The Climate Change and Conflict Nexus in West Africa:

A New Approach for Operationally Relevant Vulnerability Assessments

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Cover design: Fernanda Rubiano

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ABBREVIATIONS

ACLED	Armed Conflict Location and Event Dataset
ANDE	National Agency of the Environment (Côte d'Ivoire)
AQIM	Al-Qaeda in the Islamic Maghreb
ASM	Artisanal and Small-scale Mining
BBNP	Boucle de Baoule National Park
CCDR	Country Climate and Development Reports
CDD	Community-Driven Development
CILSS	Permanent Interstate Committee on Drought Control in the Sahel
CNDH	Commission Nationale des Droits de l'Homme
CORAF	Council for Agricultural Research and Development
CRU	Climatic Research Unit (University of East Anglia)
CSF	Climate Support Facility
CSO	Climate Security Observatory
DLCC	Directorate of the Fight against Climate Change (Côte d'Ivoire)
ECOWAS	Economic Community of West African States
FCV	Fragility, Conflict and Violence
FoN	Friends of the Nation (Ghana)
FSRF	Food System Resilience Facility
FSRP	Food System Resilience Program
GAPVOD	Ghana Association of Private Voluntary Organizations in Development
GATIA	Groupe d'Autodéfense Touareg Imghad et Allié
GIRE	Integrated Water Resources Management
GSIM	Support Group for Islam and Muslims
HACP	Haute Autorité pour la Consolidation de la Paix (Niger)
ICG	International Crisis Group
IDP	Internally Displaced Person
IPCC	Intergovernmental Panel on Climate Change
ISGS	Islamic State in the Greater Sahara
ISS	Institute for Security Studies
IV	Instrumental Variable
JNIM	Jama'at Nusrat al-Islam wal Muslimeen
KM	Katiba Macina
KMP	Knowledge Management Platform
LSM	large-scale mining
MINEDD	Ministry of Environment, and Sustainable Development (Côte d'Ivoire)

MINSEDD	Ministry of Urban Sanitation, Environment, and Sustainable Development (Côte d'Ivoire)
MUJAO	Movement for Unity and Jihad in West Africa
MSA	Mouvement pour le Salut de l'Azawad
NASA	National Aeronautics and Space Administration
NCCSA	National Strategy for Climate Smart Agriculture (Côte d'Ivoire)
NCOM	National Coalition on Mining (Ghana)
NDC	Nationally Determined Contribution
NDVI	Normalized Difference Vegetation Index
NGO	Nongovernmental Organization
PAPS	(Directorate of) Political Affairs and Peace and Security
PBF	UN Peacebuilding Fund
PDSI	Palmer Drought Severity Index
PNCC	National Climate Change Program (Côte d'Ivoire)
PNIA	National Agricultural Investment Plan (Côte d'Ivoire)
PROLAC	Lake Chad Region Recovery and Development Project
RAIP	Regional Agricultural Investment Programme
RCP	Representative Concentration Pathway
RRC	National Strategy for Disaster Risk Management (Côte d'Ivoire)
SCAD	Social Conflict Analysis Database
SNACC	National Strategy for Adaptation to Climate Change (Côte d'Ivoire)
SNDCV	Agricultural Seed Development Plan (Côte d'Ivoire)
SNDD	Strategy for Sustainable Conservation and Biological Diversity (Côte d'Ivoire)
SODEFOR	Forestry Development Agency (Côte d'Ivoire)
UNFCCC	United Nations Framework Convention on Climate Change
WANEP	West Africa Network for Peacebuilding
WRCC	Water Resources Coordination Centre

EXECUTIVE SUMMARY

SYNOPSIS

This report advances usable knowledge on how climate change and conflict interact in the region. Its findings contribute to a growing body of research examining the links between climate change and conflict outcomes. Its objective is twofold: first, to strengthen the evidence base on the relationship between climate change and socio-institutional fragility, violence, and conflict in West Africa; and second, to develop operationally relevant vulnerability data to enable clustering of locations with similar sources of vulnerability (in terms of exposure, sensitivity, and adaptive capacity) to climate and conflict risks. In doing so, the report breaks substantial new ground. It explicitly represents the spatial distribution of climate-related conflict vulnerability and its association with a range of biophysical, social, and economic factors. It identifies the associations between different climate drivers and conflict outcomes and develops a predictive model based on machine learning to assess the extent to which climate-related variables can predict conflict outcomes. It also uses a set of in-depth case studies to examine the potential mechanisms that may mediate the climate change and conflict relationship. Finally, the report highlights why and how specific locations are vulnerable to climate and conflict risks, rather than mapping levels of climate change and conflict vulnerability across space as most existing vulnerability indices typically do. In each of these ways, the report provides useful information to design, evaluate, and assess the operational effectiveness of projects that address climate and conflict-related vulnerability.

CONTEXT

Accelerating climate change is severely threatening prospects for human development across West Africa. Mean temperatures in the region are anticipated to rise within a range of 1.5°C to 6.5°C by the end of the century depending on the planet's future emissions pathways. Within the subregion of West Africa, the Sahel is consistently projected to experience higher temperature increases and anomalies. Compared with the 1976–2005 reference period, recent regional climate models project average precipitation changes ranging from −10 percent to +10 percent by 2100, with an increase in both extreme flood and drought events (Sylla et al. 2018). According to the Intergovernmental Panel on Climate Change (IPCC 2021), precipitation patterns of the West African monsoon are projected to change over the coming decades, with decreases over the far western Sahel and increases over the central Sahel. In addition, monsoonal rains are modeled to commence and retreat with a delay compared to current conditions.

In parallel to climate change, West Africa is increasingly vulnerable to insecurity, violence, and protracted conflicts. The period between 2014 and 2019 has been the most violent five-year period on record. From 2011 to 2019, violent events in the region jumped from 581 to 3,617 incidents. Over the same period, the number of associated fatalities rose from 3,361 to 11,911 (OECD/SWAC 2020). A kaleidoscope of interconnected factors is facilitating armed insurgent groups, weakening state authority, overburdening formal and customary institutions, making livelihoods more fragile, contributing to extremism, precipitating clashes between herders and farmers, and fanning conflicts more broadly.

Violent conflicts, in combination with extreme weather events, stagnant productivity and

rising food demand, are translating into steep increases in food insecurity. An unprecedented convergence of both short-term and long-term stressors and shocks including adverse weather and deteriorating political instability, has seen food security metrics worsen over the past decade, exacerbated more recently by disruptions related to anti-covid-19 measures. Conflict has been among the most important drivers of growing food insecurity in West Africa between 2015 and 2020 (OECD 2020). With an estimated 27 million people currently requiring emergency food and nutrition assistance, the region is experiencing a major food and nutrition crisis for the third consecutive year (RPCA 2022). In the absence of strong countermeasures, more than 38 million people could face hunger and malnutrition in the lean season between June and August 2022.

Conflict, insecurity, climate change, and a mix of socioeconomic factors are driving regional migration and displacement. Between 2019 and 2021, internal displacement and forced migration in West Africa have quadrupled, from fewer than 500,000 to now more than two million people: the main driver being unrelenting and intensifying conflict (UNHCR 2021). In the absence of mitigation and adaptation, long-term prospects suggest a dramatic rise in internal migration within West Africa. According to the Groundswell report on internal climate migration in West Africa (Rigaud et al. 2021), the number of internal climate migrants in the region may reach 32 million (4.06 percent of projected population) by 2050 in the absence of solutions that address climate change, low economic development, and adaptation needs.

To address these adverse socioeconomic trends, several West African countries and regional organizations are implementing large-scale, regional investment programs with support from the World Bank. The first set of programs includes three regional operational platforms covering the Sahel's Liptako Gourma Region, the Lake Chad Basin, and the Gulf of Guinea. These projects seek to operationalize a 'think regionally, act locally' approach. To think regionally, they support access to timely and quality data and targeted analytics at the regional level. Resulting analyses—through regional development diplomacy—inform long-term strategies and priorities, including the design of multiyear investments to sustainably combat drivers of fragility, conflict and violence (FCV). Founded on a community-centered approach, these new investments strive to align community action with national and regional development strategies. The second program, the West Africa Food System Resilience Program (FSRP), aims at increasing preparedness against food insecurity and improving the resilience of food systems across the participating countries in West Africa. To enhance rural households' resilience to climate variability, FSRP will, among other activities, promote participatory development of integrated landscape management plans and invest in the rehabilitation of degraded land and watersheds. Common to these programs is their focus on delivering multisectoral intervention packages to build more resilient livelihoods, including by enhancing basic service delivery, improving market connectivity, and developing regional value chains.

The research underpinning this report also contributes to the academic debate on conflict–climate links and includes novel, multidimensional climate vulnerability data and analyses relevant to the above operations. This report is divided into three self-contained but interconnected parts. The first examines location-specific co-occurrence of conflict events and climate change indicators using a combination of a novel dataset and machine-learning-based predictive modeling. The quantitative analysis in Part I does not identify causal relationships between climate change and conflict. Instead, it focuses on probing if and where variables related to climate change can help predict the occurrence of violent conflict in the region. Part II relies on a suite of case studies to examine why and how climate change can precipitate conflict in specific circumstances. The case studies provide evidence on the causal pathways that link contextual factors and micro-level socioeconomic variables with climate change in West Africa. The third and last part explores area-specific vulnerability profiles that group regions according to their vulnerability characteristics related to exposure, sensitivity and adaptive capacity. Collectively, the three parts aim for a deeper understanding of the factors and mechanisms—of greatest relevance to decision-making—through which risks of violent conflicts change, conflicts emerge, and persist, in specific regions, as well as actions that may mitigate vulnerability to the climate–conflict nexus.

KEY FINDINGS

PART I : INVESTIGATING THE CO-OCCURRENCE OF CONFLICT AND CLIMATE CHANGE

Predictive modeling based on machine-learning confirms that conflict and climate change are systematically and positively associated across West Africa. A rapidly growing body of research has been probing the interaction of climate change and the incidence of conflict in recent years. However, the nature and extent of links between the occurrence of conflict and climate change remain subject to ongoing academic debate. This research contributes to this debate by employing predictive modeling driven by machine-learning to analyze a new integrated regional dataset with climate, socioeconomic, geographic, and conflict variables in a spatially explicit way across the entire subregion. Assessing the predictive validity of past climate change for identifying the occurrence of violent conflict from 2000 to 2020 in 16 West African nations covering over 6.8 million km2, this research shows that climate change indicators, in particular droughts and changes in maximum temperatures, can identify areas with endemic conflict with reasonable accuracy. While these findings are statistical in nature, they are consistent with causal research and recent findings from the IPCC AR6 report (2022). According to the latter, changes in maximum temperature and drought can be regarded with high confidence as conducive to increases in conflict.

PART II: EVIDENCE FROM CASE STUDIES ON CONFLICT–CLIMATE INTERACTION PATHWAYS

Findings from five case studies suggest that climate change tends to cause conflict by increasing competition for resources due to reduced agricultural outputs and by influencing households' readiness to engage with armed insurgent groups, particularly where conflict-resolving institutions are absent or dysfunctional. For a more complete understanding of geographical variations in the occurrence of conflict it is of critical importance to clarify why, how and under what conditions—in the West African context—climate change may engender social tensions and result in violent conflict. Eight qualitative case studies were therefore commissioned, to offer a better understanding of the accuracies and inaccuracies related to the quantitative modeling of climate change and conflict performed in Part I. Five of the studies focus mainly on drivers and mediators of climate–conflict relationships in individual countries, or specific mediating factors in particular locations. The three other studies focus on country-level patterns of climate-related conflict risks in Côte d'Ivoire, Niger, and Nigeria. The report features five of the eight case studies (see Part II) that focus most directly on location-specific relationships between climate and conflict.

The five cases enrich and complement the conclusions of the quantitative modeling

in three important respects. First, they provide information about how climate change and climate anomalies translate into conflict outcomes. Whereas the machine-learning models identify patterns of associations in the data, they do not by themselves identify the social, economic, political, or institutional pathways through which these patterns likely connect to fragility, conflict, or violent outcomes. Second, they identify additional socioeconomic variables that may have generalizable causal effects on conflict, and influence patterns of interactions and relationships with climate and conflicts. In-depth analysis of these pathways in specific cases points toward areas where additional efforts to create and collect data can lead to more systematic causal estimation of the channels through which climate change affects conflict. Finally, the case studies point more specifically toward policy and programmatic interventions that may dampen the negative effects of climate stresses on socioeconomic and political relationships and thereby on conflicts.

SUMMARY OF CASE STUDY FINDINGS

In western Mali, the governance of natural resource access needs to be strengthened to prevent increasing climate stresses from worsening local conflict dynamics. Using a longitudinal survey of migrant pastoralists, and additional interviews with local residents, Brotem (2021) explores the emergence of violent insurgent group cells in western Mali. Evaluating the pastoral populism theory of fragility-linked violence, the analysis pinpoints the increasing uncertainty around pastoralists' ability to access seasonal resources and their limited capacity to adapt to growing resource competition with farmers as key drivers of their growing proximity to violent insurgent groups. The mere presence of insurgent groups is found to change the calculus of pastoralist youth regarding extremism. Unless both farmers and pastoralists share a common perception that resource access is equitable, insurgent groups will be able to exploit pastoralists' grievances. The study results suggest that improving resource governance is a key condition for reducing conflict risks.

In Niger, climate risks increase conflict risks only in combination with historical factors that undermine local governance and conflict resolution mechanisms. Charbonneau et al. (2021) analyze the historical context of the Sahel and conclude that climate change acts as a threat multiplier for conflicts in Niger by affecting local governance practices, undermining conflict-resolution mechanisms, and adding renewed urgency to the need for reform. Crucially, climate change, even as a threat multiplier, does not necessarily lead to conflict because conflict implications are structured by historical institutional legacies that affect the capacity of communities to adapt to changing conditions. Furthermore, whether and how climate change risks translate into conflict will depend on the way transnational conflicts are mediated by local social and institutional dynamics. Looking ahead, resolving or preventing armed conflict requires building ecosystem resilience to securely underpin livelihoods that are dependent on natural resources.

In Ghana, migration flows resulting from climate impacts on agricultural production are associated with an increase in mining-related conflicts. Bednar et al. (2021) examine links between climate, migration, and mining-related conflicts. In the past 10 years, Ghana has experienced an increase in mining-related conflicts. Climate change has contributed to driving farmers from marginal lands hit by production shocks into artisanal mining. In some places, their arrival has resulted in conflict with local indigenous populations and has led to negative environmental spillovers in the form of deforestation, and degradation of agricultural land and water resources. There is evidence that customary institutions can play an important mediating role between livelihood groups and ensure sustainable mining operations. If they are sufficiently flexible to accommodate migrant populations, local customary institutions, such as local chieftaincies, can prove critical in mitigating conflict and environmental risks.

In Nigeria, development assistance projects seem to successfully prevent harsh climatic conditions from increasing violence. Drawing on the insight that climate-change induced reductions in agricultural productivity may lead to conflict outcomes, Schon et al. (2021) examine the effect of agricultural productivity on levels of violence. Counterintuitively, they find that there is a statistical association between higher agricultural productivity and violence. This effect exists because development assistance projects mainly target locations hit by extreme climatic events rather than focusing on more productive areas which may have other needs and grievances. The study finds evidence that temperature anomalies lead to increases in conflict risks and that assistance is effective in reducing the latter. As a result, decisive action enhancing communities' resilience to climate shocks could substantially dampen climate–conflict risks in in the medium- to longer term.

The summary table below provides an assessment of the causal variables that the case studies highlight, and which provide qualitative depth to the results of the predictive modeling based on machine learning.

TABLE ES 1 Case study locations and findings

Study	Key causal findings
Ghana	
The role of customary institutions in mitigating conflict and environmental degradation: The case of gold mining in Ghana	Climate shocks are increasing migration levels; Increased migration in the context of artisanal gold mining increases resource competition and tensions between miners and local residents.
Mali	
Climate change, pastoral resource access, and extremist group violence in the western Sahel: New data and insights from Mali	Climate stresses worsen local conflict dynamics, especially in the presence of armed groups.
Côte d'Ivoire	
A Qualitative Assessment of Climate-fragility Risks in Côte d'Ivoire	Climate risks negatively affect livelihoods and health, aggravating food insecurity; Climate risks increase migration and social tensions; Climate change increases vulnerability of pastoralist groups and risks of farmer–herder conflicts.
Niger	
Climate Impact Pathways and Fragility, Conflict, and Violence Risks in Niger	Climate risks increase conflict risks in combination with transnational conflict dynamics and historical factors that undermine local governance and conflict resolution mechanisms.
Nigeria	
How aid may over-target agricultural need: Instrumental-variable mediation analysis of climate–aid–violence links in Nigeria	Controlling for effects of climate change on agricultural productivity, higher levels of development aid dampen and lower levels increase conflict risks.

PART III: GENERATING OPERATIONALLY RELEVANT VULNERABILITY CLUSTERS

Vulnerability is generally defined as the extent to which a community will be exposed to a hazard, how sensitive the community is to the hazard, and its capacity for coping with the hazard. This conceptualization of vulnerability relies on approaches proposed by the International Panel on Climate Change and resonates with their most recent approach that focuses on risks as the intersection of hazard, exposure, and vulnerability (IPCC 2022). In concept and in its measurement, vulnerability is multidimensional. A large body of research operationalizes vulnerability for decision-making purposes by representing its magnitude by aggregating disparate variables representing the above parameters into vulnerability indices. If mapped spatially, such indices can be useful for an understanding of regional differences in levels of vulnerability. However, indices are less helpful for identifying place-specific options for tackling different sources of vulnerability since they combine diverse sources of vulnerability into a single measure.

Generating vulnerability clusters and their profiles can help identify and pinpoint locations that share similar vulnerability characteristics. Just as the pathways connecting climate change and conflict vary by geography, so also do the factors and parameters shaping vulnerability profiles differ across locations. Clustering localities according to similar levels of exposure, sensitivity, and capacity to adapt to conflict and climate hazards constitutes a novel approach. It has the potential to promote a deeper understanding for development practitioners about how multidimensional vulnerability characteristics vary spatially, how conflict contributes differentially to vulnerability across different locations, and how spatially specific vulnerability profiles may inform adaptive development decision-making. Information about sources of vulnerability and the resulting vulnerability profiles enable identification and elaboration of place-specific climate change adaptation strategies to prevent conflict or dampen conflict dynamics. Importantly, compared to traditional ways of measuring the magnitude of vulnerability through indices, the vulnerability profiles approach developed for the study focuses quantitatively on the heterogeneous nature of climate–conflict vulnerability, recognizing and reflecting local realities with greater fidelity. Vulnerability profiles thus allow for describing different types of vulnerabilities across a region in language that is usable and transparent.

A groundbreaking regional dataset covering 16 West African countries using open access, spatially explicit data at 5 x 5 km grid cell resolution was created to identify unique vulnerability clusters across West Africa. In line with the definition used by the IPCC and Adger (2006), vulnerability was operationalized by compiling spatial data on variables representing the three distinct dimensions of exposure, sensitivity and adaptive capacity. In this analysis, exposure variables include projected changes regarding temperature and precipitation from 2020 to 2100; the number of conflicts; and total fatalities attributable to conflict. Examples for variables relating to sensitivity include population count, population change, travel time to surface water in 2020 and other environmental variables such as forest loss between 2000 and 2020. Adaptive capacity variables consist of variables such as nighttime light emittance, change in nighttime light emittance (2000 to 2020) and travel time to nearest populated place. To identify relevant clusters in World Bank operational regions, the task team relied on a combination of variable reduction and variable weighting techniques with hierarchical agglomerative clustering and domain knowledge.

Areas situated within a given cluster have similar levels of exposure, sensitivity and adaptive capacity to climate and conflict risks. For any given geography for which spatial data for exposure, sensitivity and adaptive capacity is available, the approach maximizes differences in vulnerability characteristics across clusters and minimizes differences across locations within them. It is important to note that optimal cluster size and distribution changes according to the geographical scale selected for analysis. Running hierarchical agglomerative clustering in each of the four West African operational World Bank regions coupled with domain expertise helped select a total of 55 clusters with optimal cluster size comprising 12 in the Gulf of Guinea region, 15 in the Lake Chad region, 19 in the Sahel region, and nine in the Westernmost Africa Region. Figure ES 1 below shows the cluster distribution in each of these four regions while Table ES 2 summarizes three key clusters identified in the Sahel Region.

