52	0.000	7.216828	12.30093
_nl_2	-.0414351	.0563478	-0.74	0.462	-.1518748	.0690045
_nl_3	.1449091	.0549989	2.63	0.008	.0371132	.2527051
_nl_4	.489611	.0915848	5.35	0.000	.310108	.669114

```
.
end of do-file

. do "C:\Users\DELL\AppData\Local\Temp\STD64b4_000000.tmp"

. estimates store indirect_effects

.
end of do-file
```

Table 14 Effect of adaptive capacity on conflict

VARIABLES	(1) Capacity	(2) Migration1	(3) Conflict	(4) lnsig_1	(5) lnsig_2	(6) atanhrho_12	(7) atanhrho_13	(8) atanhrho_23
Capacity		23.54	-5.362					
		(0)	(0)					
Sensitivity		2.728	2.641					
		(0)	(0)					
Exposure		12.76	1.060					
		(0)	(0)					
Log(Arable)		-0.565***						
		(0.00744)						
Log(GDP)		0.426						
		(0)						
Conflict		2.985***						
		(0.0186)						
Readiness	-0.758							
	(0)							
Migration			0.319***					
			(0.00353)					
Log(Education)			-0.104					
			(0)					
Log(Populaion)			0.662***					
			(0.000361)					
Constant	1.011	-38.57	-6.183	-2.897***	1.155***	-0.131	-0.0414	-2.450
	(0)	(0)	(0)	(0.0479)	(0.0135)	(0)	(0)	(0)
Observations	216	216	216	216	216	216	216	216

Table 15: the effect of Sensitivity on conflict

VARIABLES	(1) Sensitivity	(2) Migration	(3) Conflict	(4) lnsig_1	(5) lnsig_2	(6) atanhrho_12	(7) atanhrho_13	(8) atanhrho_23
Capacity		28.62***	-8.957***					
		(3.471)	(1.429)					
Sensitivity		8.261***	4.730***					
		(3.021)	(0.919)					
Exposure		20.72***	-5.295***					
		(4.070)	(1.359)					
Log(Arable)		0.00516						
		(0.124)						
Log(GDP)		0.381***						
		(0.123)						
Conflict		1.190***						
		(0.324)						
Readiness	0.193							
	(0.120)							
Migration			0.311***					
			(0.0143)					
Log(Education)			-0.0847***					
			(0.0251)					
Log(Populaion)			0.210**					
			(0.0997)					
Constant	0.386***	-48.55***	6.256***	-2.509***	1.122***	-0.235	-0.430	-1.088
	(0.0362)	(5.231)	(1.909)	(0.0385)	(0.0441)	(0)	(0)	(0)
Observations	216	216	216	216	216	216	216	216

Table 16: The effect of exposure on conflict

VARIABLES	(1) Exposure	(2) Migration	(3) Conflict	(4) lnsig_1	(5) lnsig_2	(6) atanhrho_12	(7) atanhrho_13	(8) atanhrho_23
Capacity		18.54	-6.939					
		(0)	(0)					
Sensitivity		-0.153	2.518					
		(3.969)	(0)					
Exposure		27.45***	11.16***					
		(4.125)	(1.512)					
Log(Arable)		-0.390***						
		(0.0260)						
Log(GDP)		0.344*						
		(0.199)						
Conflict		3.189***						
		(0.194)						
Readiness	0.163***							
	(0.0585)							
Migration			0.334***					
			(0.0160)					
Log(Education)			-0.112					
			(0.125)					
Log(Populaion)			0.918***					
			(0.0825)					
Constant	0.463	-39.32***	-13.91	-2.866***	1.179***	-0.299	-0.576	-0.805
	(0)	(4.845)	(0)	(0.0449)	(0.0551)	(0)	(0)	(0)
Observations	216	216	216	216	216	216	216	216