FIGURE ES 1 Overview of Vulnerability Clusters

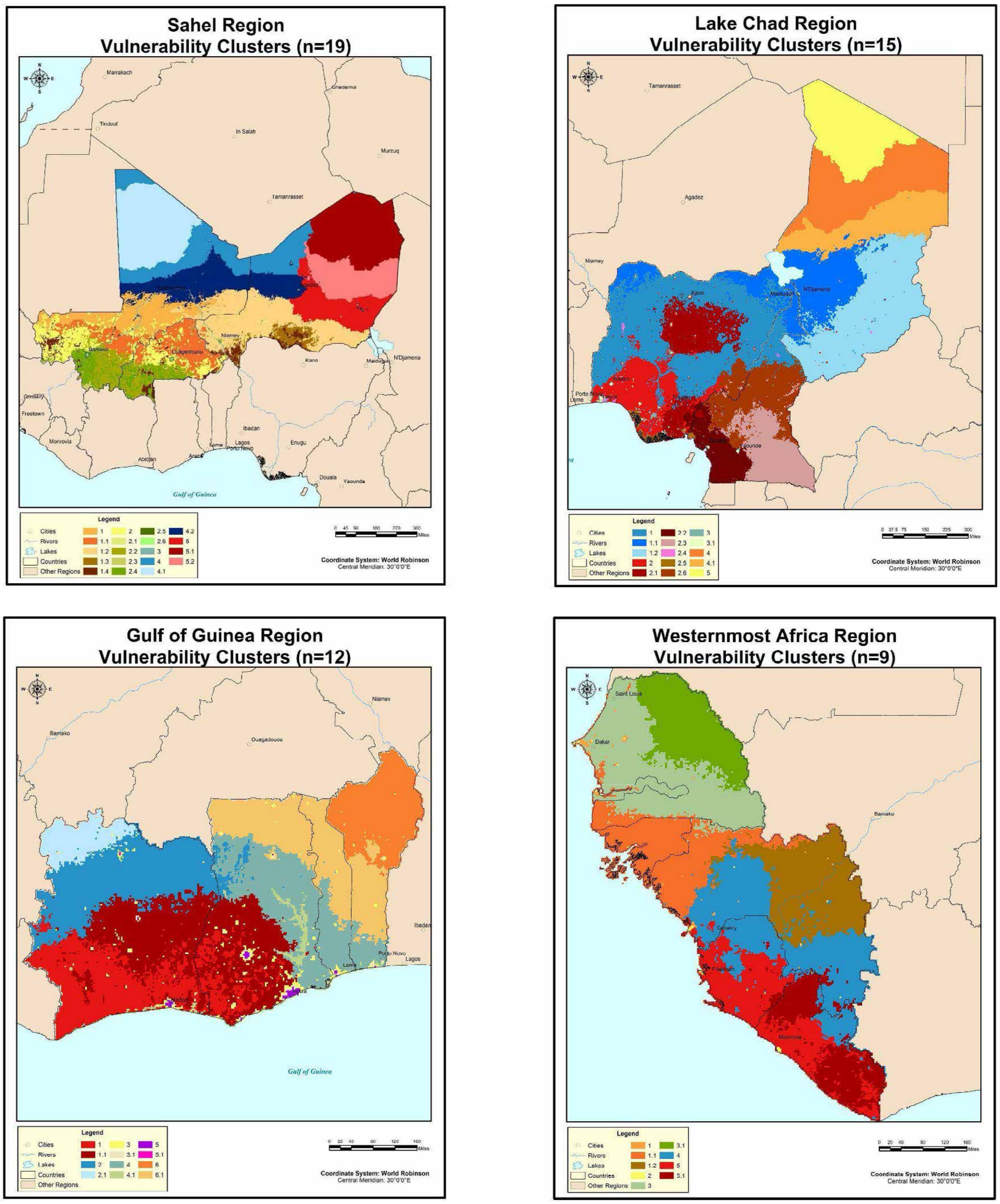
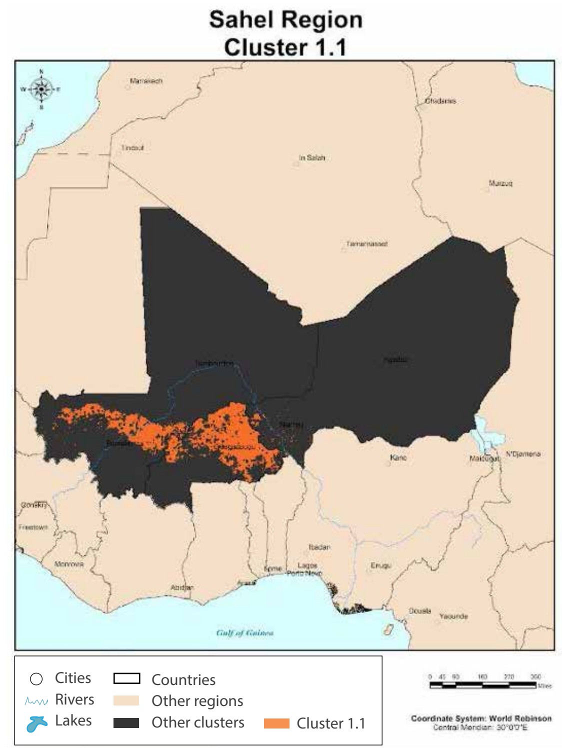


TABLE ES 2 Key Sahel Region Clusters

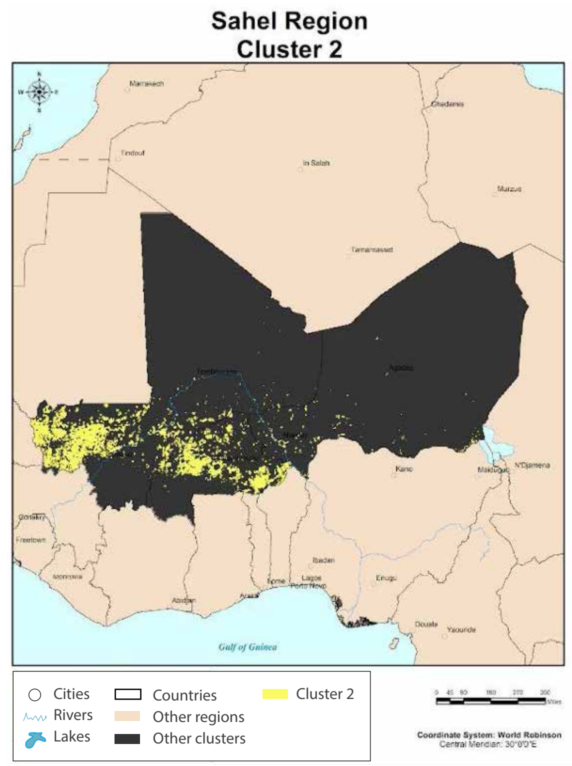
Sahel Region, Cluster 1.1

Cluster 1.1 in the Sahel Region is dominated by the border region between Mali and Burkina Faso, with the majority of grid cells in Burkina Faso. This cluster is 174,250 km2 with a mean population of 44.9 people/km2. From 2000 to 2020, the population in this cluster grew at an average of 18.8 people/km2. The change in average maximum temperature between 2020 and 2100 is predicted to be 3.66°C, with a decrease in annual precipitation of 114.83 mm. Conflict deaths per 1000 inhabitants were 0.29. For such a rural region, this represents a comparatively high number of conflict fatalities.



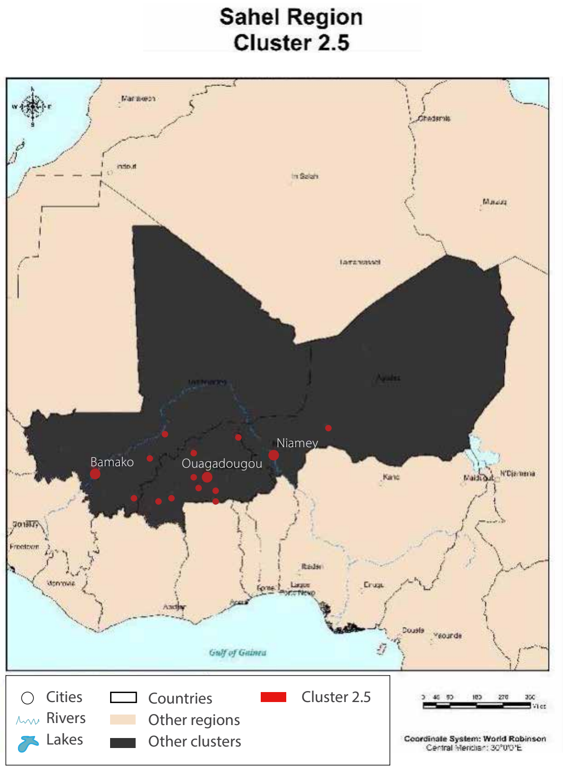
Sahel Region, Cluster 2

Cluster 2 in the Sahel Region covers an area of 191,375 km2, with most grid cells in Mali and Burkina Faso. Much of this cluster occurs on or near international borders, the most common land type is grassland, and the cluster contains the third greatest tree cover loss in the region. Between 2020 and 2100, average monthly temperature is expected to increase by 3.5°C, and annual precipitation is projected to decrease by 164.06 mm. These climate impacts are some of the most severe for this region, and they are compounded by exposure to violent conflict. Cluster 2 contains the third highest level of mean conflict deaths per grid cell (1.28 per 1,000 people) in the Sahel Region. One of the defining qualities of this cluster is the high number of conflicts in cells with comparatively low population densities. With an average population density of 46.5 people/km2 that grew by 20.8 people/km2 from 2000 to 2020, this region contains a high ratio of conflict deaths to total population. This cluster also has the second longest average travel time to surface water in the region among clusters that are not sparsely populated desert (that is, primarily desert land cover with < 4 people/km2).



Sahel Region, Cluster 2.5

Cluster 2.5 in the Sahel Region covers an area of 5,450 km2, with most grid cells in Mali. This cluster is dominated by peri-urban grid cells with grassland comprising the dominant land cover. Between 2020 and 2100, average monthly temperature is expected to increase by 3.3°C, but with precipitation almost unchanged. Cluster 2.5 contains the second highest level of mean conflict deaths per grid cell (14.9 per 1,000 people) in the Sahel Region. This cluster contains the second greatest population (690.9 people/km2) and the second greatest increase in population within the region (436.2 people/km2). Infrastructure is similarly low relative to the population here, with the second longest average travel time to surface water (that is, excluding cells that are primarily desert).



Note: To improve visualization, Sahel Cluster 2.5 is depicted in red. In the regional map, Sahel Cluster 2.5 is depicted in green.

In sum, results of the cluster analysis show that rural West Africa's vulnerabilities tend to differ considerably from those characterizing Urban West Africa. While urban clusters typically show higher levels of endemic conflict, they are predicted to face comparatively lower temperature and precipitation changes between 2020 and 2100. In addition, urban areas benefit from infrastructure and connectivity that may mitigate the impact of exposure variables. Rural regions defined by high levels of conflict, projected increases in temperature and decreases in precipitation, and limited energy or water infrastructure will be at particular risk. For the most part, these clusters are inland, often adjacent to international borders, and occur in each region. Although their sensitivity as measured by total population or population change is less compared to urban clusters, these clusters also face greater challenges for adaptation due to poor connectivity and low infrastructure. It is important to note that adaptive capacity emerging from infrastructure is contingent on local conditions. Working at local scales, and in consultation with communities, thus remains of critical importance for the identification of climate vulnerabilities that are not visible in large-scale statistical modeling.

The climate–conflict vulnerability profiles identified through this report can help development operations addressing conflict and climate risks in three major ways. One, they provide information on the different types of vulnerabilities common to clusters of locations in a region and how different clusters differ in their vulnerability. Two, they enable practitioners to work across national and subnational boundaries to identify localities that face similar vulnerabilities and may benefit from similar operational responses. Three, the process for generating vulnerability clusters and profiles is highly flexible and can be adapted depending on operational needs. More specifically, clusters can be generated at different geographical and administrative scales (that is, administrative units or spatial grid cells) and customized to include other vulnerability factors of interest including socioeconomic or biophysical variables for which spatial data is available at fine resolution (5 x 5 km in our analysis). This flexibility makes the approach relevant for informing sector and development plans at diverse spatial, administrative, and political levels and across disciplinary boundaries.

RECOMMENDATIONS AND USE CASES

1. Vulnerability clusters can strengthen the evidence base underlying regional, national and subnational climate adaptation dialogues and knowledge management platforms. While vulnerability clusters featured in this work were generated at the regional level, the existing dataset can also be used to derive clusters at national and subnational levels depending on operational requirements. Vulnerability cluster information could thus be adapted to feed into both regional and national knowledge management platforms (KMPs) planned under ongoing regional operations such as the PROLAC project. Combining regional, national, and/or subnational cluster analysis can provide additional evidence to identify communities and areas that require interventions most urgently and thus facilitate the prioritization of resources for interventions with the greatest impact. In addition, information provided by the clusters could enhance regional Country Climate and Development Reports (CCDR). Designed specifically to tackle the disjuncture between climate and development policies, CCDRs help inform country strategies by exploring synergies between climate action and measures that promote economic growth, shared prosperity, and poverty reduction. Integrating multidimensional climate–conflict vulnerability data would strengthen the evidence base of the CCDRs by providing an opportunity to map hotspots and contribute to identify resilience-building strategies that adequately reflect subnational variations of climate exposure and adaptive capacity.

2. Vulnerability profiles can facilitate comparative research on the effectiveness of development interventions and knowledge exchanges. Connecting vulnerability profile data with program monitoring and evaluation systems can facilitate monitoring the impact of diverse types of interventions both across and within vulnerability clusters. More specifically, vulnerability clusters might be useful for informing the selection and comparison of monitoring/impact evaluation sites. In addition, cluster data could be leveraged for targeted knowledge exchanges and peer-to-peer learning by bringing together participants (at community, municipality, provincial or national level) from areas with similar vulnerability profiles . Such exchanges can promote the diffusion of best practices and lessons learned linked to conflict-sensitive climate adaptation strategies across areas with shared vulnerability characteristics.

3. Making vulnerability data accessible at the subnational and local levels can serve as the starting point for local-level discussions to identify adaptation investments tailored to local conditions. Tying together information about climate change and conflict pathways with regional, district, or village vulnerabilities is critical to identify and promote adaptation strategies best suited to improved resilience. For program facilitators, downscaled vulnerability information could serve as a valuable input for relating the targeted communities' most pressing development challenges to their climate exposure and adaptive capacity. Facilitators can use that vulnerability information for exploring the viability of adaptation action during local community-driven dialogues. To conduct a viability assessment of measures under discussion (such as investments into infrastructure needed for the processing of a specific crop), facilitators could overlay information contained in the vulnerability profiles with contextual knowledge provided by community members. Applying vulnerability data this way might benefit regional investment programs financed by the World Bank or other institutions. Ongoing or upcoming programs to which the tool may be useful include the Lake Chad Region Recovery and Development Project, the Community-Based Recovery and Stabilization Project for the Sahel, the Gulf of Guinea Northern Regions Social Cohesion Project as well as the West Africa Food System Resilience Program (FSRP).

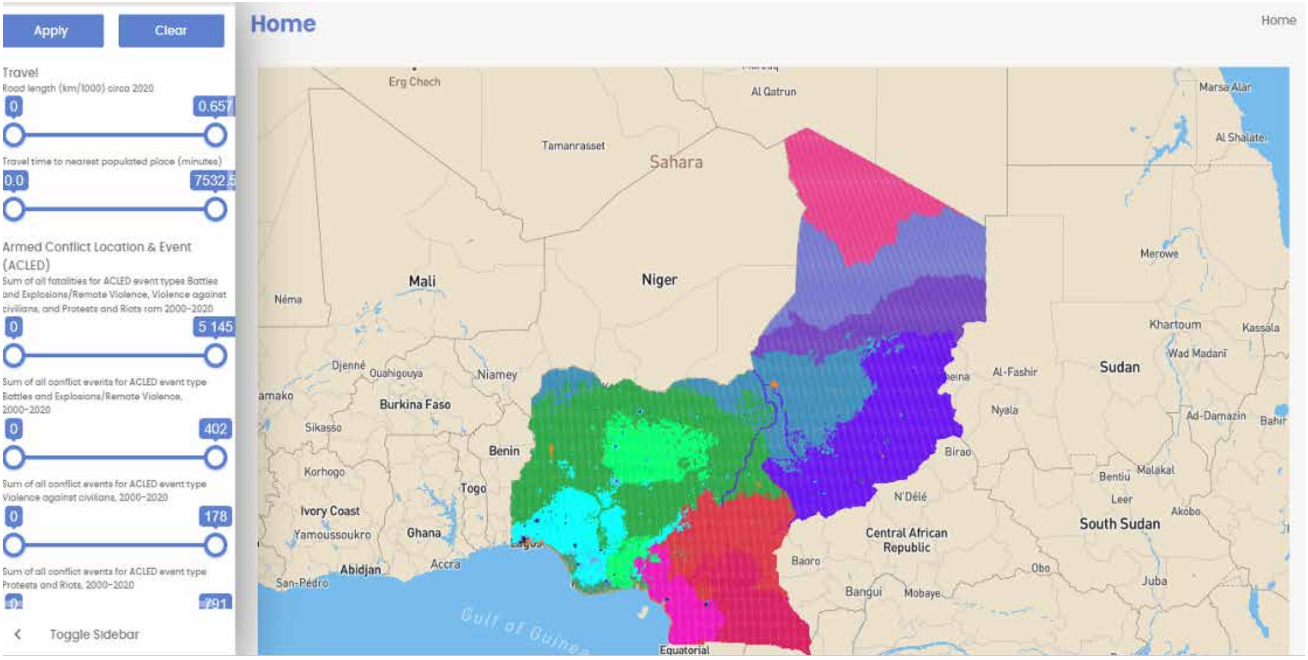
NEXT STEPS

Identify additional data on key socioecononic and political dimensions of vulnerability at needed resolution to incorporate into vulnerability profiles and clustering analysis. Further work should consider adding new information on climate hazards, and socioeconomic and political dimensions, to enrich the analysis for identifying vulnerability clusters and profile descriptions of each vulnerability cluster. For example, additional climate data could help the clusters to accurately reflect climate vulnerabilities of agricultural, pastoral and urban communities that average values cannot fully capture (sometimes owing to time-scale discrepancies). Potential variables include near-term temperature and precipitation projections, seasonality, probability of meteorological thresholds and extreme weather events such as flooding in a given year. Entry points for sourcing data for additional vulnerability variables include the World Bank's Climate Change Knowledge Portal, national surveys, and social media. Including this data in analysis based on user and operational needs should be a core objective of future work.

Communicate vulnerability cluster and profiles data to a wider audience by translating the summary statistics into clearly written profiles for all vulnerability clusters. Follow-up work should compile easily accessible descriptions of vulnerability profiles to improve the understanding of development practitioners and government agencies about how conflict and climate change combine to generate a range of vulnerability profiles across West Africa. Through learning workshops involving World Bank task teams and clients, development practitioners can help concretize and raise awareness for the use cases of this data. Moreover, enabling diverse stakeholders to engage with the vulnerability profiles will lead to additional insights on relevant additional vulnerability variables that should be considered for the generation of future vulnerability clusters.

Publish the vulnerability information through an interactive data tool. To maximize the actionability of the vulnerability data, a web-based tool is currently under development. The data platform will allow policy makers, researchers and development practitioners to access the data directly and use filtering and visualization mechanisms for their own usage and analysis. Users will be able to do simple querying and filtering of the data and tailor basic visualizations to their needs. For instance, the tool will allow users to explore and compare exposure, sensitivities and adaptive capacity of specific locations with one another, and this may help them to deliberate on areas that most acutely require resilience-building interventions. Negotiations are currently underway with academic institutions that could host the tool as a global public good that benefits both research and development action.

FIGURE ES 2 Snapshot of interactive data tool



INTRODUCTION

Across different fields of policy making and research, a substantial and growing literature on climate vulnerability and conflict has emerged over the past two decades to elucidate the connections between the two phenomena (Burke et al. 2015, Koubi 2019, Nordås, R., & Gleditsch 2015). Many differences mark these writings. Beyond focus, methods, data, and theoretical motivations, these differences include how existing research conceptualizes climate change, what it defines as conflict, and findings in terms of climate–conflict relationships (Meierding 2013, Raleigh and Urdal 2007, Salehyan 2008, Sharifi et al. 2021). Differences in findings run the gamut from assertions about absence of any effects of climate change on conflicts to substantial and clear evidence on the presence of effects. Some attribute these differences to the complexity of pathways connecting the two phenomena, patchy data, and differences in analytical approaches and theoretical commitments (Adams et al. 2018, Sakaguchi et al. 2017, Sheffran et al. 2012). In developing our analysis of climate–conflict vulnerability and operational guidance based on this analysis, we take into consideration how the existing research on the subject has evolved over the past two decades.

Despite differences, research on climate–conflict relationships in the past two decades agrees that climate change by itself does not generate conflicts. Rather, climate-related factors such as temperature, precipitation, and disasters influence and reshape risks of different types of conflict (Barnett and Adger 2007, Hsiang and Burke 2014). Some of the mediating and moderating variables that structure the connections of climate change to conflicts are: economic wellbeing; migration; resource dependence; variations in agricultural production; commodity price volatility; existing socioeconomic relationships; and institutional capacity (the list could continue). The diversity of these writings, coupled with the rapidly increasing volume of the literature, demonstrates the importance of gaining a systematic understanding of the climate–conflict vulnerability relationship and of the mechanisms through which this relationship becomes manifest in different regions.

This report brings together the results of a year-long World Bank project on climate change and conflict in West Africa. The project undertook three connected analytical tasks. The first focused on assessing the association between climate change and risks of conflicts in West Africa. The second used a suite of case studies to understand the mechanisms that may explain observed quantitative associations between climate risks and conflict. The third built on available data on climate and conflict to characterize the forms of vulnerability that affect different locations and communities in West Africa. Collectively, the three analyses help advance a deeper understanding of the factors and mechanisms through which risks of violent conflicts change, conflicts emerge—and persist—in specific regions, and actions that may mitigate these vulnerabilities.

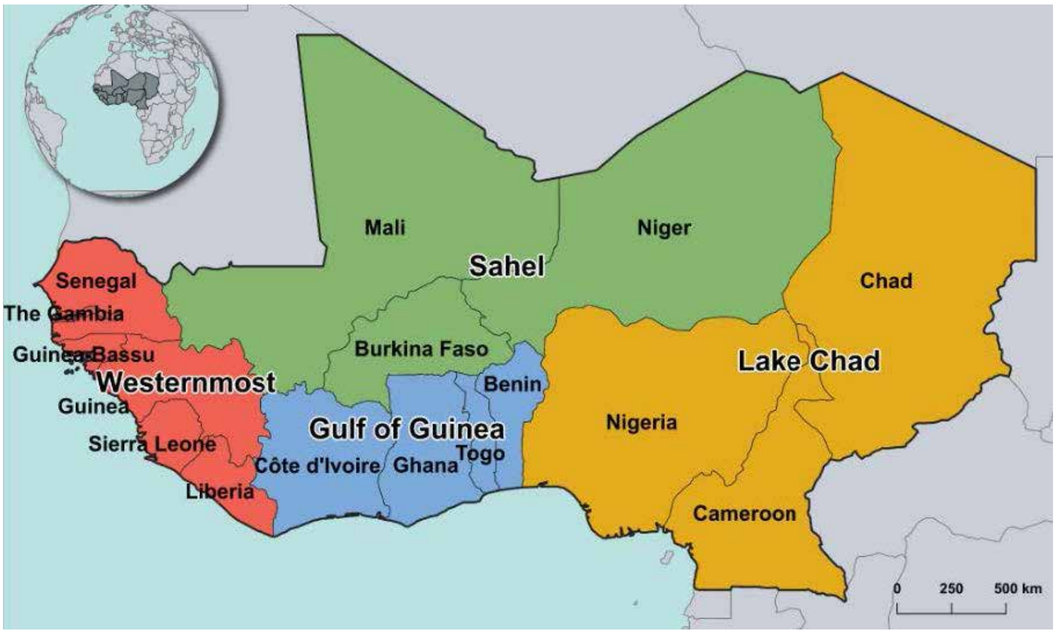
The report is in three parts. Part I quantitatively models location-specific information on climate and conflict for West Africa. It thereby assesses the degree to which general factors— both climatic and others—that may affect conflict risks accurately predict likelihood and occurrence of conflict. Part II draws upon a small set of commissioned case studies of climate and conflict to examine particular mechanisms that connect climate change to conflict in specific places. In both these ways, the report advances existing knowledge about links between climate change and conflict, and offers usable information for designing and targeting different types of development investments. Part III delves deeper into how climate and conflict-related exposure, sensitivity and adaptive capacity combine to create different vulnerability profiles for communities in West Africa. Understanding how climate–conflict vulnerability comes into being, rather than focusing primarily or exclusively on levels of vulnerability, is useful to identify more targeted adaptation actions to address the risks of climate change and conflict.

The report has two major objectives. The first is to strengthen the evidence base on the relationship between climate change and socio-institutional fragility, violence, and conflict in West Africa. This is the objective of the first two parts of the report: Part I contributes to this objective with quantitative data; Part II does so qualitatively, but with greater attention to the mechanisms through which climate change related stresses translate into conflicts, and climate–conflict vulnerability comes into being. Because the report uses spatially explicit data for analysis, a corollary of the first objective is the identification of different options for mitigating conflict risks in specific locations. The second objective of the report is to assess how vulnerability in different places is structured, what is common or different across locations in terms of the forms of their vulnerability and how it can be mitigated. In so doing, the report also contributes to the goal of a green and climate-resilient recovery in the wake of the global pandemic. Finally, the evidence and insights from this report are useful to to develop and enhance digital tools in the service of decision-makers and others who need to understand the risks of climate change-linked conflicts in different settings in the region.

STUDY AREA AND GENERAL METHODOLOGY

Sixteen countries lie in the area covered by the study. These countries can be divided into four regions (Figure 1.1). The Sahel region includes Burkina Faso, Mali, and Niger. The Gulf of Guinea region includes Benin, Côte d'Ivoire, Ghana, and Togo. The Lake Chad region denotes Cameroon, Chad, and Nigeria. Finally, the Westernmost Africa region includes Gambia, Guinea, Guinea-Bissau, Liberia, Senegal, and Sierra Leone.

FIGURE 1.1 Map of study area of 16 countries and four regional designations



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1 CLIMATE AND CONFLICT CO-OCCURRENCE IN WEST AFRICA

1.1 BACKGROUND

In contrast to most literature on climate change and violent conflict, this section assesses regional patterns between variables that represent climate change and violent conflict. Much of the current literature on climate change and conflict is dedicated to understanding causal relationships between changes in temperature or precipitation and the occurrence of violent conflict. Advancing such an understanding remains important, but it rarely produces findings that apply to entire countries, let alone international regions. In this section, we seek to validate the co-occurrence of climate change and conflict by assessing the predictive validity of climate change variables for identifying the occurrence of violent conflict from 2000 to 2020 in 16 countries that cover more than 6.8 million km2 in West Africa.

This research examines where variables commonly used in mechanistic models of climate change and violent conflict accurately, or conversely, inaccurately, predict the occurrence of past conflict. We identify regions where variables common in quantitative research on climate change and conflict pathways accurately predict conflict occurrence using machine-learning algorithms to classify grid cells as areas where conflict has, or has not, occurred from 2000 to 2020. Areas that include the correct identification of violent conflict or the absence of violent conflict may be described accurately using the suite of variables we investigate; however, areas where the models we train inaccurately identify conflict (or a lack of conflict) may need additional data to understand why conflict did or did not occur. Table 1.1 (below) summarizes the relationship between model validation and the relationship between climate change and violent conflict in West Africa.

We summarize insights from our quantitative analysis by focusing on overall model validity as well as a set of subnational regions that contain a large proportion of true positive, false positive, and false negative results. Overall model validity reveals whether or not the variables we include here—all of which are commonly used in the quantitative study of climate change and conflict relationships—are useful for understanding violent conflict in West Africa. Broadly accurate models support further investigation of where, how, and why climate change and conflict co-occur. Broadly inaccurate models reveal that either the data or the algorithms in this research are insufficient for understanding where violent conflict has occurred or that there exists no recognizable pattern of interaction between the relevant variables under consideration.

It is important to note that research in Part I is agnostic to the causal relationships between climate change and conflict. Part I seeks only to determine if climate change and conflict have occurred together in West Africa and where the variables most often employed in quantitative research accurately or inaccurately predict past conflict. It does not provide insight into whether or how climate change leads to violent conflict. Rather, it examines whether and where commonly used variables that represent climate change can predict the occurrence of violent conflict in West Africa from 2000 to 2020.

1.2 METHODS

1.2.1 DATA

To model conflict occurrence as determined by climate change related variables, we generate a novel spatial dataset within a cartesian grid of 5 x 5 km cells across 16 nations in West Africa. Based on the climate change and conflict pathways identified in Part II, and drawing upon publicly available spatial data, we analyze 35 variables that contain information on present and multidecadal change in average minimum and maximum monthly temperature and precipitation; average monthly drought severity and standard deviation; present Normalized Difference Vegetation Index (NDVI); loss of forest cover; population in 2020 and multidecadal population change; number of different ethnicities; majority land cover type and change in majority land cover; total road coverage; travel times to the nearest city and to the nearest source of surface water; country; region, and presence of international border. Annex A contains additional information on data sources, data treatment, and variables.

1.2.2 MODELING CONFLICT OCCURRENCE

We analyze a suite of publicly available datasets commonly referenced in existing quantitative work on climate change and conflict to assess the co-occurrence of climate change and conflict in West Africa. To analyze these data, we compare the accuracy of binary logistic regression, random forest, and artificial neural network models to project where past conflict occurred, based on variables that represent climate change. We re-run the models with case weights based on a combination of propensity scores and Mahalanobis matching.

We evaluate models based on their classification accuracy. We define classification accuracy using two different definitions to assess the robustness of our results. The first applies only to the machine-learning algorithms (that is, random forest and artificial neural network models) and uses 80 percent training data classification as well as sampling with replacement five times (k-fold=5) to classify grid cells as "conflict" or "no conflict." The second validation strategy arrives at regression-based conflict probability for all three models by defining cells with "greater conflict likelihood" as those with any value over the population mean, while cells showing "less conflict likelihood" have any value below the mean. In the body of this report, we analyze findings from the model with the greatest overall classification accuracy, as measured by Kappa. Annex A contains parameter and tuning information for each model, model accuracy, and a spatial visualization of combined model output.

We use model validation information to focus our visualization and analysis of the results. Table 1.1 presents a typology for understanding where, and potentially why, data accurately or inaccurately predict conflict occurrence in West Africa. True positives, when the model predicts conflict—and where conflict indeed occurred—represent correctly assigned climate and conflict pathways found in our data. False positives, where the model predicts conflict, but no conflict occurred, represent regions where the climate change and conflict pathways our data represent were blocked or otherwise incorrectly assigned. False negatives, where the model predicts no conflict—but conflict in fact occurred—represent regions where our data and models are insufficient to represent climate change and conflict pathways.

The methodological approach presented in this section does not tease out causal relationships between climate change and conflict. Instead, it uses machine-learning algorithms to assess if variables often used in the literature on climate change in West Africa can provide reliable predictions of where conflict has occurred at a regional level. Unlike studies that draw upon econometric or statistical methods in order to assess relationships between variables, the purpose of this research is to determine where data are sufficient to produce reliable classification (such as conflict occurrence). This provides a starting point to begin generating basic inferences about the co-occurrence of climate change and conflict in West Africa. Conversely, the method helps to identify where current data and selected models produce inaccurate classifications. Such inaccurate classifications, if they persist across model types, may point to the need for additional data to better characterize the relationship between climate change and conflict.

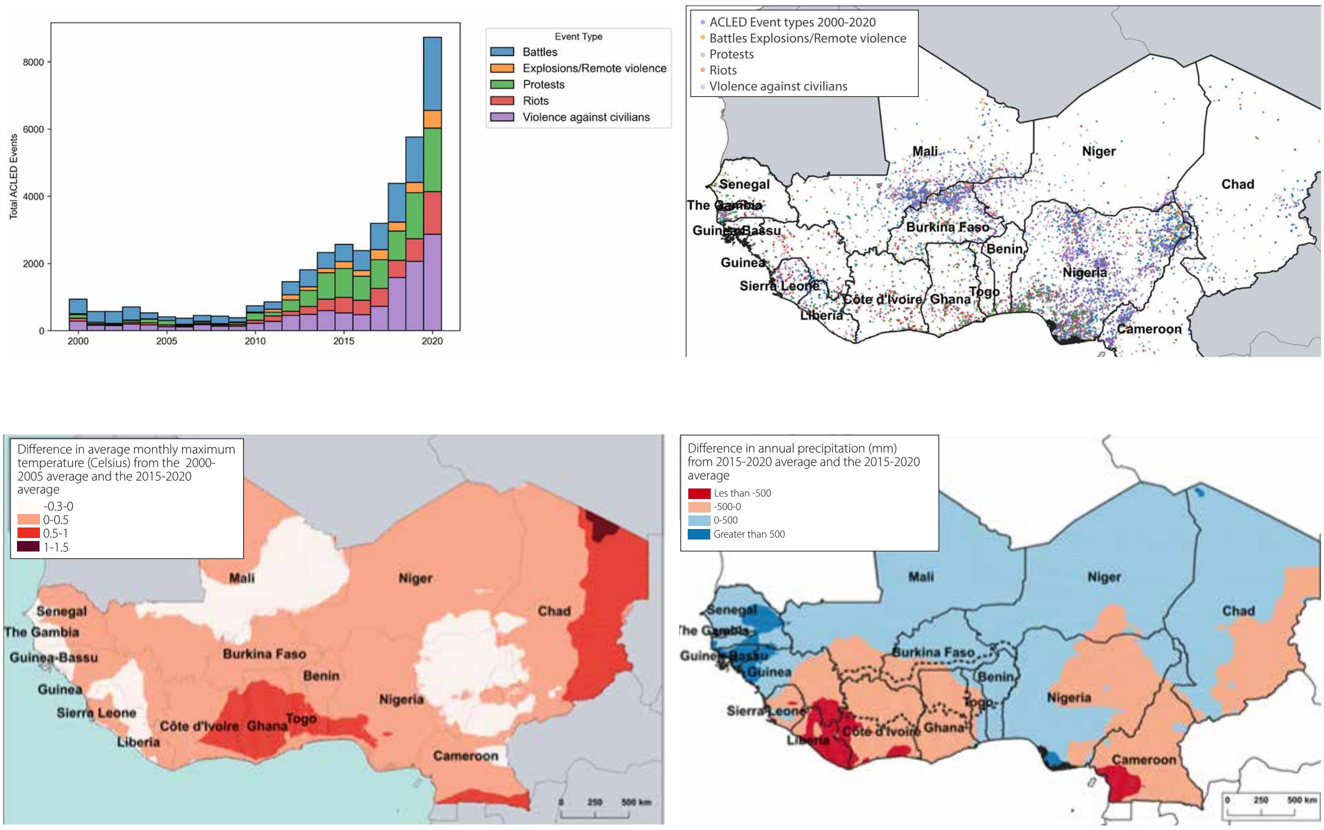
TABLE 1.1 Observed versus Predicted Conflict – Model validation categories and related questions for climate change and conflict pathways

	Model Predicts Conflict	Model Predicts No Conflict
Conflict Occurred	**True Positives** **Assessing model validity:** • What drives the correct identification of conflict in these areas?	**False Negatives** **Understanding "model error":** • What explains conflict in these areas? • What does the model lack?
Conflict Did Not Occur	**False Positives** **Understanding "model error":** • What explains peace (or dampened conflicts) in these areas? • What data does the model lack?	

1.3 RESULTS AND DISCUSSION

Patterns of conflict occurrence and projected climate change demonstrate general trends across the region that nonetheless vary by location. Above all, our data show that conflict occurrence in West Africa is increasing over time, and it affects every country studied (Figure 1.2A), although the number of conflicts varies widely across countries (Figure 1.2B). Temperatures from 2000 to 2020 increased, with some regional variation (Figure 1.2C). Precipitation differences for the 2000–2020 period are more difficult to describe for the area studied, because regional weather patterns are highly variable (Figure 1.2D).

FIGURE 1.2 Violent conflicts in West Africa by year and by type (A, top left), map of all violent conflicts in West Africa by type (B, top right); map of change in monthly maximum temperature from the 2015–2020 average and the 2000–2005 average (C, bottom left); and difference in annual precipitation between 2015–2020 average and 2000–2005 average (D, bottom right).

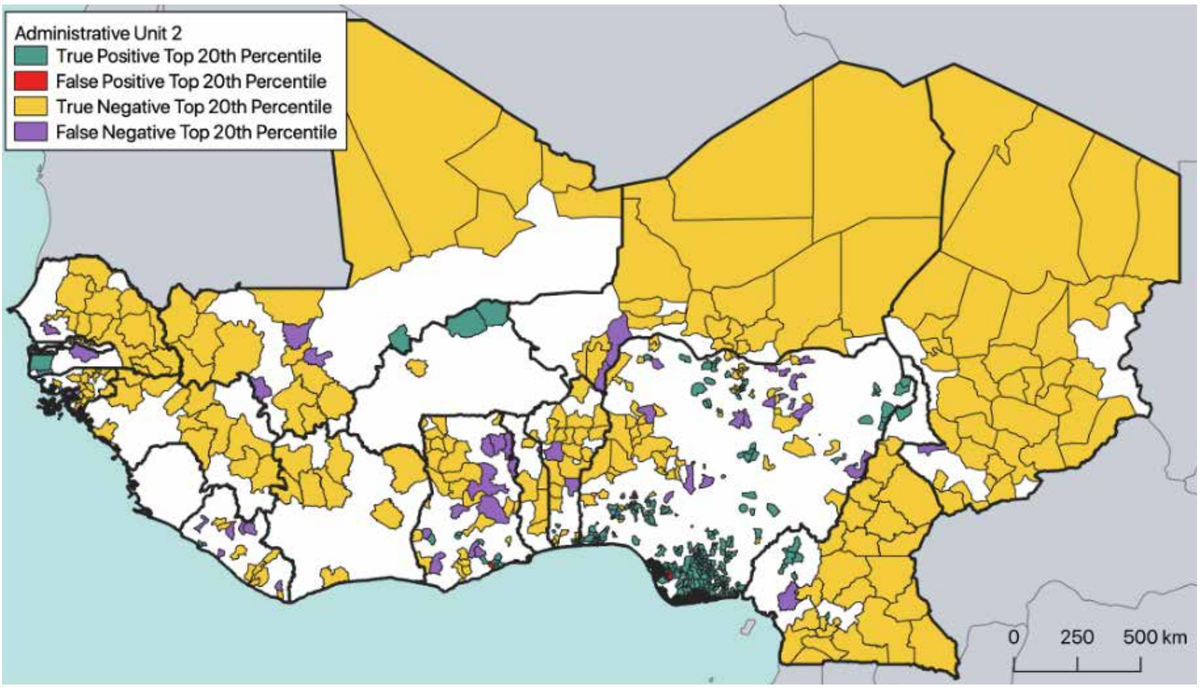


Source: Authors

After tuning hyperparameters, the weighted random forest model demonstrated the highest classification accuracy among all machine-learning algorithms (Accuracy=0.92, Kappa=0.64). Thus, we present the results from the weighted random forest model in the main text, and we provide all classification accuracy statistics and visualizations for combined model results in Annex A.

To emphasize locations where the weighted random forest model was most accurate versus least accurate, Figure 1.3 below visualizes administrative units with the greatest proportion of grid cells in a given category (that is, True Positive, False Positive, True Negative, or False Negative, respectively). Moving from East to West, the most accurate model finds groups of administrative units defined by high proportions of true positive cells (where observed and predicted conflicts match) in coastal and more heavily populated areas of The Gambia and Senegal; coastal and more heavily populated areas in Liberia; inland and more sparsely populated regions along the Mali–Burkina Faso border; coastal and more heavily populated areas of Ghana; coastal and more heavily populated areas of Nigeria; inland Nigeria moving north toward the Niger–Nigeria border; more heavily populated and inland western Cameroon; and inland more sparsely populated northern regions along the Nigeria–Cameroon border. These locations tend to be urban, heavily populated, and either coastal or abutting an international border.

FIGURE 1.3 Subnational Administrative Units most defined by model validation categories. White regions represent subnational administrative units that were not within the top 20th percentile of any model validation category.