Table 17: effect of farmer-herder vulnerability on conflict

	First Regression				Seccond regression			
Dependents variable	Farmer-herder conflict				Farmer-herder conflict			
	Estimate	Std. Error	t value	Pr(>|t|)	Estimate	Std. Error	t value	Pr(>|t|)
intercept	0.867489	2.8621236	-0.303	0.762	-0.04963	2.820976	-0.018	0.986
Age	-0.02626	0.0294907	-0.891	0.3737	-0.030118	0.025688	-1.172	0.2417
Gender	-1.05877	1.1533262	-0.918	0.3591	-1.009779	1.144293	-0.882	0.378
Local_institution	-1.54911	0.7570218	-2.046	0.0413 *	-1.640344	0.752599	-2.18	0.0298 *
Crop_diversification	0.065269	0.2759974	0.236	0.8132	0.079053	0.273371	0.289	0.7726
Time_taken_police_station	-0.00462	0.0055421	-0.834	0.4047	-0.004337	0.00551	-0.787	0.4317
Migrant	1.234677	0.9913096	1.246	0.2136	1.280856	0.985561	1.3	0.1944
Number_animals	0.032627	0.0235204	1.387	0.1661	0.033972	0.023395	1.452	0.1472
Fractionalization index	13.66081	3.4473633	3.963	8.7e-05 ***	13.137703	3.341598	3.932	9.86e-05 ***
Vulnerability index	0.871358	0.5116386	1.703	0.0893 .				
Sensitivity index					0.591312	0.343974	1.719	0.0863 .
Adaptative capacity index					0.245802	0.459761	0.535	0.5932
Exposition Index					0.624516	0.29342	2.128	0.0339 *
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1								
First regression					second regression			
Residual standard error: 6.769 on 422 degrees of freedom					Residual standard error: 6.731 on 422 degrees			
Multiple Adjusted R-squared: 0.07319					Multiple R Adjusted R-squared: 0.08371			
F-statistic: 4.109 on 11 and 422 DF, p-value: 9.293e-06					F-statistic: 4.596 on 11 and 422 DF, p-value:			

Table 18: test de validite des instruments

```
. ***Pour tester la sur-identification dans un modèle à équations simultanées sous Stata, tu
>  dois d'abord estimer le système avec des instruments (par exemple, avec ivregress ou reg3
> ) et ensuite utiliser le test de sur-identification (test de Sargan ou Hansen)***
.
. * Équation (1) : VCC_i = α1 + α2 Readiness_i + ε_i
. * Pas besoin d'instrumentation ici, simple régression
. regress VCC Readiness
```

Source	SS	df	MS		
Model	.025228001	1	.025228001	Number of obs	= 216
				F(1, 214)	= 8.23
Residual	.656123714	214	.003065999	Prob > F	= 0.0045
				R-squared	= 0.0370
				Adj R-squared	= 0.0325
Total	.681351715	215	.003169078	Root MSE	= .05537

VCC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Readiness	-.2245328	.0782752	-2.87	0.005	-.378822	-.0702436
_cons	.6291987	.0228725	27.51	0.000	.5841144	.674283

```
.
. * Équation (2) : Migration_i = α1 + α2 VCC_i + α3 GDP_i + α4 Conflict_i + β5 Arable_land_i
>  + ε_i
. * On instrumente VCC et Conflict par Readiness, GDP, Arable_land, education
. ivregress 2sls Migration1 (VCC Conflict = Readiness ln_GDP ln_Arable ln_EDUC), robust

Instrumental variables (2SLS) regression          Number of obs   =        216
                                                  Wald chi2(2)    =      19.21
                                                  Prob > chi2     =     0.0001
                                                  R-squared       =          .
                                                  Root MSE        =     4.2796
```

Migration1	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
VCC	13.4599	9.341286	1.44	0.150	-4.848687	31.76848
Conflict	6.678348	1.523882	4.38	0.000	3.691594	9.665101
_cons	-12.2688	5.504029	-2.23	0.026	-23.0565	-1.481098

```
Instrumented:  VCC Conflict
Instruments:   Readiness ln_GDP ln_Arable ln_EDUC

.
. * Test de sur-identification pour l'équation Migration
. estat overid

  Test of overidentifying restrictions:

  Score chi2(2)          =  12.0792  (p = 0.0024)
```

Household Level survey

H Section 0 [to be filled out prior to interview]

Date : ____/____/_____

Interviewer ID _____

Region: _____ Commune : _____ Village : _____

Section 1: Household Demographics

1. **Are you the head of the household?** _____

- (1) Yes (2) No

2. **What is the age of the head of household? (Years)**: _____
3. **Sex of the household head**: _____