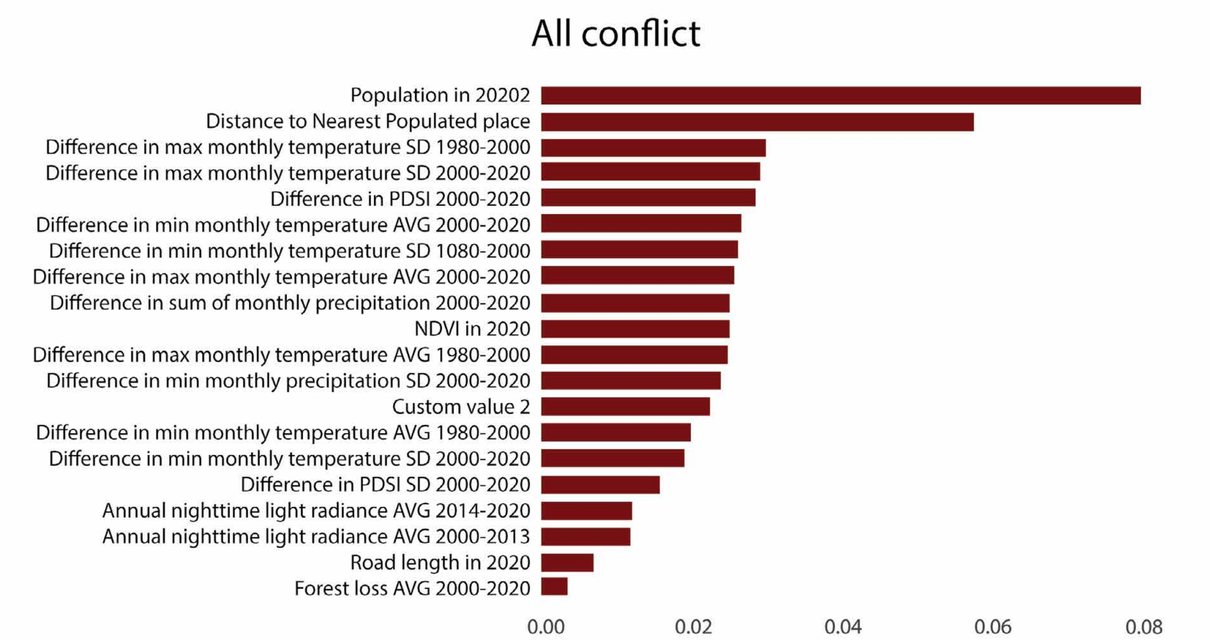
Source: Authors

Clusters of administrative units defined by false negative grid cells include regions in Senegal surrounding the Gambia; several units in inland Liberia; Western Mali; Central and Northern Ghana; Western Niger along the Niger–Nigeria–Togo border; pockets of inland Nigeria; and inland Cameroon. Annex A provides the names of the administrative units for which the model predicts no conflict, but where endemic conflict occurred. Additionally, it includes visualizations for the predicted probability of all conflict occurrence by subnational administrative unit as well as subnational administrative units defined by model categories, as determined by composite outcomes from all models (n=5).

Administrative units defined by false positive grid cells were rare, owing to the small number of false positive grid cells. Each of these units contains or is near a cluster of true positives that are high-population and urban. Units containing the greatest proportion of false positive cells include Adjarra, Benin (near Porto-Novo); Ga West, Ghana (near Accra); Ugwa West and Mbaitoli, Southeast Nigeria, near Port Harcourt and Oweri, respectively; Badagary and Ifet, Nigeria (near Lagos); and Eket, Nigeria.

Variables of importance (Figure 1.4) for modeling all conflict types across West Africa emphasize the trends that can be identified from analyzing spatial patterns. Although grid cell population in 2020 was the most important variable, followed by travel time to major populated places, a suite of climate change variables was also important in predicting conflicts across West Africa. In particular, the modeling highlights the role of "the difference in monthly variation of maximum temperature between 1980–2000 and 2000–2020," and "changes in the Palmer Drought Severity Index from 2000 to 2020" as being among the top five most important variables predicting conflict occurrence. It is important to note that the variable importance measures of these variables do not imply causality in our models. However, the findings are broadly consistent with research that focuses more carefully on causal inference and concludes that changes in maximum temperature (and their variations) and drought predict increases in conflict.

FIGURE 1.4 Plot of the top 20 variables, ranked by importance, for modeling conflict occurrence in West Africa (2000–2020) using weighted random forest models.



Source: Authors

The modeling presented here reveals the locations where a particular machine-learning algorithm accurately or inaccurately predicted the occurrence of endemic conflict. At a regional level, this modeling exercise was broadly accurate, though it contains important and revealing inaccuracies. Examining where accuracy is manifest at the subregional level can provide greater insights into where data often used in climate change and conflict studies is likely to prove adequate for modeling conflict occurrence; conversely, analyzing where inaccuracies exist can identify where additional data or different methods might be required.

The goal of the analysis above is less to identify the different drivers that lead to and precipitate conflict. Rather, it is to highlight and identify the locations where climate-related disruptions may be associated with conflict. Climate change, as an extensive body of literature on the subject shows, is associated with many socioeconomic and political drivers of conflict in both the short and the long run.

Such additional variables include institutions, policies and governance, interactions among different ethnic and social groups, degree of social cohesion, levels of deprivation and economic well-being, food prices and changes in demand for and supply of food, and levels and patterns of migration, among other key variables. Disentangling the relative effects of these is at the cutting edge of research on climate change and conflict. In our report, unpacking subregional differences and investigating the mechanisms that connect climate change and violent conflict is the focus of Part II and is undertaken through a series of case studies.

2 SELECTED CASE STUDIES ON CLIMATE AND CONFLICT IN WEST AFRICA

2.1 BACKGROUND

The machine-learning based quantitative modeling helps us to understand the predictive relationship between a range of climate change and other vulnerability variables and the outbreak or persistence of societal conflicts. The associations we find can be enriched through in-depth examination of conflicts in specific locations and countries. More careful case-based investigations can help generate novel insights into why and how vulnerability precipitates social tensions and conflicts. Indeed, vulnerability can lead citizens to passive acceptance but also to resistance and protests. In addition, case analysis can shine a light on variables and processes for which comparable data across locations do not exist, but which the authors recognize as important via domain expertise or theoretical knowledge and can identify in the context of a particular study.

Thus, to better understand the accuracy of our quantitative analyses of climate change and conflicts, we focus on a set of climate and conflict case studies in this part of the report. The studies examine the direct and indirect mechanisms through which climate variables influence human behaviors, patterns of social relationships, and social tensions in the region. These mediating factors probably also shape the fundamental contours of negative social interactions more generally (including conflicts). After all, even where climate change has substantial effects on conflict additional to the factors on which researchers have conventionally focused, it likely does so through social mechanisms that connect variables such as temperature, precipitation, and disastrous events to societal outcomes.

We commissioned eight studies. The main text of the report includes the five that are most directly responsive to the objective of identifying the mechanisms that exacerbate or dampen climate change and conflict relationships, or which highlight the importance of factors on which data over time or across contexts do not exist or are not easily available. The remaining three are included in Annex B. The studies examine human behaviors, social change, and conflict vulnerability at a range of scales—from households in individual sites to the entire region. The studies included deploy various analytical strategies and direct attention in particular to the mechanisms through which climate change stresses translate into conflict and fragility. Collectively, they generate key insights that have the potential to inform future work, help identify the social mechanisms that connect climate change with conflict, and provide useful evidence regarding the role of development projects in ameliorating the negative effects of climate stresses on social and institutional relationships and conflicts.

The next section summarizes the key findings from the five studies in the main body of the report, followed by a summary table. The subsequent sections in this part of the report elaborate on these summary findings.

2.2 REVIEWING THE INSIGHTS FROM CLIMATE CHANGE AND CONFLICT CASE STUDIES

Five of our studies focus mainly on drivers and mediators of climate–conflict relationships in individual countries, or specific mediating factors in particular locations. They cover five countries in West Africa. Three of the studies focus on country-level patterns of climate-related conflict risks in Niger, Côte d'Ivoire, and Nigeria (Charbonnneau et al. 2022, Brown and Penel 2022, Schon et al. 2022). These studies highlight specific climate risk factors that are the subject of further analysis in the other two cases. Wai et al. (2022) focus on migration. They examine how migration induced by elevated climate risks in Ghana translates into conflictual relationships between different social groups with different livelihood pathways. Brottem (2021) examines farmer–herder relationships in Mali and explores how these intersect with the emergence of armed groups to amplify tensions and conflicts. These two latter studies also assess how increases in insecurity linked to climate change are changing the risk that migration and associated farmer–herder interactions become conflictual.

Charbonneau et al. (2022) situate their assessment of climate-associated risks of violence in Niger by examining the broader literature and its conclusions on these different impact pathways. Analyzing how the historical context of the Sahel renders greater specificity to the broader literature, they suggest—as does a large body of work on the subject—that climate change serves as a threat multiplier for conflicts in Niger (Selby et al. 2017, Smith and Vivekananda 2007). It affects local governance practices, undermines conflict-resolution mechanisms, and accelerates the timeline of changes needed. The regional context is one where the increasing intensity of activities by armed groups undermines social stability and peace. Here, historical legacies and political processes tend to dictate how country level actors respond to climate and conflict risks. The study makes two larger points: first, that climate change, even as a threat multiplier, does not necessarily lead to conflict, and that its conflict implications are structured by historical institutional legacies; and second, how climate change risks translate into conflict depends on the relationship between transnational conflicts and local social and institutional dynamics.

Brown and Penel (2022) examine how climate change vulnerabilities translate into conflict risks in Côte d’Ivoire. Their analysis recognizes three particular climate-fragility risks for Côte d'Ivoire—health outcomes, including security of food and livelihoods aggravated by climate-associated factors, migration exacerbating social tensions, and increased risks of farmer–herder conflict. Climate change projections for the country suggest that climate change is likely to increase each of these risks over the coming decades, but the paper argues that whether these risks actually precipitate conflicts will depend on the policy and institutional responses of decision-makers. The study also provides a window into the specific forms of gender-linked climate vulnerability. As a response to climate–conflict risks, the study highlights the potential of a range of development interventions that may address the mediators through which climate change translates into conflicts. These include improved water and land management, strengthening of sustainable agricultural practices, deeper regional collaboration, and improved data collection to monitor, analyze, and respond to climate–conflict risks in a timely manner.

Schon (2022) focuses more directly on the relationship between climate change risks for conflict in Nigeria and examines whether and how development programs—particularly in the agricultural sector—have the potential to mitigate climate–conflict risks. A larger literature already provides insights into whether aid reduces violence. Aid can dampen violence (de Ree and Nillesen 2009), but in contexts of instability and fragility, poorly managed aid projects can increase the likelihood of violence (Zürcher 2017, Findley 2018). Using a novel instrumental variables-mediation analysis, Schon finds that temperature anomalies reduce vegetation and productivity, increase aid, and reduce violence. Counter-intuitively, the study also finds that locations with higher agricultural productivity receive less aid, and also witness greater violence. The findings are thus nuanced, and suggest that targeting agricultural aid projects more widely, including in regions that have higher agricultural output may have broader effects in terms of dampening climate-linked violence.

While Schon (2022) examines whether development interventions affect the likelihood of conflict occurrence in response to climate anomalies, the analysis by Brottem (2022) digs deeper into how changes in farmer–herder interactions induced by climate change (and other social drivers) can lead to conflict. Based on a longitudinal survey of migrant pastoralists and additional interviews with local residents, the study explores the emergence of violent insurgent group cells in western Mali. It also examines the relationship of these cells to farmer–herder interactions. Western Mali is viewed as a frontier in the expansion of the active extremist group, Katiba Macina. The analysis evaluates the pastoral populism theory of fragility-linked violence in the western Sahel. Drawing both on political-ecological insights and on research on vulnerability, the analysis pinpoints the increasing but uncertain dependency of pastoralists on access to seasonal resources, and their limited capacity to adapt to growing resource competition as key drivers of their increasing connections to violent insurgent groups. Focusing on seasonal movements, economic diversification of livelihoods, and access of pastoralists to natural resources, the study elicits information on perceptions of extremists and the role of a range of local factors in shaping climate change-induced conflict outcomes. The sheer presence of armed insurgents changes both the local security context and the calculus of pastoralist youth regarding extremism. The study concludes that increasing climate stresses in coming years can further worsen local conflict dynamics, especially if local institutions and governance of access to natural resources do not change.

Finally, the analysis by Bednar et al. (2022) examines how migration flows—resulting from climate impacts on agricultural production shocks—may be associated with an increase in mining-related conflicts in Ghana. The basic mechanisms connecting climate impacts to mining conflicts are straightforward. As a result of agricultural shocks related to climate change people have moved from areas made less suitable for agriculture. Their arrival, resulting in part from the pull of artisanal mining, creates pressures on resources and competition with existing miners among local indigenous groups. Not only does migration generate tensions between immigrants and local residents, but it also implies other environmental spillovers from mining activities in the form of deforestation, and degradation of agricultural land and water. In many cases, existing institutions and power brokers such as local chiefs can only play a role in resolving these conflicts if they can adapt to include migrant populations. This study of artisanal and small-scale mining (ASM) in Ghana goes beyond other literature on mining by explicitly considering links between climate, migration, and mining-related conflicts. Table 2.1 below presents a synoptic view of the location and key findings of each of the five studies.

TABLE 2.1 Case study locations and findings

Title and location	Key findings
The role of customary institutions in mitigating conflict and environmental degradation: The case of gold mining in Ghana	• Climate shocks are increasing migration levels; • Increased migration in the context of artisanal gold mining increases resource competition and tensions between miners and local residents.
Climate change, pastoral resource access, and extremist group violence in the western Sahel: New data and insights from Mali	• Climate stresses worsen local conflict dynamics, especially in the presence of armed groups.
A Qualitative Assessment of Climate-fragility Risks in Côte d'Ivoire	• Climate risks negatively affect livelihoods and health, aggravating food insecurity; • Climate risks increase migration and social tensions; and • Climate change increases vulnerability of pastoralist groups and risks of farmer–herder conflicts.
Climate Impact Pathways and Fragility, Conflict, and Violence Risks in Niger	• Climate risks increase conflict risks in combination with transnational conflict dynamics and historical factors that undermine local governance and conflict resolution mechanisms.
How aid may over-target agricultural need: Instrumental-variable mediation analysis of climate–aid–violence links in Nigeria	• Controlling for effects of climate change on agricultural productivity, higher levels of development aid dampen and lower levels increase conflict risks.

CASE STUDY 1 - THE ROLE OF CUSTOMARY INSTITUTIONS IN MITIGATING CONFLICT AND ENVIRONMENTAL

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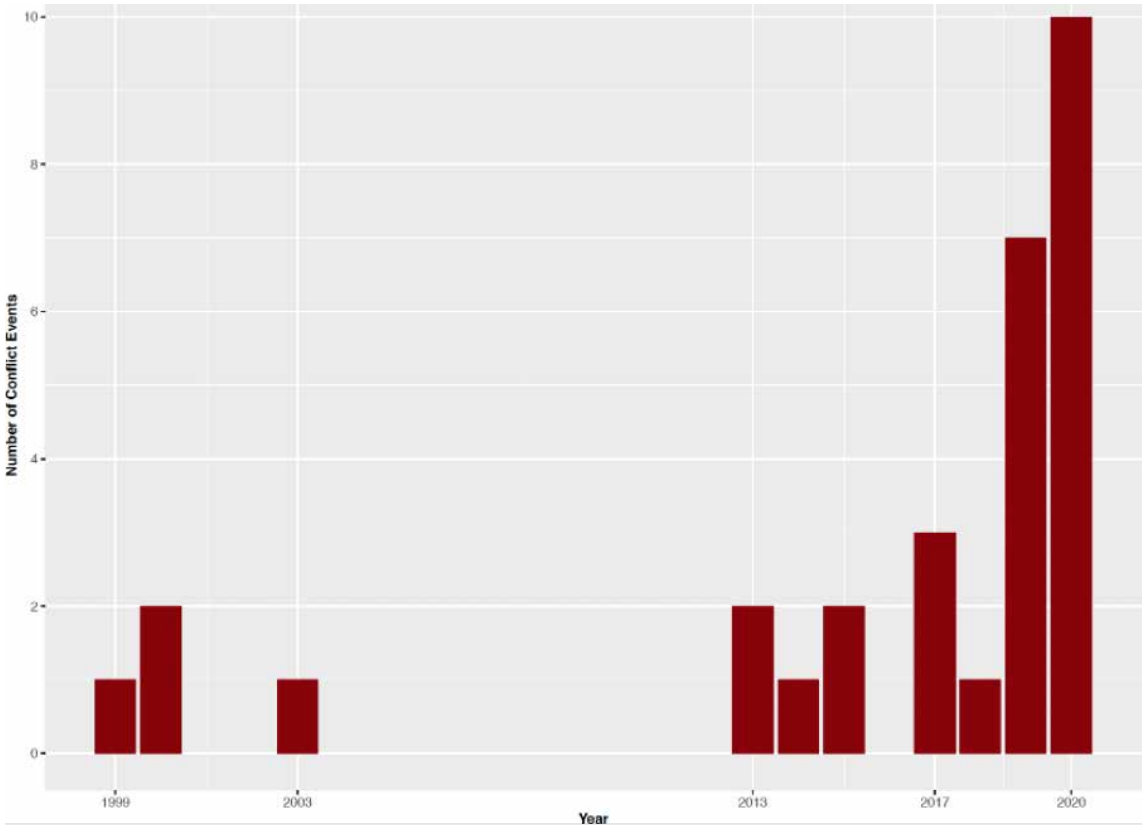
ABSTRACT

In the past 10 years Ghana has experienced an increase in mining-related conflicts. This trend can be linked to key developments related to climate change. People have moved away from less productive arable areas, creating conflict between local indigenous populations and migrants in the mining areas. Environmental spillovers from mining activities further degrade agricultural land and water, and lead to deforestation. We draw on new qualitative interviews and existing quantitative data to outline the different types of conflict that can be affected by climate change in the mining areas of Ghana. Customary institutions, such as local chiefs, might have the potential to reduce conflict risk in these areas, but only if these institutions can adapt to include migrant populations. While there have been many studies on artisanal and small-scale mining (ASM) in West Africa, few studies have explored the complex and multifaceted links between climate change, migration and various types of conflict in ASM communities.

Conflict is rising in Ghana (Figure 2.1.1) and its roots can be traced to the rapid expansion in gold mines. In this case study we identify key components in this complex problem space and make preliminary recommendations informed by complexity science. We highlight two developments with potentially irreversible consequences: environmental degradation of land and water from mining activity, and the emergence of terrorist networks. In both cases, we believe that the local level is crucial, particularly when it involves customary institutions. Empowering chiefs and communities through education and organizational capacity could enable them to work with miners to minimize negative spillovers. Ideally, migrants will be integrated into the local communities, building the rich overlapping relationships and interdependence that lead to mutual care and commitment to conservation of local resources. A strong, integrated community is also the best security against the growth of terrorist networks.

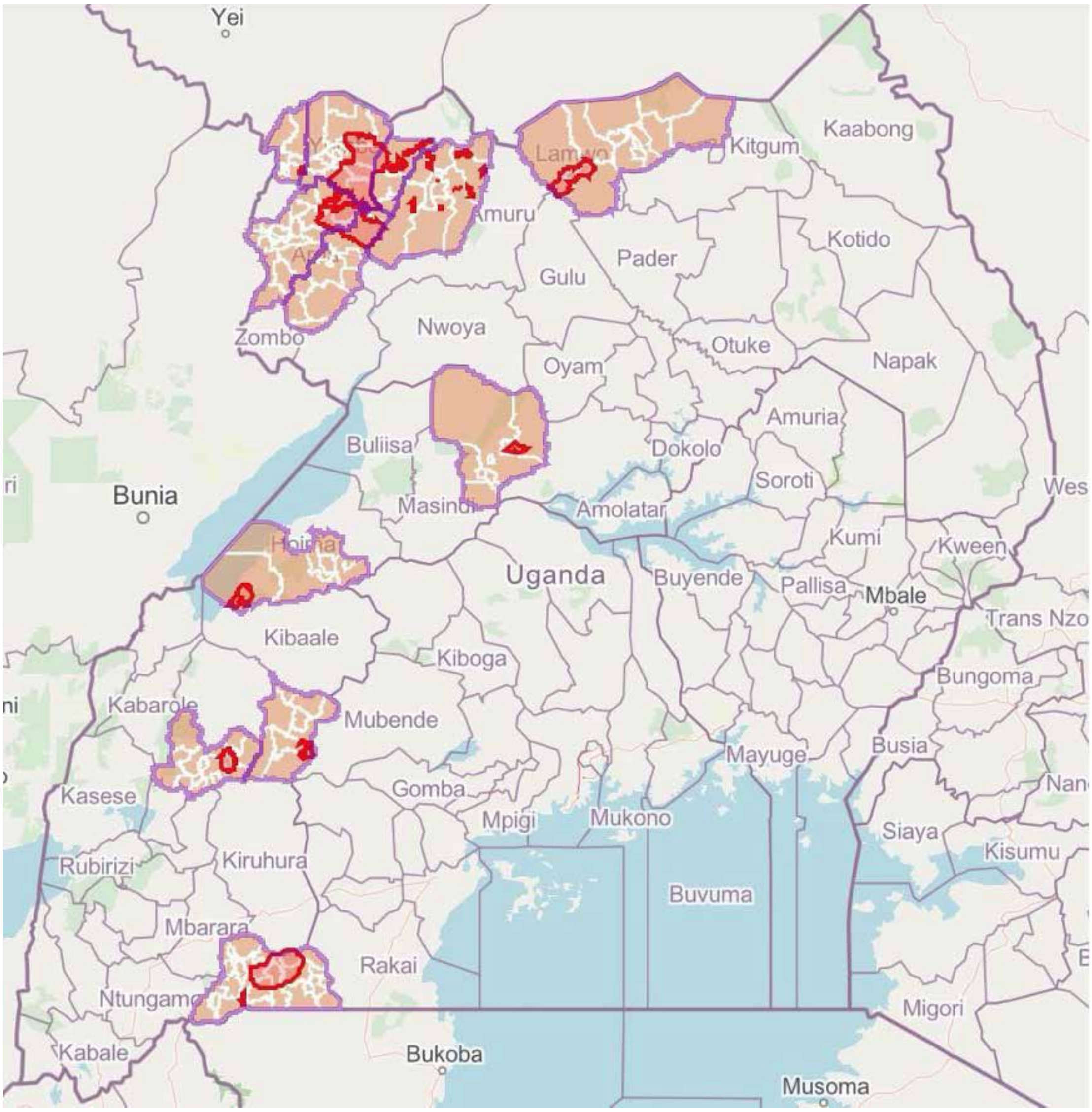
FIGURE 2.1.1 Frequency of mining-related conflicts in Ghana by year



Source: ACLED

We survey literature across multiple disciplines and carry out interviews with various relevant stakeholders. The evidence collected to date suggests that migration, land tenure systems, and the environmental impact of mining play key roles, and that climate change is the broader context which sets in motion some of these processes that lead to conflict. After discussing the nature and drivers of conflicts in the mining areas, we will outline the potential mitigating and preventative role of customary institutions and leaders in the mining areas. Our case study focuses on Ghana, but findings can be applied to other coastal West African countries that are both affected by climate change and have large ASM sectors governed by customary or community institutions, such as Côte d'Ivoire, Guinea or Senegal.

FIGURE 2.1.2 Locations of mining-related conflicts



Source: ACLED

1. THE COMPLEX PROBLEM SPACE

1.1 CONFLICT TRENDS: GENERAL

In Ghana, there are increasing reports of what the Armed Conflict Location and Event Dataset (ACLED) and Social Conflict Analysis Database (SCAD) refer to as specifically mining-related conflicts. However, some of the conflict events in the mining areas might be related to mining, but only indirectly. In any case, according to ACLED and SCAD data, incidences of mining-related violence and conflict in Ghana have drastically increased over the past decade. From 2000 to 2010, there were only four instances of mining-related conflict. However, from 2010 to 2020, there have been 25 instances (see Figure 2.1.2 above). Migrant involvement in ASM exponentially increased after the rise in gold prices in 2008. Tensions between host communities and migrant miners reached a breaking point in 2012–2013, evidenced by a sharp increase in news reports about conflicts between miners and host communities (Crawford & Botchwey, n.d.). Many of these incidents involve community members whose frustrations against miners led to protests, riots or even killings. We will unpack these trends by resource and interest group below, after we have described the primary groups involved.

1.2 ECONOMIC TRENDS: GHANA'S ECONOMY TRANSITIONS FROM AGRICULTURE TO MINING

Climate change has greatly affected agriculture in West Africa as droughts and unpredictable rainfall patterns have reduced crop yield and productivity. In Ghana, an adaptation strategy employed by agricultural landholders in the gold-rich southwestern parts of the country is to convert their land into artisanal and small-scale mining (ASM) sites for gold. Artisanal and small-scale gold mining has seen exponential growth in recent years, following the growth of Ghana's wider extractive sector (oil, gas and mining), which in 2018 comprised 13.6 percent of GDP (EITI). The agricultural sector, at 17 percent of GDP in 2019, still slightly outweighs the mining sector, but agriculture has been in decline over the past decade, while the mining share has only grown (Ghana Statistical Service). The growth of the extractive sector is in large part due to the growth of gold mining. Mining made up six percent of Ghana's GDP in 2018 (as compared to 1.2 percent only two years earlier) and mined minerals made up 38 percent of Ghana's total exports, with gold constituting 95 percent of Ghana's total mineral revenue (EITI, ICMM). Gold is in fact the most important export commodity in Ghana, ahead of cocoa beans, crude oil and timber, and in 2018, Ghana surpassed South Africa to become the world's largest producer of gold (Annual Report, 2018).

In Ghana, an ASM site is any plot of land below 25 acres (Adu-Baffour, Daum, & Birner 2021). ASM mining makes up a large part of the growth of the gold mining industry. In 1989, ASM contributed only 2.2 percent to Ghana's total gold production. However, this proportion rose to around 43 percent of total reported gold production by 2018, as estimated by the Minerals Commission of Ghana (Mcquilken & Hilson 2016; Hilson, Amankwah, & Ofori-Sarpong 2013). The mining sector provides a livelihood for more than 4.5 million Ghanaians, both directly or indirectly, and gold mining makes up 60 percent of Ghana's total mining labor force (Mcquilken & Hilson 2016; Hilson et al. 2013; Hilson & Osei 2014). ASM provides a substantial part of this employment; it was estimated that by 2017, 200,000 Ghanaians relied on ASM for their livelihood, and three million more were supported indirectly by ASM mining. It has been estimated that 85 percent of ASM gold mining activity is unlicensed and illegal, colloquially known as "galamsey", an abbreviation of "gather them and sell" (University of Ghana Business School, 2017). If these numbers are accurate, gold production is probably drastically underreported, given the scale—and illegality—of ASM. This poses an important problem for both public goods provision and management of land and environment. Underreporting of gold production means a loss of tax revenue and therefore, less money for public goods. Furthermore, when these ASM sites are unlicensed, rampant pollution and land degradation expand unchecked by any form of oversight. While ASM provides a good alternative livelihood for Ghanaians affected by climate change, the growth of ASM has engendered new circumstances of vulnerability that are in effect primed for conflict and further climate-driven deterioration. Rather than being a beneficial adaptation to climate change pressures, the shift from agriculture to mining has already coincided with a significant increase in conflict.

1.3 DIFFERING INTERESTS AND ACTORS

West Africans, especially those dependent for a livelihood on farming, are not strangers to seasonal and circular migration. During the dry season, a large proportion of the rural workforce in Ghana—and other West African countries—turns to artisanal mining. Migration is usually along a north-south axis and regionally contained, with two-thirds of West African migrants staying in the region (Hamro-Drotz 2014). It is important to remember that those hardest hit by climate change are those least able to move away from dire conditions. An IOM report stated that in Burkina Faso, "food scarcity during drought was found to lead to increased prices, forcing people to spend more money on their basic needs rather than on long-distance migration" (Laczko & Aghazarm 2009).

Migrant ASM miners from China

It is estimated that about 50,000 miners from China emigrated to Ghana to participate in the ASM sector from the mid-2000s to 2013 (Botchwey, Crawford, Loubere, & Lu, 2019). As most of these migrants come from Shanglin County in Guangxi Province, which has a tradition of gold mining, they were able to bring more advanced equipment and techniques, which increased the productivity of ASM mines. ASM mining is legally reserved only for Ghanaians and foreigners are not allowed to participate in it. However, Chinese migrant miners have found ways around this, either by collaborating with Ghanaians already working in the sector, or using Ghanaians as conduits to set up legal entities (interview). However, the illegality of the Chinese miners' activities has caused conflict between local and Chinese miners, especially because Chinese miners' activities feed into the widespread corruption in the ASM industry. These tensions reached a boiling point in 2013 that eventually led to a harsh crackdown against foreign miners with more than 4,500 Chinese nationals either deported or leaving "voluntarily" (Modern Ghana 2013) Three of the 30 relevant mining-related conflict incidents from 1999 to the present noted in the ACLED and SCAD datasets involved Chinese miners.

Large-scale mining companies

Large-scale mining (LSM) in Ghana dates back to the colonial era. However, it saw a decline in the 1980s due to a drop in the price of minerals (Yankson & Gough 2019). LSM companies are able to mine land based on concessions provided to them by the Ghanaian government and both international and local companies participate in this sector. Although the LSM sector has recovered, the number of people it employs is still low compared to the ASM sector. Given the illegality of much of the ASM sector, there are no precise figures here, but it is estimated that it "employs one million workers and supports approximately 4.5 million more" as compared to the 28,000 that the LSM sector officially employs (Aryee, Ntibery, & Atorkui 2003; Mcquilken & Hilson 2016).

Chiefs

Traditional leaders, called chiefs, antedate the colonial era. They were then absorbed into the state when the colonial government needed local intermediaries to help it govern. When Ghana gained independence, the new government also relied on traditional leaders to administer the new country. The government recognized chiefs as a legitimate local authority and gave them a great deal of discretion to decide on rules that would fit local conditions. However, in 2005, the government created a Ministry of Chieftaincy and Traditional Affairs in order to "more tightly control the chiefs, mitigate succession and border disputes and limit unpredictability" (Tieleman & Uitermark 2019). The chief's role in the community is to be the gatekeeper and interlocutor between the state and his community. As the state becomes more formalized and Ghana grows more urbanized, the chiefs' role as mediator between state and their community grows more important. One of the chiefs' main responsibilities is to manage the community's land and settle land disputes among community members. The responsibility of chiefs as land managers is so critical because 80 percent of land in Ghana is customary or stool lands—held in custody for the community by chiefs (Bugri, Yeboah, et al. 2017). The concentration of a chief's role on the management of community land is neatly illustrated by Tielman and Uitermark, who found that in the community they examined, more than 80 percent of the cases that the chief handled were about land issues (2019). However, the increasing commercialization of land and formalization of the state have somewhat under- mined the authority of the chiefs. On the other hand, chiefs have enjoyed greater freedom to do as they see fit with customary land as communal ties break down and they feel less beholden to the community and customs (Tieleman & Uitermark, 2019). As demand for land increases, chiefs have more opportunities to unilaterally lease or sell customary land without sharing profits with the community.

Nongovernmental organizations

As the mining sector in Ghana started growing in the 2000s, so did activism from nongovernmental organizations (NGOs) regarding issues associated with the industry. NGOs advocated on a plethora of issues including environmental sustainability, human rights and community support. Some of their most high-profile cases involved legal action over "issues ranging from police brutality against protestors to environmental pollution by mining firms" (Oppong 2018). They also sought to build solidarity with communities affected by mining, and took a collaborative an approach by creating coalitions and shared platforms, such as the Ghana Association of Private Voluntary Organizations in Development (GAPVOD) and the National Coalition on Mining (NCOM). NGOs have led calls for mining host communities to receive appropriate compensation for livelihoods adversely affected by mining activities, as well as calls for a sharp reduction in environmental damage that affects local communities. NGOs bring information to communities and empower them to fight for their rights and against potential abuses by the mining sector. Therefore, NGOs are a vital, locally integrated group of actors well placed to explain how to prevent mining-related conflict.

Erratic rainfall patterns

Climate change has led to a decrease in agricultural productivity due to erratic rainfall patterns and increasing temperatures. IPCC's Fifth Assessment Report, published in 2014, found that West Africa is expected to see an increase of 3°C to 6°C in the 21st century above its 1986–2005 baseline (IPCC 2013). Although seasonal rainfall has not necessarily decreased across all of West Africa, parts of Ghana—like the northern border with Burkina Faso and the south coast near Côte d'Ivoire—have seen declines in seasonal rainfall of more than 50mm (Hamro-Drotz 2014). Furthermore, "the mean seasonal rainfall is still below the long-term average from 1900 to 2009" (Hamro-Drotz & Programme 2011). Similarly worrying is the increase in the frequency of extreme rainfall events projected in West Africa. The 4th IPCC report published in 2007 stated that extreme rainfall events could increase by 20 percent over the coming decades in West Africa (IPCC, 2007). This projection was repeated in the 5th IPCC report, where they noted that regional models have a "low to medium confidence" that the number of extreme rainfall days in West Africa will continue to increase (IPCC 2013). The increase in high-intensity rainfall is especially worrying for Ghana as most of its agriculture is rain-fed, and extreme and erratic rainfall can decrease the productivity of crops due to loss of soil and a greater prevalence of crop pests (Hamro-Drotz & Programme 2011). A study in Ghana by the International Food Policy Research Institute predicted future decreases in yields across all crops, although there was some regional variation (De Pinto et al. 2012). Therefore, converting their land into mines becomes more attractive to farmers.

Desertification in the Sahel region

The Sahel region has always been comparatively vulnerable to drought and rainfall variability. During the 1970s and 1980s, the region experienced long periods of drought that resulted in a substantial displacement of people due to loss of livelihoods. However, since then average rainfall has increased and environmental conditions have improved, even if the region still experiences variations in its rainfall patterns (Buontempo 2009).

Despite the improvement, it is unclear what the environmental future holds for the Sahel region. As laid out in IPCC's fourth report, models do not concur on whether the Sahel will become drier or experience increased rainfall (Boko et al. 2007). Therefore, while periods of droughts have caused out-migration from the Sahel, we cannot solely blame climate change and desertification for the increasing out-migration and vulnerability of the Sahel region as "the combined effects of population growth, land degradation (deforestation, continuous cropping and overgrazing), reduced and erratic rainfall, lack of coherent environmental policies and misplaced development priorities, have contributed to transform a large proportion of the Sahel into barren land, resulting in the deterioration of the soil and water resource" (Kandji, Verchot, & Mackensen 2010).

Pollution of water sources

ASM has negative environmental externalities, such as the pollution of nearby rivers and the degradation of soil quality (Cuba et al. 2014). The pollution from mining quickly encroaches onto neighboring agricultural land, making surrounding lands less cultivable (Wacam interview). It can also lead to maladaptive practices (such as cutting of forests) that increase erosion and thereby the consequences of changes in rainfall, including floods. When communities do not pay attention to the effects of mining on their land and surrounding areas and allow unregulated and unsustainable mining, their approach becomes maladaptive. In other words, instead of adapting to shifting circumstances driven by climate change, their approach—or neglect—exacerbates environmental issues and jeopardizes their own future livelihoods.

Deforestation caused by mining

ASM also causes deforestation which exacerbates the effects of climate change. Ghana experienced a 60 percent rise in primary forest loss between 2017 and 2018, the highest of any tropical country during that time period (WRI 2019). A large proportion of this loss is attributed to mining activity; a NASA study found that artisanal mining accounted for 25 percent of vegetation loss in the gold-mining region from 2005 to 2019 (Patel 2021). According to the interviews we conducted with local civil society organizations, farmers who convert their own land into mining sites also contribute to deforestation by turning forested areas into new agricultural land. Deforestation has been linked to a rise in temperatures and more erratic rainfall patterns (Luwesi et al. 2017; Mensah et al. 2020). In other words, the process simply renders more urgent the factors that caused farmers to convert their land into mines in the first place. It is important to pay attention to how ASM induces forest loss because even though ASM "only accounts for about one-third of the country's gold production today, artisanal mining caused seven times more deforestation than industrial efforts between 2007 and 2017" (Patel 2021).

1.4 MIGRATION PATTERNS

The mining industry in Ghana has always relied on migrant labor from within Ghana as well as from elsewhere in West Africa. Migrants are driven by both "push" and "pull" factors.

Climate-driven migration from the Sahel region to the South

Desertification in the Sahel region strips people in Northern Ghana and other parts of West Africa of their traditional agricultural livelihoods and forces them to move south in search of jobs in other sectors less affected by climate change. ASM is a commonly chosen sector. As the supply of mining labor increases, so does the demand for mining land. Furthermore, miners from the Sahel are also migrating southward to Ghana as desertification is also affecting mining in countries like Mali and Burkina Faso, rendering them too hot to mine (Solidaridad interview).

Seasonal economic migration because of mining opportunities

In addition to "push" factors, such as climate-induced drought or violent conflict, ASM miners are often migrants drawn by "pull" factors, such as the pursuit of better economic opportunities. A common migration pattern involves out-migration from Sahelian countries like Mali, Mauritania and Niger during the dry season to plantations and mines in coastal West African countries like Ghana and Côte d'Ivoire, where there are more job opportunities.

Economic "pull" reasons are usually the main impetus for migrant miners from outside Sub-Saharan Africa, who make up a substantial portion of ASM miners—notably migrants from China, who bring with them capital and prior skills.

Migration of farmers displaced by mining activities

The conversion of agricultural land to mining sites also leads to out-migration from host communities as farmers who used to farm on those lands will need to look for jobs elsewhere. If they are well compensated by the miners who took over the land, farmers could stay in the community and go into other economic activities like setting up soap-making businesses or buying interests in other farms (Francis Agbere, Oxfam). However, they are rarely sufficiently compensated to take such action. They must therefore leave the community in search of work, sometimes leading to personal stress and familial tensions.

"Yes, some will stay in their community and try to diversify their economic activities. Others will have to migrate to other communities. Or sometimes, it leads to what we call the "broken home", where the father will have to migrate to other places to look for virtually nonexistent jobs to try and take care of their families, which leads to drop-out of school by children." – Dr. Samuel Obiri, Center for Environmental Impact Analysis.

However, according to expert interviews, those in the host community most affected by the conversion of agricultural land to mining sites are migrant farmers. Seasonal migration has always been common in Ghana and West Africa as many migrate to earn a livelihood during the farming off-season. Therefore, host communities of mining activities are accustomed to seeing migrants because they have long played host to farmers who migrate from the north to the south—which enjoys a longer farming season—to look for agricultural jobs. These migrant farmers are the most acutely affected by the conversion of agricultural land to mines because they have no power or influence to stop the land conversion (A Rocha Ghana interview). They have no rights or say in the use of the land they farm: it can be leased or sold without their consent or knowledge. These migrant farmers usually have lived and worked in these communities for a long time and when the land is converted, they lose their jobs and have to move away from the host communities because they lack the skills to take up mining jobs (WACAM interview). Although they are not permanent residents of the community, mining has upended their lives too by disrupting a stable pattern of livelihood.

With this displacement, the kind of migrants in the host communities is changing. Formerly they were largely farmers with a long-established routine of coming to host communities to farm the locals' land. Now they tend to be recently arrived mining migrants taking mining jobs that are often disruptive. This change has shifted the social dynamic between migrants and host communities, with the potential to cause conflict within the community—an issue further explored below.

1.5 CONFLICT TRENDS: TENSION BETWEEN DIFFERING INTERESTS

Conflict between farmers and miners

As the ASM sector grows, so does demand for land. As mining leaves land uncultivable for many years, most agricultural landholders would ordinarily refuse to allow miners on their land. However, as their crop yield falls, due to erratic rainfall patterns, their calculus has started to shift in recent years. They have become more willing to allow miners on their land simply because they see their land being less and less productive in the future. They reckon it is worth allowing their land to be mined for gold in order to get a large sum of money in the short term, rather than betting on the unpredictability of their agricultural future. Furthermore, miners are often far from candid with farmers about how mining affects their land. Farmers often fail to understand the full extent of the detrimental effects. Although mining and agriculture can comfortably co-exist in close proximity, this is only when miners are very careful to prevent pollution and maintain the quality of the land for agriculture. Unfortunately, this is rarely the case, and mining usually causes land, water and air pollution. Water pollution is often so bad that it affects the drinking water supply of the host community and causes health issues (FON interview).

"So, in these communities, the major conflict is competing land usage. For example, ASM mining and agriculture can often be on the same piece of land, and ASM has significant impacts on that land. There is land degradation, water pollution, and other forms of pollution, including air pollution. These continue to provide challenges for communities who live in these areas. For example, communities are heavily concerned about land degradation by ASM and the extent of water pollution because some of the water is a source of drinking water for these communities." – Solomon Ampofo, Friends of the Nation (FON) Ghana.

Conflict between the host community and miners

Economic migration has always been common in Ghana and, as noted earlier, many communities with rich agricultural land often play host to internal migrants from more impoverished areas of Ghana like the North. Migrants have lived in these communities without conflict for a long time as customary institutions have been able to integrate migrant farmers within the existing agricultural and economic system. According to a civil society organization that works with mining communities, chiefs are often not respected by miners because miners see themselves as wealthier and more powerful than traditional authority (A Rocha interview). The wealth of a miner is in fact greater than anything a community member could normally accumulate through farming and traditional activities. It therefore tends to engender influence and respect, especially among local youths who aspire to similar riches (A Rocha Ghana).