- (1) Male (2) Female

4. **Marital status of household head:**

- (1) Married (2) Separated (3) Widow (4) Single (5) Divorced

5. **How many people live in the household?:** _____
6. **How many people are between the ages of 15 and 64?:** _____
7. **How many people aged 15–64 are not working?:** _____
8. **Number of years of education completed by the household head:** _____
9. **Highest degree obtained by the household head:** _____

- (1) No answer (2) CEP (3) CAP (4) BEPC
  (5) BAC (6) BAC+2 (7) Licence (8) Master1
  (9) Master2 or more

10. **Are you originally from this locality?** _____

- (1) Yes (2) No

11. **What ethnic group does the household head belong to?** _____
12. **How much do you trust people from your ethnic group?** _____

- (1) Not at all (2) Just a little (3) Quite a bit

- (4) A lot (5) No answer

13. **How much do you trust people from other ethnic groups?** _____

- (1) Not at all (2) Just a little (3) Quite a bit
- (4) A lot (5) No answer

14. What is your religion (of the household head)? _____

- (1) Muslim (2) Catholic
- (3) Protestant (4) Animist

15. How much do you trust members of your own religion? _____

- (1) Not at all (2) Just a little (3) Quite a bit
- (4) A lot (5) No answer

16. How much do you trust members of other religions? _____

(1) Not at all (2) Just a little (3) Quite a bit

(4) A lot (5) No answer

Section 2: Land Tenure and Usage

17. What is your land tenure status for the land you primarily use? _____

- (1) Own land (2) Rented
- (3) Community land (4) No answer

18. Which of the following actions are prohibited on your land? (Select all that apply)

- (1) Selling to a family member (2) Selling to village members
- (3) Selling to outsiders (4) Renting to outsiders
- (5) Giving as inheritance (6) Building houses

19. If the state wants to use your land for public infrastructure, under what condition would you agree to give it up?

- (1) Financial compensation (2) Land of equal value (3) Would not give it up under any condition

20. How much land have you rented for your own business?: _____

Section 3: Access to Infrastructure, Transportation and Equipment

21. Distance to the nearest hospital (in km): _____
22. Time taken to reach the hospital (in hours): _____
23. Number of visits to the hospital in the last year:

- (1) Not once (2) Once (3) Twice (4) Three times (5) Four times or more

24. Do any household members have health insurance?

- (1) Yes (2) No

25. If yes, how many?: _____

26. Distance to the nearest police station (in km): _____

27. Time taken to reach the police station (in hours): _____

28. How would you describe the road quality between your home and field/grazing area?

- (1) Good (2) Bad

29. Distance to your field or grazing area (in km): _____

30. Time taken to reach the field or grazing area (in hours): _____

31. Time taken to transport crops or animals to the market (in hours): _____

32. Which means of transportation do you own? (Check all that apply)

- (1) Vehicle (2) Motorbike (3) Motorcycle (4) Bicycle (5) Wagon (6) None

33. What transport means do you frequently use to go to the market?

- (1) Own Vehicle (2) Motorbike (3) Motorcycle (4) Bicycle (5) Public transport (6) On foot

34. Which of the following equipment do you own? (Check all that apply)

- (1) Television (2) Radio (3) Laptop (4) Phone (4) Phone (5) None

35. How many working phones are in the household?

- (1) None (2) One (3) Two (4) Three (5) Four or more

Section 4: Housing, Utilities, water access

36. What material is used for your house walls?

- (1) Cement bricks (2) Sand bricks (3) Compacted earth (4) Wood (5) Other

37. What is the roofing material of your house?

- (1) Iron sheet (2) Tile (3) Tarpaulin (4) Straw or grass (5) Other

38. Which of the following financial assets do you own? (Check all that apply)

- (1) Bank account (2) Mobile money account (3) Rotating savings group (Tontine)
- (4) None

39. Have you had access to a government loan or subsidy?

- (1) Yes (2) No

40. What source of energy do you use for lighting?

- (1) Electricity (2) Solar panel (3) Biogas (4) Battery (5) Kerosene lamp (6) Other

41. What is your main cooking energy source?

- (1) Electricity (2) Butane gas (3) Charcoal (4) Wood (5) Other

42. Do you have access to a source of drinking water?

- (1) Yes (2) No

43. If yes, distance to the source (in km): _____

44. Distance to the nearest town or city center (in km): _____

45. Time taken to travel to the city center (in hours): _____

Section 5: Food Insecurity

46. In the past four weeks, were you worried that your household did not have enough food?

- (1) Yes (2) No

47. If yes, how often did this happen?

- (1) Rarely (less than 3 times) (2) Sometimes (3–10 times) (3) Often (more than 10 times)