In areas where there is a lot of ASM activity, migrant miners are externally supported not by the government but by individual investors, either domestic or international, who enable the miners to gain far more money than is traditionally available in the community through agriculture. The resulting influence, and local power, emboldens miners to act in ways that cause conflict in the community. Miners often promise communities that impacts on the land will be kept to a minimum and that they will share economic benefits from the mines. However, these promises are often broken. Instead, miners use their profits to pay off community elites to suppress dissent, breeding corruption. Furthermore, host communities often experience an increase in crime and sexual violence: migrant miners are commonly not held accountable for their actions either because authorities fear a consequent loss of economic benefits, or because the miners have been able to pay off victims, or those authorities (A Rocha interview). This sometimes results in community members taking matters into their own hands. Usually, they hold protests against mining activities. However, it has become increasingly common for community members to attack miners and destroy their site and equipment.

Therefore, where mining activity replaces agricultural activity, the dynamic between host communities and migrants becomes less stable. This is exacerbated by the fact that a large proportion of ASM miners are from China. On one hand, they bring technology to make ASM production more productive. On the other hand, they have aggravated the tensions between miners and communities because of their rapid and sometimes careless expansion, and their ignorance of local informal institutional norms. These new ASM migrants do not feel bound by local social norms, nor are they invested in the long-term preservation of the community's land. Therefore, they are not concerned with the sustainability of the land or reducing the negative effects of mining on the land. Furthermore, they often do not fulfill promises made to the community and chiefs when they first request permission to operate. Promised jobs often fail to materialize, and profits are not equally shared.

"We have some of the lands that are given up because people think those lands are no longer of use for agricultural purposes, for crop farming. Instead of holding onto them and if there is mineral there, one might say, 'Why don't you lease them to these mines?' Usually, that is done with the government. Later on, they find that that lease probably has not served their interest better, because they no longer have places where their generations can farm again, and they don't know how long the miners can hold the land. When they finish with the mining, the concession expires and usually the land is not given back to the people who originally owned the lands. So, some of the communities: now they are agitated and want to have strong ownership of their land."

"They gave up the land because they told the landlord it was so dry. Later on, they realized that if the land is so dry, there is something valuable there. We can give it out for mining to a Chinese mine and other new mines that have formed near there. There is now also the issue of consent after these mines have left. What happens to these mines when they are done? In the meantime, the youth are agitated and say they have nothing to do in terms of local content. The mines should employ a majority of the population of the youth, who can constantly have some income coming from that. Instead, it is as though they are continuing to plow their

lands and continue to plant crops. So, those tensions have been there and that has been the concern generally by many of the people."

– Albert Yelyang, West Africa Network for Peace Building

Within the community

ASM mining has the potential to cause conflicts arising from naturally competing interests in the community. For some, ASM is a source of profit and livelihood, while for others, it might be detrimental to their livelihoods on account of the pollution it causes. Furthermore, miners rarely involve all the stakeholders of the land in the process of gaining approval for a mining project. As explained above, they often only go to the chief or the landowner to gain approval. Some chiefs will then grant approval without consulting the community; this leads to conflict and protests when community members find out that mines have been set up without their permission (WACAM, FoN, Kingsford Appiah interview).

"About 50 percent of the community was at the ceremonial grounds and the other 50 percent were singing and chanting around the community grounds. We waited and waited from 4 p.m. to almost 10 p.m. They were not coming out from the palace. Then, an idea came that if they were not coming out from the palace, why don't we join them there. So, with the red banner and placards, "the chief is selling the community". If your forefathers sold the land, then how can you get the land if you are selling it? So, with placards and demonstrations, we came into the palace. There, it wasn't easy. So, we tried controlling the youth and told them to leave the palace. We tried and tried. It was a massive demonstration. So, the paramount chief was just getting ways and means to leave the community and other individuals were also looking for ways and means to leave the community. So, as the ceremony was going on, the anger and the youth were also moving up. So, as the leaders, we tried to escape the paramount chief away from the community. We didn't do it easily, but we did. Then, during the demonstration, the paramount chief and the chief of Donkro Nkwanta came out with some lists of names that they wanted the police to arrest. About 26 people were on the list, of which my name was first." – Kingsford Appiah, community member.

"It is always a very difficult challenge with this. On one side, a part of the community is benefiting from the mining. On the other side, another part of the community is feeling the impact of the mining… You can have a piece of agricultural land, but multiple people have an interest on the land. The farmer has an interest on that land but the one who actually owns it also has an interest on the land. So, when a miner wants to mine, he needs to meet all of these interests on that particular piece of land. The miner needs to pay compensation for the one who owns the land, and he needs to also pay compensation to the farmer whose crops are going to be destroyed because of mining… That level of communication is not widely done with the consent of the community. So, the community has limited participation in that process, and this is sometimes where the conflict starts since they are very rarely empowered to determine who is allowed to mine." – Solomon Ampofo, Friends of the Nation (FON) Ghana.

"You have some of the concessions given off by the local people. Some of the concessions, like the antenna systems, are owned by the chiefs but the chiefs need to have consultations with community members. The chief has custody of the land but...those things are not done. With prospecting this exploration and all of that, there is confusion between them and the chiefs… local governance issues and traditional governance issues, because now there are some other people who probably wanted to become chiefs or who wanted to promote chieftaincy from their section. They take advantage of that and that usually creates chieftaincy conflicts within the local communities, and this creates tension between the local people and the

miners, who they and the government consider intruders." – Albert Yelyang, West Africa Network for Peace Building.

In certain communities, existing conflicts are exacerbated by miners who come in seeking land. As the Director of the Center for Environmental Impact Analysis explains below, sometimes there are succession disputes for the chieftaincy, and miners come in and manipulate the conflict so that those willing to permit them to mine customary lands attain power.

"In some areas where there are conflicts, chieftaincy conflicts especially, the miners take advantage of that situation. In Ghana, we have what we call a royal family. Within the royal family, we have individual clans or families within the entire royal family. There is a structure that says that 'If I come from a royal family, my family intends to nominate a chief. If the nominated chief passes away, it moves to the next family within the royal family.' Sometimes there is a conflict between the families as to who should occupy that. So, in certain instances, you have the miners, political elites, influential leaders, and others begin to dip in and fuel these conflicts. As those conflicts go on within family, there is a leadership vacuum, and these entities fill in that vacuum to get the royal they want." – Dr. Samuel Obiri, Center for Environmental Impact Analysis.

Conflict between ASM and LSM miners

Where there are LSM companies, you will also find ASM miners illegally mining on or around the LSM sites. A study found that 52 percent of identified ASM activity occurs within the boundaries of LSM concessions (Patel et al. 2016). This often results in conflict between LSM companies and ASM miners as the companies try to prevent ASM miners from illegally mining on their land. ASM miners, especially those from the community or local area, are especially willing to participate in illegal mining on LSM concessions because they feel it is their right to partake in the profits of any mining on their own community land.

"Conflict, as we have noted, has been between the small-scale miners and then the large-scale miners... For many small-scale miners… it's kind of like it's within the realm of what we call resource nationalism. They feel like this is a resource, and so you guys can't come and take the whole spot. You have a lot of concessions, you make a lot of money, yet our conditions aren't changing within the community... So many of the communities in and around the field, there's not much they are getting from it, and these large-scale miners are just exploiting the resource and leaving, and nothing is improving in their lives, so that is the angle from which what I would call their anger emerges... So, if maybe the whole community has been leased to a mining company, you still have some natives in and around the whole field where originally this was our land and we know that there's gold here, so they're going to start digging up and stuff like that—what we call "galamsey", illegal mining because you don't have a license." Francis Agbere, OXFAM.

Furthermore, LSM companies victimize ASM miners by calling the police or using their own private security forces to push them off the land. This has resulted in many violent conflicts between ASM miners and agents carrying out the will of LSM companies, as ASM miners will often push back forcefully. LSM companies also act antagonistically toward ASM miners by refusing to work with them and ensuring that the state and public look askance at ASM miners.

"They oftentimes feel that because the large-scale miners have a lot of power and influence, they are able to capitalize on the power asymmetry. To paint these small-scale miners in a terrible way to say that they are not responsible, they don't mine responsibly... So, there is also that tension between the recognized small-scale miners and the large-scale miners. So, these are all things I believe

are fostering some conflict." Francis Agbere, OXFAM

Potential financial source for jihadists

Coastal West African countries have long been worried that the jihadist violence in the Sahel region will spill over their borders. For Ghana, the increasing strength of jihadist groups in Burkina Faso is an especially pressing matter. Burkinabe intelligence officers have already warned Ghana that there are reports of jihadists fleeing Burkina Faso and taking refuge in Ghana. There have also been reports of armed group activity along Burkinabe towns bordering Ghana. Most directly, jihadist groups in the Sahel have publicly declared their intention to destabilize Gulf of Guinea countries like Ghana and called on the primarily Muslim Fulani ethnicity to "pursue jihad" in the country (ICG).

The threat of jihadi activity poses a potential problem for Ghana and its ASM sector in the future, given that jihadist groups have already targeted ASM gold mines in neighboring Burkina Faso to secure a lucrative source of funding for their activities. Much of the gold extracted from jihadist-linked Burkinabe gold mines is reportedly bought and sold in Ghana (ISS report, Reuters). Furthermore, according to a researcher with the West Africa Network for Peacebuilding, there have been reports of migrant Burkinabe ASM miners forcefully taking over mines in the north of Ghana (WANEP interview).

"We have had an instance where you have some of the migrant miners from Burkina Faso trying to take control of those mines. The report that we have gotten says that some of them had conflict with those who were already miners there, but they came in to say, 'Let's share this mine. We can mine toward this area and you can mine toward that area.' There were apparently strong tensions between these people and those who were already there had to fight them off." Albert Yelyang, West Africa Network for Peace Building.

There is a possibility that as jihadist groups try to expand into coastal West African countries, they might first target vulnerable gold mines in Ghana and exploit the Sahelian migrant miner network that already exists in Ghana. One of the reasons that Burkinabe ASM gold mines have been taken over by jihadists is that an overwhelming proportion of ASM gold mines in Burkina Faso are not formally licensed and recognized. It is estimated that only 1.5 to 2.0 percent of the country's gold production is officially recorded (Reuters). Ghana's ASM sector is also mostly illegal, and unless formalized will be similarly vulnerable to exploitation by jihadist groups.

Jihadist groups are also able to gain control of mines because they take advantage of pre-existing instability, poverty and dissatisfaction with the government. For people in mining areas who lack public services or access to natural resources, jihadist groups provide an alternative to the state. The north of Ghana, which borders Burkina Faso, is the most vulnerable to this issue because it experiences a much higher level of poverty than the national average: 70 percent versus 25 percent (The Economist). As the inequality gap between the north and the rest of the country expands, the north grows more vulnerable to potential jihadist infiltration (perhaps in particular within segments of the Muslim population in Ghana), especially as jihadist groups grow stronger across the border in Burkina Faso and they see gold mines as a lucrative way to finance their expansion.

Sexual and gender-based violence

Sexual and gender-based violence could become a particular concern in the ASM areas of Ghana in the future. There are different risk factors that we can identify based on previous research on this type of violence as well as based on our own interviews with stakeholders in these areas. Sexual and gender-based violence might increase in society in general, as well as through direct connections to political violence and terror. We outline some areas to consider below. First of all, our interviews show concerns among the host communities of ASM that the mining activities import unwelcome social mores and an increased prevalence of prostitution, which the communities see as a risk factor for more sexual harassment and abuse in future (Dr. Obiri Interview, FON interview, Women in Mining Ghana interview).

"People are also worried about issues of social vices because, in some way, there are other social issues such as prostitution and drug abuse in areas where ASM occurs." – Solomon Ampofo, Friends of the Nation (FON) Ghana.

"Some, especially with women, have to resort to prostitution just to make ends meet because we may not have some of these economic opportunities." – Samuel Obiri, Center for Environmental Impact Analysis.

"But, even with the migrants, it is from neighboring towns that they migrate to. Sexual violence is there but... even when you ask them, they wouldn't be willing to talk about it because that is a cultural setting. A cultural setting doesn't allow you to talk about those things. So, it is very difficult to talk about it in any way." – Rosemary Okla, Women in Mining Ghana.

"It is prevalent on the field. There has been harassment and people who have gotten violated sexually but then, talking about it is not easy. When you report, you are normally stigmatized, or the person tries to create the impression and it makes other people hate you." – Rosemary Okla, Women in Mining Ghana.

"It is really hard for people to talk about sexual abuse in most of the mining communities... With small-scale mining, other community people come together and just start mining. It is not that the government has introduced the community mining sector, where two or more people can just come together with their alliances and start operating. So, getting them to open up in this section of news is tough because if I open up and tell you what is happening in the day-to-day activities, then I am trying to pinpoint some people. I might lose my job and I will even feel uncomfortable in a society I am a part of, so it is better if you just experience it and then go about it. If possible, you can just report it but that mostly doesn't take you anywhere." – Emma Appiah-Thompson, Women in Mining Ghana.

This concern echoes a common view of mining in many parts of Africa that mining booms attract women who engage in prostitution. Although this might sometimes be an exaggerated or stereotypical view (see, for example, Bryceson et al. 2013) it warrants scrutiny from three angles. First, it is linked to greater female participation in the formal economy as well as changes in the marriage market whereby marriage and partnering decisions are less often made by elders and family members (especially when people have moved away from their traditional homeland and family network).

Second, in mining areas women are more often involved in the formal economy—and might have greater earning potential. When this represents a change or challenge to traditional gender roles in the family and society, it might lead to a backlash in the form of more violence against women, including domestic violence (Benshaul and Baum 2019, Solidaridad Ghana Interview). However, research is still inconclusive on the latter point, as some authors suggest that there might be a reduction in reported domestic violence when women in mining areas join the formal economy (Krauser et al. 2019). One critical element here might be whether mines are domestically or internationally owned and operated.

"Yes, in regard to financial independence... that also brings issues where in forums or discussion, the men held some complaints that when the women are more financially independent, they don't take care of their families and they don't do their tasks." – Rosemary Oka, Women in Mining Ghana.

Third, if armed conflict follows from the patterns of climate-related migration and mining identified above, we can also expect an increase in sexual and gender-based violence as part of the repertoire of violence in war. For jihadi groups in particular, there are well known examples of women and girls being targeted, such as the abduction of girls by Boko Haram in Nigeria, and sexual slavery by the Islamic State in Syria and Iraq. In the latter case, "the organization adopted ideologically motivated policies that authorized certain forms of sexual violence, including sexual slavery and child marriage." (Revkin and Wood 2020). We also know—from systematic scholarship on rape in war—that organizations that recruit members by force are more likely to also use sexual violence as a cohesion building tool within the armed group (Cohen 2016; Cohen and Nordas 2015). Abduction of children for armed conflict and sexual violence by the groups that recruit in this way has occurred in Côte d'Ivoire, DRC, Sierra Leone, and Uganda. Many of these conflicts have also been fueled by natural resources and involved fighting over control of valuable minerals. In the eastern DRC, where armed conflict has been ongoing for decades, and where mineral resources have been closely connected to the dynamics of violence, research shows how women living in close proximity to ASM are more likely to experience sexual violence by both partners and nonpartners, although the effect is stronger for nonpartner sexual violence (Rustad et al. 2016). Other research has found that rebel movements that extort from producers of natural resources are more willing to risk alienating the local population by engaging in sexual violence (Whitaker et al. 2019). Although the mechanisms are complex and context specific, we can assume that there is a pronounced risk of increased sexual and gender-based violence if armed conflicts were to erupt in Ghana.

2. DIAGNOSIS: WHY IS CONFLICT INCREASING?

2.1 WHY DOES CONFLICT HAPPEN?

Scholarship on land conflict can be situated in larger debates about "greed" versus "grievance" arguments in the civil war literature (Scott 1976; Gurr 1970; Collier 2004; Fearon & Laitin 2003), and the literature on the role of natural resources and the "resource curse" (Ross 2004) and inequality (Murshed & Gates 2005; Østby 2008; Østby, Nordås, & Rød, 2009) in violent conflict.

The causes of conflict in Sub-Saharan Africa are numerous and complex, but often revolve around the existence of valuable natural resources, and weak institutions, with or without bad governance (Collier 2008). It is relatively recently that land-related conflicts have emerged as a major concern. Demography is important here; population growth has been exceptionally high, but without sufficient investment in human capital. Sub-Saharan Africa is therefore still in a transitional phase, and it is unclear whether this will in time unlock the demographic dividends seen, for example, in East Asia. Whereas functional land has historically been abundant, it is in many areas now becoming scarce.

High availability of land in Sub-Saharan Africa gave rise to customary systems of land tenure and management; these differ from the more exclusive property systems seen in other parts of the world (Deininger & Castagnini 2006). It is estimated that 80 percent of Ghana's land is held under a customary land-tenure system. Customary land is owned collectively by tribes, families or ethnic groups with a chief (often called skin) in charge of governing the collective entity and land (Bugri et al. 2017). Land has therefore traditionally been allocated at the village level, and there are few large properties. Individuals or smaller family subgroups often hold an interest in a particular plot, allowing them to lease it. However, the interest holder must still recognize the superior authority of the chief. Therefore, any decision affecting the land should be made with the consent both of the chief and the individual landholder.

Land inequality has however worsened in the last two generations, in part fueled by rapid population growth. Land occupation movements and land-related disputes have been spreading across the continent, and some have coupled land inequality and scarcity to large-scale violence such as during the Rwandan genocide or the Darfur crisis. The demographic pressure in Sub-Saharan Africa has disrupted the traditional customary land tenure by substituting for ancestral communal land management the modern marketization of land involving titling processes. The creation (and maintenance) of more formalized property rights has been seen as a solution to conflicts, but critics have pointed to consequent extreme inequalities, exacerbated by rising land values, and, in Sub-Saharan Africa, natural hazards, such as droughts, floods, or unpredictable and changing weather patterns. Long-standing ethnic and regional inequalities are well understood drivers of armed conflict (Østby 2008; Østby et al. 2009), but population pressure and associated inequalities have also sparked lethal conflicts over dwindling resources, bringing entire civilizations to their knees (Diamond 2006). Land-related conflict in Sub-Saharan Africa has risen over time and is likely to further increase. Conflicts become more severe if they map onto identity fault lines. Conversely, identity fault lines can be constructed around inequalities, rendering more likely the emergence of powerful organizations in favor of land redistribution and subsequent large-scale mobilization. Although the Malthusian interpretation of the causes of conflict is still often assumed, scarcity does not necessarily or uniformly drive conflict: it can also spur cooperation, and the conflict potential can be mitigated. Nevertheless, Malthusian logic can still underpin local-level conflict, caused either by the pressures of demographic growth, or displacement bringing new arrivals into competition with the existing population.

2.2 WHAT PREVENTS LAND CONFLICT?

Despite increasing land inequality, the customary land-tenure system has been shown to mitigate land conflict. According to Boone, in areas where customary authorities support the host communities in land disputes, peace and the status quo is maintained because migrants know they cannot challenge the existing institutions (Boone 2017). However, if the state chooses to provide external support to migrants to challenge the status quo, conflict often occurs between migrants and host communities—a shift in the balance of power has now given migrants the confidence to fight for their interests. Therefore, strong customary institutions and leaders that put the interests of host communities first, are vital to keeping the peace between migrants and host communities. However, this also results in the marginalization of migrants in these communities as they have no power to push back against locals in situations of exploitation. Customary institutions have also been found to mitigate conflict between migrant miner and local farmer because they require mining operations to mitigate environmental impacts (Bugri et al. 2017; Persaud, Telmer, Costa, & Moore 2017; Huntington & Marple-Cantrell 2021). Studies have shown these institutions to be more effective than government authorities at managing ASM sites, because artisanal miners (whether locals or migrants) are much more trusting of local community leaders than of national government authorities (Siwale 2018; Huntington & Marple-Cantrell 2021). However, customary institutions tend to work best in closed communities where people know one another, posing a problem in terms of the ASM issue. As many miners are not locals, they do not feel bound by social norms to ensure that mining operations are sustainable and do not affect land elsewhere. Furthermore, some landholders who worry about the future productivity of their land might consider mining their best bet, in the hope of striking gold now.

The literature on conflict associated with climate change has discussed a series of climate change related factors and how they might be connected to increasing risk of violent conflict. Yet the research findings remain diverse and hotly contested (Mach et al. 2019). Many of the causal links suggested have yet to be confirmed empirically. Koubi recently summarized that "the literature shows that climatic conditions breed conflict in fertile grounds: in regions dependent on agriculture and in combination and interaction with other socioeconomic and political factors such as a low level of economic development and political marginalization" (Koubi, 2019). Ghana can be considered such "fertile ground". Of the most likely links between climate change and conflict, economic shocks are robustly related to conflict. These can be the result of climate-related agricultural shocks, especially in low-income countries, such as Ghana, that are relatively dependent on agriculture and natural resources.

In this case study, we identify and analyze several primary candidate factors linking climate change to conflict. Migration has also long been suggested as one of them (Gleditsch et al. 2007), and this continues to be discussed as a relevant risk factor that needs to be mediated to avoid violence. In our case study, intercommunal conflicts are one of the most prevalent forms of conflict—namely between miners and farmers, or between farmers. In order to understand mining-related conflict better, we look at the cause of the conflict, whether it is land-based or socially based. Land-based conflicts are conflicts that generally arise from community members clashing with miners about the impacts that mines have on the community's land. Socially based conflict occurs when a community is unhappy with how miners have acted or treated the community.

Common causes of socially based conflict are when communities think miners have not fairly shared the profits of mining with the community, or when they think miners have committed crimes and the community then decides to take matters into its own hands. We also look at which mining actor is involved—a large-scale mining company or ASM miners. We also consider whether and how sexual and gender-based violence and domestic violence seem to be more prevalent in the mining areas, and whether this is contributing to conflicts between miners and the community. Other types of conflict and violence that are in part attributed to climate change could also be a factor behind the migration that in turn affects conflict in receiving areas. In particular, the jihadi terrorism in the Sahel region is also considered to contribute to out-migration from affected areas. Jihadists are already taking over gold mines in the Sahel region and taking advantage of the gold trade in coastal West African countries such as Ghana to fund themselves. There is a possibility that they might soon target Ghanaian mines, because these are very lucrative. These complexities highlight the relevance of a complex systems approach to studying the climate–conflict nexus in the Ghanaian case.

2.3 EXPLAINING CONFLICT IN GHANA

Conflict is rising because of three interrelated factors. First, migration, or population churn. Secondly, the exacerbation of migration by foreign investment and the development of large-scale mining. LSM both attracts mining workers and imports its own workforce from abroad. Local immigration disrupts the claim to authority of customary institutions. Third, climate change is exacerbating internal pressures. Agricultural land is not as productive, and runoff makes it even less so.

3. PROGNOSIS: WHERE IS THIS HEADED?

The more interconnected a system, the more potential there is for feedback. This feedback can lead to virtuous or vicious cycles including the likelihood for tipping, resulting in possibly irreversible and unrecoverable circumstances—such as dire environmental degradation or escalation of conflict and violence.

4. RECOMMENDATIONS

When thinking about solutions to this issue, it is important to note that it is a complex problem, so a single straightforward solution will never be found. The environmental and conflict problems are interlinked, and the actors and consequences are interrelated. Therefore, it is important that when we think of solutions, we take into account the possibility that a solution to one problem might exacerbate another.

Furthermore, this is an urgent problem because it threatens unrecoverable environmental effects, including the loss of topsoil and the pollution of bodies of water. There is also the potential for certain conflict issues to escalate rapidly toward irreversibility. For example, there is a possibility that the influence of Jihadi terrorist groups spreads into Ghana's gold mining industry, which might lead to the takeover of gold mining sites.

As we think about the complexities of this issue, we are struck by the importance of actors at the local level. Chiefs and community members are at the front line of addressing this issue as they hold the most localized knowledge, and they bear most of the negative externalities of mining. Chiefs can help with both social and environmental issues.

We see educating and empowering chiefs as one lever point to reduce this downward cycle, and perhaps create positive externalities. By providing them with information about the negative impact of mining on land and empowering them to minimize the negative effects of mining, they can work with both the community and miners to come up with localized solutions. This in turn reduces friction and conflict between two groups that might otherwise have little opportunity or desire to interact with one another. Here, chiefs can play a bridging role to solve both social and environmental problems of mining.

"You cannot know that, but there is a strong correlation between a very strong, traditional leadership and areas where mining is sustainable. Suppose the mining company is not a caring company or is not mining sustainably. The individual will have to complain to the chief and the chief will have to call the company for order.

So, that is why I say there is a strong correlation because government agencies are not in all the mining communities, so the first point of contact for any conflict or issue is the chiefs." – Dr. Samuel Obiri, Center for Environmental Impact Analysis

As we educate and empower chiefs, we must also do the same for host community members. The community plays an important role as a check and balance on chiefs to prevent them from abusing their position of power. Our interviews reveal that communities able to mitigate conflict and haphazard mining are invariably well organized and determined to be involved in decision-making processes. Education about their rights and the effects of mining has empowered and inspired communities to fight against potential exploitation by miners colluding with corrupt chiefs. Empowering both chiefs and community members will also improve communication between the two groups and ensure that the flow of information needed to reach equitable and effective solutions is not impeded.

"In my opinion, the solution in the long term would be getting the communities involved in the licensing and allocation for mining activities and in the sensitization on the positive and negative impacts of mining. The community could serve as a monitoring mechanism as well, so if an issue arises in how they intended the mining to be, they can raise alarms and address this. I think one other thing is to strengthen the previous mechanisms for mining so that if people have a concern, they know where to go and know which medium of communication to use. People will also be able to understand the feedback mechanisms available to them, which could help them address issues as they arise." – Solomon Ampofo, Friends of the Nation (FON) Ghana.

Finally, we are struck by how important it will be to develop a long-term strategy to integrate migrants into the mining communities. At present, relations between host communities and migrant miners are merely managed; at best, their presence is tolerated, and relations are relatively peaceful. Increasingly, the population upheaval created by mining and climate-related effects has led to conflict. It is important that they work toward integration of migrant miners into the community for the future. As the gold mining industry in Ghana grows, the migrant population in mining host communities will only grow. Simply managing the relations between migrants and host communities might solve some economic and environmental problems, but in order to prevent social problems and conflict, migrant miners must be integrated into the host community. Increasing the sense of ownership and responsibility to the community through integration can help reduce social friction, because communication and contact between the two groups will increase.

5. CONCLUSIONS

Climate change has caused both the "push" and the "pull" factors of migration into the ASM sector. Migrants are being pushed from their traditional livelihoods due to desertification in West Africa affecting agricultural productivity or increased incidences of natural disasters. On the other hand, migrants are being pulled into the ASM sector because of the increase in the availability of mining sites and jobs due to the increased willingness of farmers to convert their land into gold mining sites. We cannot meaningfully address either aspect of this issue without looking at how climate change is inducing both "push" and "pull" factors and changing the community system as a whole.

CASE STUDY 2 - CLIMATE CHANGE, PASTORAL RESOURCE ACCESS, AND EXTREMIST GROUP VIOLENCE IN THE WESTERN SAHEL: NEW DATA AND INSIGHTS FROM MALI

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Climate-FCV Dynamics in West Africa Project

ABSTRACT

This study analyzes changing patterns of semi-nomadic pastoralists' resource dependency and their relationship to the emergence of violent insurgent group cells in western Mali with specific reference to the Boucle de Baoule National Park (BBNP). Western Mali is a principal frontier in the expansion of the country's most active extremist group, Katiba Macina and the study area offers a unique opportunity to evaluate the pastoral populism theory of fragility-linked violence in the western Sahel.

The study integrates elements of vulnerability and political ecology to investigate the degree to which pastoral livestock keepers' dependency on seasonal resource access—and their limited capacity to adapt to growing resource competition and degradation—is leading them to sympathize with or even join insurgent groups that use violence as a political tactic.

The study is based on a longitudinal survey (2011 and 2021) of semi-nomadic pastoralists and additional interviews with local residents who have frequent contact with Katiba Macina in and around the BBNP. It evaluates their dependency on seasonal movements, diversification strategies, and access to natural resources. A follow-up survey with younger shepherds focused specifically on their views of extremists in the area and what they perceive to be the group's motivation and strategy.

The study concludes that the link between climate change, resource-related stressors, and violent insurgency is complex and contingent on a variety of local factors. There is little current evidence that western Mali represents a case of pastoral grievances leading to the expansion of armed insurgent groups. However, the presence of armed insurgents changes the local security context, which has the potential to aggravate local conflicts and increase the risk of violence. Climate stress in coming decades could potentially influence these fragile dynamics unless local governance substantially improves. The study ends with specific recommendations to improve natural resource access and reduce the risk of conflict escalation.

1. INTRODUCTION

This study investigates changing patterns of semi-nomadic pastoralists' resource dependency and their relationship to the emergence of armed insurgent group cells in western Mali. Western Mali is a principal frontier in the expansion of one of the country's most active extremist groups, Katiba Macina (KM). The area offers a unique opportunity to evaluate the "pastoral populism" theory of fragility-linked violence in the western Sahel (Raleigh, Nsaibia et al. 2020). Pastoral populism posits that insurgent groups gain legitimacy by representing and advocating for pastoralist interests and concerns. This includes effective conflict resolution, prevention of cattle theft, and the protection of equitable grazing rights.

This theory is important because it is used to explain the spread of pastoralist-aligned armed groups, including those that conduct violence in Mali, Burkina Faso (Hubert 2021), Nigeria (Ojo 2020), and central Africa (Vircoulon 2021). Additionally, the pastoral populism theory differentiates these groups from criminal networks that typically operate in the same kinds of territories, such as forest reserves. The reality is that the distinction between insurgent and criminal groups is often vague, while pastoral populism holds fast to the possibility that such groups will become embedded in local communities and carry out political agendas related to pastoralism. However, the evidence for this is highly limited to date and analysis relies on a limited amount of case study material and a large amount of speculation.

By investigating the activities of a sizable cell affiliated to Katiba Macina operating far from its base in Mali's Mopti Region, this study will provide a stronger empirical basis for understanding the relationship between climate change, growing resource competition and the spread of extremist-related violence throughout the region.

This case study builds on recent empirical and qualitative research on the relationship between seasonal pastoral mobility known as transhumance and farmer–herder conflict in the study area. The analysis is based on a published study that emphasizes early livestock herd movements as a trigger for violent conflict between farmers and herders (Brottem 2016). Early pastoral movement as a conflict trigger was recently validated by a continent-scale econometric study focusing on the same question (McGuirk and Nunn 2021). It is thought that these farmer–herder conflicts could be linked in important ways to organized violence by groups such as Katiba Macina and their recent expansion in western Mali but there has yet to be an empirical investigation into the relationship.

2. THEORETICAL FRAMEWORKS

This study integrates elements of the vulnerability and political ecology frameworks to answer its principal research question: Has changing resource availability increased the appeal of violent insurgent groups that seek local legitimacy and recruitment opportunities in western Mali's pastoralist communities?

Vulnerability

Vulnerability is defined as an outcome of exposure, sensitivity, and adaptive capacity (Adger 2006). Pastoralists are exposed to temperature increases and changes in precipitation regimes due to climate change; livestock are sensitive to changes in resource availability and physiological impacts of heat and drought; livestock-dependent households have the capacity to adapt to these risks by investing financial and other forms of capital in their production systems and diversifying income sources away from climate-vulnerable activities. Vulnerability is an important framework for evaluating the relationship between environmental resources, livelihoods, and institutions as a way to analyze pastoralist involvement in armed insurgent groups.

In short, are pastoralists responding directly to resource-related grievances by joining or supporting armed groups? Important secondary questions on which this study will also shed light include: What does the absence of intercommunal conflict say about armed groups operating in Mali? To what degree does the enforcement of rules of access to forest reserve resources represent a potential future pathway to conflict?

In terms of vulnerability, the study focuses specifically on how pastoral livestock keepers' dependency on seasonal resource access—and whether their limited capacity to adapt to growing resource competition and degradation—could lead pastoralists to sympathize with or even join insurgent groups that use violence as a political tactic. Pastoralist livestock keepers play a disproportionate role within violent insurgent groups across the western Sahel (Brottem 2020). Policy makers debate the causes of this but there is insufficient scholarship on the issue and even less up-to-date empirical data that can shed light on the phenomenon, especially its extent, and whether it is robustly linked to climate change.

Many researchers feel that abuses by government forces in the natural resource sector play a preponderant role in driving recruitment of livestock keepers by insurgent groups (Quidelleur 2020). Others argue that violence is driven by inequality of access rights between livestock keepers and farmers, plus increasing resource competition made worse by global climate change (Brottem 2016; Sani Ibrahim, Ozdeser et al. 2021).

This study will investigate the hypothesis that livelihood strain caused by reduced access to critical resources or other kinds of environmental degradation will generate political grievances, which, if unaddressed, can create the conditions for violent insurgency and sympathies for extremists.

Political ecology

Political ecology is a necessary framework for answering these questions because power relations shape resource access dynamics and state power is seen as a critical factor within the regional nexus of fragility and violent conflict (Raleigh 2010). State agents are seen to strengthen the legitimacy of insurgent groups by abusing rural inhabitants (Verweijen and Brabant 2017), especially pastoralists, and depriving them of access to the resources on which they rely (Hubert 2021). While this is an important part of the pastoral populism theory of violent extremism, it remains underinvestigated and largely untested in the Sahel.

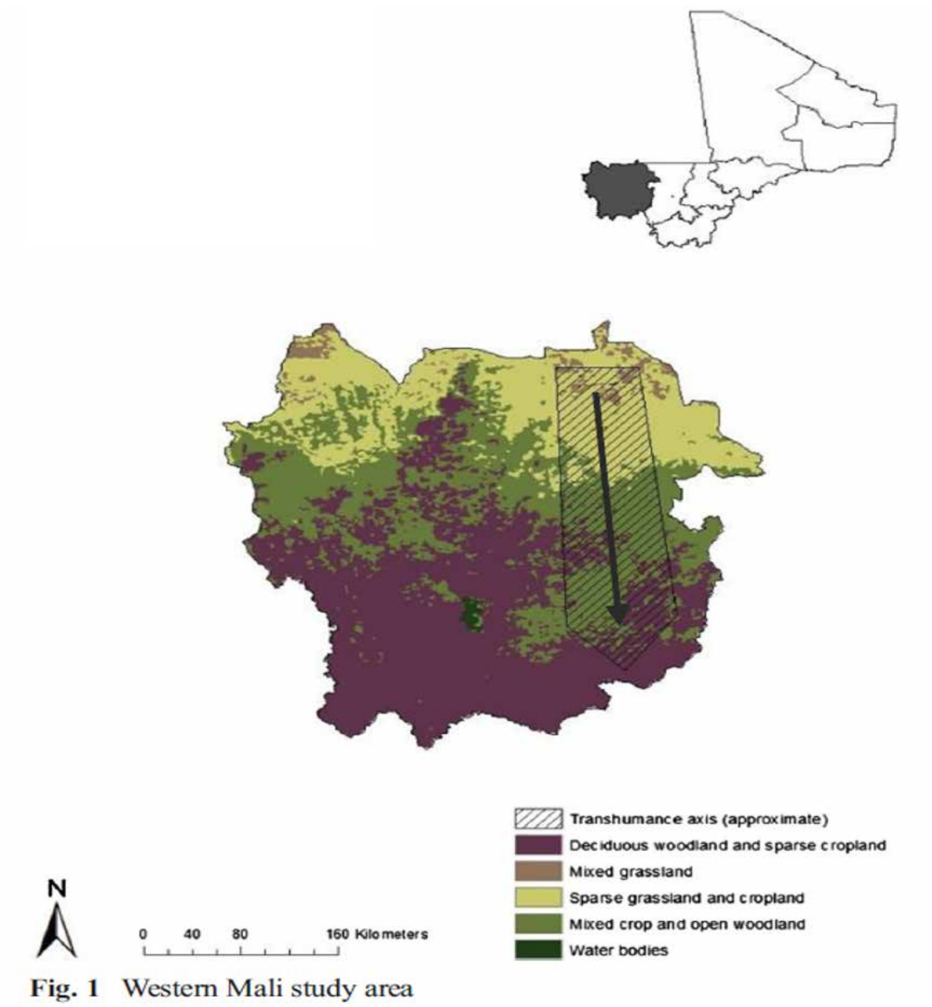
The pastoral populism theory of violent extremism is constrained by limited empirical evidence and faulty assumptions. The theory remains grounded in a stimulus–response model of grievance in which resource users are reacting directly to being deprived of resource access. The reality is more complex, with systems of resource tenure, legal and customary norms, black market transactions, and various kinds of power relations forming a web that mediates the climate–conflict relationship. Running through this web is the notion of justice, which strongly informs a sense of grievance among pastoralists and farmers alike (Nwozor, Olanrewaju et al. 2021).

This study aims to contribute to a more robust FCV theory by accounting for how this web shapes pastoralists' capacity to adapt to change and what kinds of politics result from the presence of armed groups and the insecurity they generate. A point of departure is that climate-related environmental changes have the potential to increase conflict risk through direct resource disputes or by contributing to the conditions where armed insurgent groups become established. However, the web of rules, norms, and power relations have the potential to reduce conflict risk under conditions where FCV theory would point to a likely increase. Case studies such as this one can reveal lesser-known and surprising factors that weaken the relationship between grievance and insurgency, thereby reducing the risk for violent conflict.

3. CASE PROFILE

The study is based on a two-phase survey of semi-nomadic pastoralists (2011 and 2021) who traverse the Boucle de Baoule National Park each year with their livestock and additional interviews with local residents that have contact with Katiba Macina elements in and around the BBNP in western Mali (Figure 2.2.1). As a site for investigating the pastoral populism theory, the BBNP landscape offers the following unique and valuable opportunities to generate insights: 1) pastoralists rely to some degree on access to protected area resources, which exposes them to predatory resource governance practices that are seen to generate pastoralist grievances, 2) the park interior lacks surveillance and currently provides a territory within which armed insurgents operate, and 3) the BBNP is an agricultural frontier that is experiencing growing resource competition and degradation.

FIGURE 2.2.1 Study area in western Mali with transhumance axis and land cover zones



Climate change projections

The western Mali study area, which includes Boucle de Baoule National Park, spans the Sudano-Sahelian eco-climatological gradient from semi-arid rangelands in the north to subhumid woodlands to the south (Figure 2.2.1 above). Climate models predict that western Mali is at risk for temperature increases up to 3.6°C in the decades up to 2060, which would increase the duration of heat waves and reduce the length of cold spells. While changes in precipitation are difficult to predict, models suggest an increase in heavy rainfall events in the south and a decrease in rainfall in the north.[1] Over the past two decades, summer rains in Mali have remained relatively steady but are 12 percent below the 1920–1969 average. Temperatures have increased by 0.8°C since 1975, amplifying the effect of droughts.[2] Taken together, these indicators of climate variability and change suggest that pastoral movements in the study are likely to be impacted in significant ways over the coming years.

Population growth in western Mali

Population growth will influence how pastoralists are able to adapt to changing rainfall and temperatures. The population of western Mali's Kita district, which encompasses most of the article's study area grew thirteen-fold during the twentieth century: from 33,800 to 434,379 persons (Brottem 2016). Since the 1990s, local-level resource competition in these areas has been compounded by in-migration and the introduction of cash cropping and mechanized agriculture, which enable farmers to cultivate larger areas of land, often substantially encroaching on areas historically relied upon by livestock herders (Figure 2.2.2 below). Resource tenure laws that favor crop production over pastoralism (Lane 1998) and the convergence of agricultural and pastoral livelihoods have exacerbated these trends (Kossoumna et al. 2010).

Ethnic Fulani livestock herders from home areas in the northern reaches of the area practice transhumance through BBNP each year to reach dry season grazing resources found in the Sudanian woodland-savanna found to the south of the protected area. Growing numbers of Bamana and Fulani smallholder farmers cultivate a variety of dryland crops in the area and their fields overlap geographically with the movements of livestock that are managed and mostly owned by Fulani pastoralists.