48. In the past four weeks, did you or a household member go without eating due to lack of money for food?

- (1) Yes (2) No

49. If yes, how often did this happen?

- (1) Rarely (2) Sometimes (3) Often

50. In the past four weeks, did you or a household member fail to diversify your diet due to a lack of resources?

- (1) Yes (2) No

51. If yes, how often did this happen?

- (1) Rarely (2) Sometimes (3) Often

52. In the past four weeks, did you or a household member eat undesired food due to lack of money?

- (1) Yes (2) No

53. If yes, how often did this happen?

- (1) Rarely (2) Sometimes (3) Often

54. In the past four weeks, did you or a household member not eat enough to feel full?

- (1) Yes (2) No

55. If yes, how often did this happen?

- (1) Rarely (2) Sometimes (3) Often

56. In the past four weeks, did you or a household member reduce the number of meals per day?

- (1) Yes (2) No

57. If yes, how often did this happen?

- (1) Rarely (2) Sometimes (3) Often

58. In the past four weeks, was there ever no food in your household due to lack of money?

- (1) Yes (2) No

59. If yes, how often did this happen?

- (1) Rarely (2) Sometimes (3) Often

60. In the past four weeks, did any household member go to bed hungry due to lack of food?

    Yes (2) No

61. If yes, how often did this happen?

    (1) Rarely (2) Sometimes (3) Often

62. In the past four weeks, did you or a household member go a whole day and night without eating?

    Yes (2) No

63. If yes, how often did this happen?

    (1) Rarely (2) Sometimes (3) Often

Section 6: Climate Change and Catastrophic Risk

64. Have you noticed a change in rainfall patterns over the past 10 years?

- (1) Yes (2) No (3) I don't know

65. In your opinion, how would you describe the intensity of rainfall pattern in your area
    (1) Low (2) Moderate (3) high (4) very high

66. Does this change affect your household's livelihood?

- (1) Yes (2) No (3) I don't know

67. Have you observed a shift in the start of the rainy season?

- (1) Yes (2) No (3) I don't know

68. Does this change affect you?

- (1) Yes (2) No

69. Have you noticed a change in water availability over the past 10 years?

- (1) Yes (2) No

70. In your opinion, how would you describe the avaibility of water in your area
71. (1) Low (2) Moderate (3) high (4) very high

72. If yes, does this change affect you?

- (1) Yes (2) No

73. If yes, did you face difficulties responding to this change?

- (1) Yes (2) No (3) I don't know

74. Has there been a change in the flood intensity over the past 10 years?
75. (1) Yes (2) No
76. If yes, how would you describe the intensity of flood in your area :
77. (1) Low (2) Moderate (3) high (4) very high

76. Does this change affect you?

- (1) Yes (2) No

77. What are the consequences of these floods?

- _____

78. Have you observed a change in temperature patterns over the past 10 years?

- (1) Yes (2) No

79. If yes, how would you describe the intensity of temperature changed:

    (1) Low (2) Moderate (3) high (4) very high

80. Have you observed extreme temperature events?

- (1) Yes (2) No

81. If yes, how would you describe the intensity of temperature extreme?

    (1) Low (2) Moderate (3) high (4) very high

82. Has drought become intense in your area in the past 10 years?

- (1) Yes (2) No

83. If yes how would you rate their intensity
    (1) Low (2) Moderate (3) high (4) very high

84. If yes, does this change affect your livelihood?

- (1) Yes (2) No

85. What are the consequences or physical impacts of drought?

- _____

86. Are you noticed the change in winds over the past 10 years?

    (1) Yes (2) No

87. If yes how would you rate their intensity
    (1) Low (2) Moderate (3) high (4) very high
88. Have you noticed a change in heatwave intensity over the past 10 years?

- (1) Yes (2) No

89. If yes how would you rate their intensity
    (1) Low (2) Moderate (3) high (4) very high
90. Do periods of extreme heat affect your activity?

- (1) Yes (2) No

91. Have you noticed change in soil degradation over the past 10 years?

- (1) Yes (2) No
- If yes how would you rate their intensity
  (1) Low (2) Moderate (3) high (4) very high

92. Have you received training in climate change adaptation strategies?

- (1) Yes (2) No (3) I don't know

93. What do you do in case of drought or water shortages?

- _____

94. What do you do in case of flooding in your agricultural or grazing area?

- _____

95. What do you do in case of high temperatures to protect your farming or livestock?

- _____

96. What do you do in case of reduction of grazing areas?

- _____

97. What do you do in case of soil degradation?

- _____

Section 7: Main activity of Household head

98. What is your main activity (head of household)?

- (1) Farmer
- (2) Herder → If selected, go to Question 135

Section 8: Agricultural Practices and Farmer Perceptions

99. Years of experience in agriculture: _____
100. Number of household members engaged in:

- Agriculture: _____
- Non-agriculture: _____

101. How many people received agricultural technical training last 12 months? _____
102. What is the total size of agricultural land (hectares): _____
103. What is the total size of area cultivated in the past 12 months (hectares): _____
104. How many family members participate in community/village activities? _____
105. Has access to land changed in recent years? _____

- (1) Yes (2) No

106. If yes, has land accessibility: _____

- (1) Increased (2) Decreased

107. If accessibility decreased, why?

- _____

108. How can you rate your farmland's fertility: _____

- (1) Very fertile (2) Fertile (3) Low fertility (4) Not fertile

109. Crops grown (select applicable numbers): _____

- (1) Sorghum (2) Corn (3) Millet (4) Rice (5) Fonio (6) Cotton (7) Peanut
- (8) Sesame (9) Soybean (10) Cowpea (11) Yam (12) Sweet potato (13) Voandzou (14) Other

110. Which Vegetables do you grow (select applicable numbers)?: _____

- (1) Tomato (2) Cabbage (3) Eggplant (4) Carrot (5) Green bean (6) Potato (7) Onion (8) Cucumber (9) Other

111. Who decides what crops to grow? _____

- (1) Adult men (2) Adult women (3)Men 15–30 Women 15–30 (5)Boys <15 (6)Girls <15 (7) NGO/State

112. In which season do you grow your main crops? _____

- (1) Rainy season (2) Dry season (3) Both

113. Rate your harvest quality over the past 12 months:

- (1) Good (2) Average (3) Poor

114. What was the unit of measurement used for your last year's production and the amount?

- Unit: _____ | Amount: _____
- (1) Kilogram (2) Bag (3) Ton

115. Did you use irrigation in the last 12 months?

- (1) Yes (2) No

116. If yes, what was the size of the irrigated field? (hectares): _____

117. Did you plow your land last year?

- (1) Yes (2) No

118. Does your household use soil and water conservation techniques?

- (1) Yes (2) No

119. If yes, which techniques? _____

- (1) Half-moon (2) Water Pond (3) Drainage (4) Contour plowing (5) Agroforestry (6) Other(specify) (7) None

120. What is the size of insured or credit-backed farmland (hectares): _____

121. Do you do animal breeding?

- (1) Yes (2) No

122. If yes, list the animals raised and their numbers:

- Cattle: ___ | Sheep: ___ | Goats: ___ | Poultry: ___ | Other: _____

123. What is your main grazing area used:

- (1) Private (2) Communal (3) Transhumance (4) Other

124. How do you respond to agricultural risks (flood, drought, etc.)? Select numbers:

- (1) Agroforestry (2) Change sowing time (3) Relocate fields
  (4) Install irrigation (5) Intercropping (6) Change crops
  (7) Avoid flooded areas (8) Resow (9) Other

125. What is the amount of Income did you earn from your main activity: _____

126. What is the amount of Income did you earn from secondary activities: _____

Section 9: Farmers' Perceptions, Insecurity, Climate Change and Conflict

127. What are your main agricultural challenges/threats?

- _____

128. Is unavailability/inaccessibility of land a source of insecurity?

(1) Yes (2) No (3) No response

129. Is water scarcity or reduced rainfall a source of insecurity?

(1) Yes (2) No (3) No response

130. Is declining soil fertility a source of insecurity?

(1) Yes (2) No (3) No response

131. What other sources of insecurity affect your farming?

- _____

132. Could climate change worsen your insecurity or risk?

- (1) Yes (2) No (3) No response

133. Could your insecurity trigger conflict?

- (1) Yes (2) No (3) No response

134. Could agricultural insecurity worsen existing conflict?

(1) Yes (2) No (3) No response

135. Does your climate-related vulnerability increase conflict risk in your area?

(1) Yes (2) No (3) No response

136. Could worsening insecurity due to climate change affect relations with herders?

(1) Yes (2) No (3) No response

137. Could environmental resource competition increase future conflict?

(1) Yes (2) No (3) No response

Section 10: Herder Livelihoods

138. How many years of herding experience do you have? _____

139. What are the animals do you raised and their numbers:

Cattle: ___ | Sheep: ___ | Goats: ___ | | Other(specify): _____

140. Do all these animals belong to your household?

(1) Yes (2) No

141. Number of animals affected by disease last year:

- (1) None (2) 1–2 (3) 3–4 (4) 5 or more

142. What is your main grazing area used:

(1) Private (2) Communal (3) Transhumance (4) Other

143. What is the number of household members in:

Livestock: _____ Other activities: _____

144. Do you keep livestock in pens at night?

- (1) Yes (2) No

145. Who decides on animal sales?

- (1) Adult men (2) Adult women (3) Men 15–30
  (4) Women 15–30 (5) Boys <15 (6) Girls <15 (7) NGO/State

146. Did you lose any animals in the last 12 months?

(1) Yes (2) No

147. Do you collect milk from animals?

(1) Yes (2) No

148. Do you do crop farming?

(1) Yes (2) No

149. What is the amount of Income did you earn from main activity: _____

150. What is the amount of Income did you earn from secondary activities: _____

Section 11: Herders' Perceptions , Insecurity, Climate Change and Conflict

151. What are your current livestock-related challenges?

- _____

152. Is reduction/scarcity of grazing areas a source of insecurity?

(1) Yes (2) No (3) No response

153. Are unavailable transhumance routes a source of insecurity for herding activities?

(1) Yes (2) No (3) No response

154. Is deteriorating animal health a source of insecurity for herding activities?

(1) Yes (2) No (3) No response

155. Is declining animal productivity a source of insecurity for herding activities?

(1) Yes (2) No (3) No response

156. Is water scarcity or reduced rainfall a source of insecurity for herding activities?

(1) Yes (2) No (3) No response

157. What other insecurity factors do you face?

- _____

158. Could your insecurity trigger conflict?

- (1) Yes (2) No (3) No response

159. Could livestock-related insecurity worsen conflict?

(1) Yes (2) No (3) No response

160. Does climate vulnerability increase conflict risk in your area?

- (1) Yes (2) No (3) No response

161. If climate/resource insecurity increases, what will your community likely do?

- (1) Migrate (2) Negotiate (3)Confront
  (4) Reduce herd size (5) Other

162. Could worsening insecurity harm relations with farmers?

- (1) Yes (2) No (3) No response

163. Could resource competition due to environmental change lead to future conflict?

- (1) Yes (2) No (3) No response

Section 12: Farmer-Herder Conflict

164. Most frequent conflicts in your area:

- (1) Land-related (2) Farmer-herder (3) Farmer-farmer (4) Herder-herder
  (5) Ethnic (6) State-community (7) Religious

165. Have you had conflict with farmers/herders in the past 12 months?

- (1) Yes (2) No

166. If yes, how many times? _____

167. If yes, did this lead to losses (yield/property/animals/life)?

- (1) Yes (2) No

168. Are there local conflict prevention associations?

- (1) Yes (2) No

169. In farmer-herder conflicts, which authority is approached?

- (1) Amicable settlement (2) Traditional court (3) Departmental court
  (4) Judicial system (5) Other

170. In your opinion or experience, what is the most effective conflict resolution method(between farmer-herder):

- (1) Amicable (2) Traditional (3) Departmental
  (4) Judicial (5) Other

171. When do farmer-herder conflicts occur most?

- (1) Dry season (2) Start of rainy season (3) During harvest
  (4) After harvest (5) Year-round (6) Other

172. Can village chiefs take bribes to impose lighter penalties?

- (1) Yes (2) No (3) No response

173. Can chiefs reduce penalties based on ethnic affiliation?

- (1) Yes (2)No (3)No response

174. Can chiefs reduce penalties based on religion?

- (1) Yes (2) No (3) No response