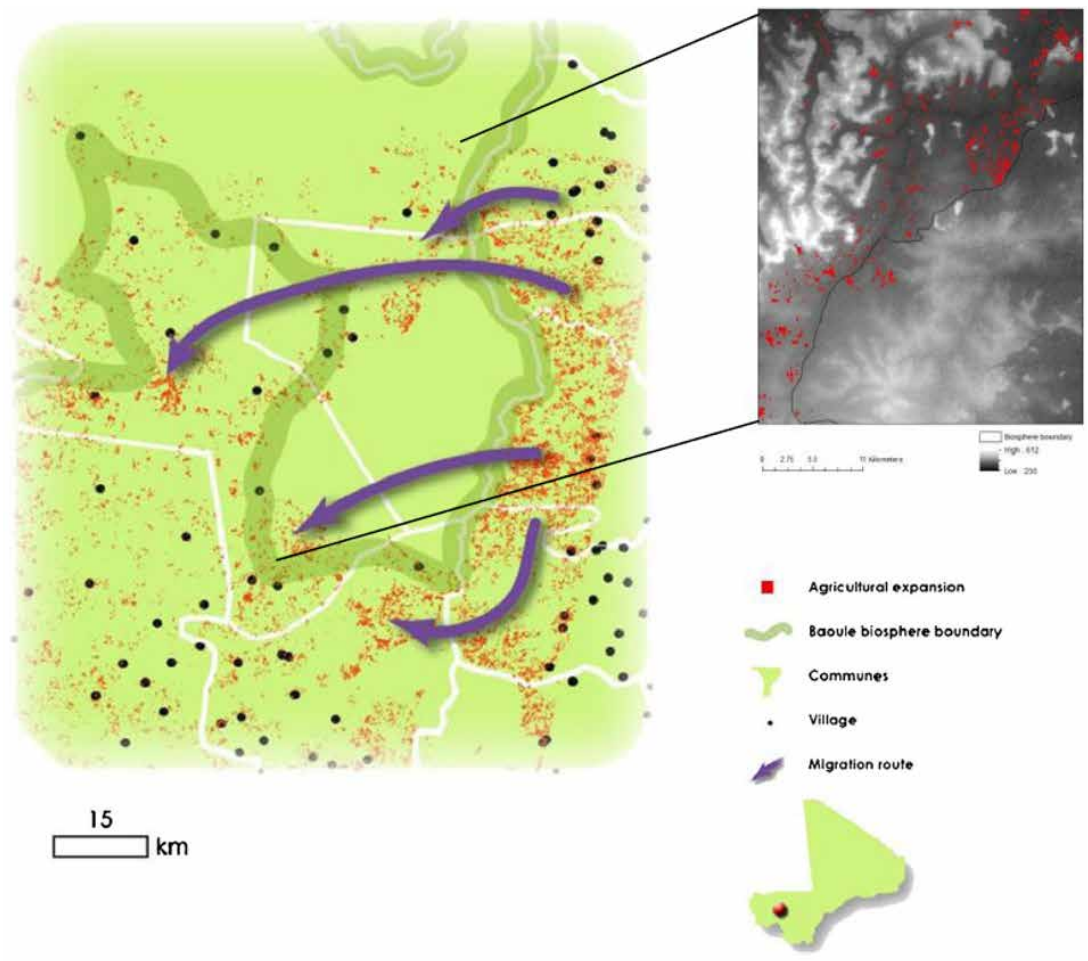
Jihadist activity in study area

Katiba Macina is the most important subgroup in terms of men and influence within the Support Group for Islam and Muslims (GSIM), a prominent insurgent group and al-Qaida affiliate established in 2017 as a way to expand into Mali.[3] As a reflection of pastoral populism's logic, the group's strategy has been to talk to local populations and create operational bases outside the Wagadou forest, located northwest of this paper's study area. There are reports that the group also exploits grievances related to the practice of slavery in nearby rural areas.[4] While slavery has long been illegal in Mali, it continues to shape unequal social relations within local communities.

[1] https://www.climatelinks.org/sites/default/files/asset/document/Mali_CRP_Final.pdf
[2] https://pubs.usgs.gov/fs/2012/3105/fs2012-3105.pdf
[3] https://www.dakaractu.com/expansion-djihadiste-vers-l-ouest-Comment-la-Katiba-Macina-s-approche-dangereusement-du-Senegal_a196320.html
[4] https://www.ofpra.gouv.fr/sites/default/files/atoms/files/2103_mli_situation_securitaire_kayes_152136_web.pdf

The group has more recently carried out deadly attacks against Malian security forces in the study area, including one in April 2020 on the southern end of the BNPP, where a new Katiba Macina (KM) cell established a base after chasing out or killing the small number of foresters that patrolled the 25,330 km^2 protected area.[5] The actions of the insurgents operating in the BNPP are broadly consistent with prior descriptions of the KM/GSIM strategy to avoid attacking civilians and to gradually embed itself in local communities through forms of integration like marriage and recruitment.

FIGURE 2.2.2 In-migration and agricultural expansion from 2000 to 2010 in and around the Boucle de Baoule National Park biosphere reserve



[5] https://www.studiotamani.org/index.php/themes/politique/23358-insecurite-au-mali-la-region-de-kayes-ciblee-par-des-terroristes

4. CLIMATE–FCV RISK PROFILE OF THE CASE CONTEXT

Description of climate risks

Resource dependency is high in the study area as the vast majority of its inhabitants rely on low-input crop and livestock production. Nonfarm employment is mostly informal and acts as a complement rather than a replacement for resource-reliant income generating activities. Changing climate conditions pose a risk to farmers and livestock keepers because declining crop productivity could lead to greater demand for shared land resources and increasing drought frequency could lengthen time during which livestock are present in cropped areas, increasing the risk of damage. When local institutions are unable to resolve cases of crop damage, the risk of violent conflict increases. Greater intensity of rainfall episodes could influence where farmers seek land to cultivate and affect the distribution of grazing resources, which would shape patterns of livestock mobility and further contribute to conflict risk.

Principal drivers of conflict

The principal driver of past conflicts in the study area is the perception amongst local residents of an injustice that in effect tramples underfoot their need for secure access to resources. For farmers, this means the ability to bring a crop into harvest without losing it to damage by livestock. An important factor in conflict escalation is whether uncompensated crop damage is seen to be carried out intentionally by herders looking to feed their animals. Incidents of uncompensated crop damage raise the risk of violent altercations when farmers and shepherds encounter one another in or around fields (Ahmed and Kuusaana 2021). Violent incidents escalate rapidly into collective punishments or expulsions of all livestock keepers from a given locality.

Climate change could further exacerbate these dynamics by increasing the demand for trees as dry season pasture. The lopping of branches by shepherds to provide their animals with fodder is already a flashpoint in their relations with farmers. In semi-arid areas, climate change may favor tree growth at the expense of pasture grasses (Brandt, Hiernaux et al. 2019), which are already disappearing due to expanding cultivation pressure.

Local links between conflict and armed groups

The presence of a Katiba Macina cell increases climate-related risk through two principal channels. KM insurgents who currently receive little support from locals could gain sympathy if climate change makes pastoral livelihoods more difficult, especially if they are suddenly or unjustly deprived of resource access. This could happen through top-down policies, such as expulsions from the Baoule National Park or other nearby reserves, or through bottom-up land grabs, such as farmers forcibly taking back land to which pastoralists historically have access.

A second channel is that the ongoing insurgent presence—in the absence of state security forces—could incite hunter groups to take up arms to protect their communities. This would greatly increase the risk of everyday farmer–herder disputes escalating into violence. An act of violence by hunters or other community militia members could provoke a response by KM if government forces did not quickly respond. Such a scenario would, at least partially, confirm the pastoral populism theory of insurgency and violence in western Africa.

Key groups, decision-makers, stakeholders and their resources (interests and capacities)

- *Pastoralists*
  Fulani Pastoralists who reside and practice transhumance in the area are originally from and maintain links to the Sahelian district of Nara, which is the home of a nationally

prominent religious figure and has served as an important node in Katiba Macina's expansion into western Mali. This is where Fulani pastoralists' political representatives reside and where they possess primary resource rights even though they spend only 2–3 months of the year there. Their interests traditionally lay primarily in securing access to pastoral grazing and water resources, but many households increasingly seek to settle permanently as a way to establish new income-generating opportunities.

This current livelihood shift lays bare the inadequacy of relying on outsider status as a political strategy. Settlement will likely require fuller political participation by pastoralists in their host communities. This principally involves paying taxes to host community municipalities rather than to those where their communities of origin are located. Although this is a practical shift, many resist it given the symbolic importance of maintaining political connections with their communities of origin.

As owners of livestock, pastoralists are typically wealthier than farmers, and they deploy that wealth to suit their political and economic interests. On the one hand, this includes the provision of patronage and financial assistance to farmers and their political leaders. However, livestock wealth also creates a level of inequality that many farmers resent, especially during times of tension. For example, farmers resist ceding land to pastoralists because, for many of them, it is the only productive asset they control, and they fear losing it.

- *Farmers*

Farmers in the study area consist of two groups: members of several lineage groups that hold autochthonous, first-comer land rights and customary political power, and a second group of Bamana migrants, principally from the neighboring Beledougou district. Autochthonous groups have held political power since the precolonial era and therefore exercise tight control over land tenure, yet these groups are a demographic minority in many outlying settlements. The steady in-migration of Bamana households has led to the proliferation of farming hamlets that typically consist of a single land-controlling autochthonous household and any number of migrant ones.

Autochthonous groups extend their control through settlement of lands by their Bamana clients, but this comes at the expense of grazing lands for pastoralists. Dependency on cultivation as a livelihood means that these households strongly resist any limits put on their ability to expand their fields. Customary and formal land tenure laws in Mali reinforce their rights to establish bush settlements for cultivation.

- *Customary leaders*

Customary leaders include village chiefs, who are typically the eldest male in a local autochthonous clan, and other Fulani elders who represent pastoral interests and help mediate disputes. These leaders typically enjoy higher levels of legitimacy than elected officials and technical agents (such as foresters) but lack education, training, and, above all, resources that are needed to govern effectively. Customary authorities effectively mediate everyday disputes and facilitate shared access to resources as equitably as possible (Turner, Ayantunde et al. 2012). However, if a conflict escalates, it quickly becomes the purview of state agents.

- *Officials*

Mali went through a process of democratic decentralization in the 1990s and people now elect mayors and municipal councils to oversee everyday governance and some administrative matters. These officials are responsible for implementing national laws and, in cases concerning land, they tend to work closely with customary authorities. Decision-making typically relies on a consensus model that leads to the creation of local conventions that dictate the terms of legitimate resource access (Djiré and Dicko 2007).

Like village chiefs, municipal officials have very limited financial and administrative capacity to carry out policy. The tax base for rural municipalities is minuscule and there are very few other sources of revenue to put toward land governance (Brottem 2019). In some places, NGO projects address unmet needs in rural areas, but they often do so in parallel and without a high level of accountability. NGO presence in this paper's study area is minimal.

- *Foresters*
  National government foresters are key stakeholders in the study area due to the number of protected reserves and the amount of territory overseen by the state forest management agency. Although there are few foresters on the ground, they are the sole actors able to enforce fines for forest product use and they therefore control access to resources within protected areas.

  Importantly, forest resource management is one domain where decentralization has been blocked, and it is likely due at least in part to foresters' reluctance to give up this important source of rent. Foresters therefore wield the law and the threat of force, but their small numbers and their corrupt actions have made them vulnerable to nonstate armed groups. In 2020, Katiba Macina insurgents killed several foresters in the BBNP and took their vehicle and equipment. Survivors fled and abandoned the park to them.

- *Security forces*
  Since attacks against foresters began in 2020, the Malian government has deployed a limited military force to address insecurity in the BBNP. In normal times, the national gendarmerie would be the only law enforcement agency in the area; the closest gendarme post to the BBNP was itself attacked in April 2020. Although a limited government force is currently present in the BBNP, observations on the ground indicate that they do not circulate very widely and they have apparently not made an attempt to engage (physically combat) the insurgents who are also in the reserve. It is possible that security forces are simply outnumbered or outgunned.

- *Armed groups*
  In June 2021, a dozen armed insurgents were seen traveling by motorcycle in an area close to the national highway that links the Malian capital of Bamako with Senegal, its neighbor to the west. At the same time, the area was suffering from a spate of banditry, which rendered the same highway unsafe to travel at night. Although the relationship between armed groups and bandits remains unclear, these were the most recent signs that insecurity had reached the southern part of Mali's Kayes Region, after many years of being limited to areas further north along the Mauritanian border. Importantly, this suggests that the KM cell present in the BBNP feels secure enough to travel far beyond its boundaries and hideouts within the BBNP.

Interactions between climate and FCV

Sedentary farmers and pastoralist livestock herders co-exist in a classic host–stranger relationship in which specific clan groups claim "first-settler" status and therefore primary land rights. These settlement rights were tightly connected to precolonial conquest and wild game hunting but now focus almost exclusively on crop cultivation. Pastoralists have long relied on "stranger" status, which guarantees them secondary, seasonal access to resources but prevents them from making the kinds of territorial claims available to farmers (Brottem 2014). This system was stable under conditions of sparse settlement, but it is now under strain from pastoralists' and farmers' changing resource needs.

Impacts of the conflict on human and social development outcomes

Local people report that the presence of armed groups in the area has begun seriously to impinge on everyday life. Nighttime travel is dangerous, and the risk of robbery on major routes has depressed commercial activity. Livestock herders report being excluded from parts of the BBNP due to the hostile presence of insurgents. There have not to date been any attacks on farmers working in their fields (this has already become a serious risk for people in northern Burkina Faso and western Niger). If these were to occur, they would rapidly reduce food security, with grave consequences.

5. ANALYSIS

Mechanisms that connect climate risks to conflict

Early herd arrival

The subhumid parts of the study area serve as a popular dry season destination for transhumant herds from the area's semi-arid Sahelian rangelands. Livestock herders typically leave their rainy season Sahelian grazing areas in September or early October and try to move their animals south as slowly as possible, passing through the BBNP, and stopping for a period of several weeks or months at the Baoule River. Over the past two decades, transhumant herds have been arriving at their dry season destinations several months earlier than in earlier years.

As an important source of farmer–herder conflict, early herd arrival is linked to climate change as a response to drought (short-term) and pasture quality (long-term). Drought reduces pasture and water availability in herders' rainy season destinations; this compels them to move toward their dry season refuges earlier and more quickly. If climate change influences the frequency or intensity of droughts, larger numbers of pastoralists will spend longer periods in subhumid areas where resource competition with farmers is greatest.

These responses to climate change are, however, situated within livelihood strategies that also respond to other constraints and opportunities that are unrelated to climate factors. A certain percentage of pastoralists will alter their livelihoods each year through settlement, diversification, or both. These decisions are often driven by household-specific factors and have other effects on farmer–herder relations that potentially but do not inevitably increase conflict risk.

Disputed Resource claims

As environmental conditions (including climate) and livelihoods change over time, pastoralists and farmers seek to establish and secure new claims to land and water resources. For pastoralists, these included livestock corridors, grazing areas, and dry season water sources. The protection of certain tree species that provide dry season fodder is also an increasingly important priority for pastoralists. Farmers secure areas to cultivate by maintaining systems of fallow land and by establishing hamlets in outlying locations. The hamlet–fallow system must accommodate newly established households and migrants arriving from other parts of Mali who receive land use rights that are subordinate to those of autochthonous land-owning groups. As population has grown, these resource demands have increasingly come into conflict, with livestock herds arriving before crops are harvested, increasing the risk of damage, and hamlets are established in places where pastoralists traditionally graze their cattle. Since customary resource tenure rights that favor agriculture remain effective, pastoralists' secondary rights have been steadily eroded. Various national laws and policies are in place to transform resource governance in order to better secure pastoral livestock production, but these suffer from weak institutions and limited implementation.

Factors and actions that amplify or mitigate conflict and vulnerability to conflict

Livelihood strategies and adaptation

Longitudinal data collection conducted in 2011 and 2021 sheds light on pastoral livelihoods and resource access. The survey evaluates their livelihood strategies, household assets, and access to natural resources, plus views of state authorities and the insurgent group present in the area. It also draws from various surveys of livestock keepers and farmers who reside around the BBNP. These additional surveys focus on resource access, various kinds of conflict, and the presence of armed insurgents in the park.

The year 2011 was a period of tension between livestock keepers and local farmers due to conflict incidents arising from crop damage and widespread frustration regarding the timing of herd arrival and the encroachment of fields by traditional livestock corridors. An NGO worked for several years to address these issues by working with municipalities to set up conflict mediation committees and to improve the protection of pastoral resources.

Pastoral livelihood adaptation: initial survey results

Among the 85 pastoral households surveyed in 2011, 27 still practice animal husbandry in the vicinity of the BBNP. The large majority of the rest returned to their customary Sudano-Sahelian homelands to the north. The number of oxen has increased for more than half of herding households and, among households that have suffered a reduction in herd size, six cited "less access to pasture" as the first or second reason for this decrease.

Among the 27 pastoralists surveyed who still frequent the BBNP, a slight majority still practice transhumance between rainy season pasture areas in the Sahelian zone and dry season grazing areas further south. Of the 15 households that continue practicing transhumance, only three have seen an increase in their herd size over the past 10 years.

Dependence on protected resources

Despite the large number of livestock and the decrease in grazing areas around BBNP, dependence on pastoral resources within the park decreased between 2011 and 2021, and relations with local farmers improved. For some pastoralists, this is due to a diversification of household income-generating activities. Among the nine households that declared a resource dependency on BBNP as "important" or " very important," six reported decreased milk from their herds. No pastoralist reported that their reliance on the park increased during the 2011–2021 period.

In contrast with accounts that resentment against exclusion from protected area resources is a root cause of insurgency violence, 21 out 22 pastoral herders under the age of 30 surveyed in August 2021 feel that natural resource access does not explain why young people join extremist groups. Survey respondents listed "personal emancipation" and "poverty" as the two most important factors, with "religion" and "economic grievance" selected by only two people and one person, respectively. Five and four out of 22 respondents feel that abuse by foresters and by farmers are, respectively, important factors behind young people joining extremist groups. These pastoral herders, who would have the most to gain from freer access to the BBNP, unanimously recognize that the park is necessary to protect wildlife and all but one of them support its territorial protection to that end.

Diversification

In terms of livelihood shifts, a correlation exists between the abandonment of transhumance and diversification into several forms of commerce, including cattle trading and milk selling. Further research would be needed to explain the factors that drive these important livelihood shifts but it is likely that decision-making is specific to individual households. This diversification is not associated with a reducton in the size of herds. This suggests that adaptive capacity increased for these households, but their overall resource dependency remained unchanged or increased. The exception to this trend is two households that have resorted to agriculture instead of trade. The herds of these two households have declined between 2011 and 2021. It is likely that this is an indicator of declining living standards and the increased vulnerability of those households.

Overall, the survey results imply that dependency on natural resources has not decreased in the BBNP area. This means that the livestock keepers secure enough fodder to feed their animals without too much recourse to protected area resources despite greatly diminished availability and quality of fodder outside of BBNP boundaries where domestic animals are allowed to graze. Resource dependency is clearly a function of household needs and capacities to secure access.

For example, more affluent pastoralist households address fodder shortages by purchasing supplements for their herds. One interviewee described having purchased approximately US$ 4,000 for his herd while that of other respondents cite the high cost and the scarcity of cotton residue as limiting their ability to secure such supplements. Households that command enough labor will send their herds ever greater distances for lengthier periods of time. Eventually, this can lead to Sahelian herds staying in southern, coastal areas on a more-or-less permanent basis. This practice could theoretically be responsible for reducing conflict risk in certain areas while raising it in others.

Aerial pasture

Another way in which pastoralists adapt to pasture scarcity is to increase their reliance on branch lopping of tree species that produce palatable leaves during the late dry season. This long-standing but now illegal practice is a source of grievance and conflict because state foresters use it as a way to extract rents from shepherds, most of whom have no knowledge of the applicable regulations.

A survey carried out in 2020 of 45 shepherds in the area revealed that reliance on branch cutting is increasing due to degradation of grazing resources. A majority of respondents have been fined for this practice and nearly all of them are unaware of forestry laws, which have been reformed in Mali to guard against such customary resource use. However, the survey revealed that only a few of the shepherds have experienced the kind of exorbitant fines often seen to contribute to pastoralist populism (Benjaminsen and Ba 2019). Instead, the majority, who pay an average of US$ 40–50 per fine appear to do so as informal payments to rangers. In this sense, tree branch cutting functions more as a black market activity than as a predatory state practice.

Resource use, governance, and corruption

The principal resource-related grievance found among pastoralists and farmers alike is corruption. In short, the residents support the conservation of the forest, but they deplore the actions of the foresters. Because of the perceived and real corruption, these residents do not have favorable opinions of the foresters who patrol the BBNP. One local resident put it simply: "There is no protection of the forest despite the presence of the foresters."

The principal complaint is unlawful or illegal logging, in which foresters and some local authorities are implicated. The residents also describe how loggers arrive with permits from the "highest authorities" in the capital city. This deep-rooted problem is due in part to an opaque management system that was never fully transferred to the local governments that were established during the 1990s through democratic decentralization (Ribot, Lund et al. 2010). A more transparent system that functions through local institutions would begin to tackle this.

The most important corrupt act in the eyes of both farmers and pastoralists is illegal logging. Illegal logging in the BBNP has spiked in recent years and was rated by the majority of the 22 young pastoral survey participants as the biggest natural resource-related problem they face. Interviewees emphasize that the branch lopping they practice is sustainable compared to the outright felling of trees. Loggers frequently target the same species as pastoralists, so it represents an important intersection of corruption and resource competition.

Corruption and insecurity

Endemic corruption in the forestry sector likely contributed to the speed and ease with which a small group of armed extremists were able to take over large parts of the BBNP. The forest service is underfunded and understaffed, a situation made worse by corrupt practices that lead local resource users to regard it as fundamentally illegitimate. This context of weak governance contributed to a rapid deterioration of local security, and caused local hunters to focus their energy on self-defense in a manner akin to the Dozo militias found in central Mali.

Although violence in the study area is certainly not comparable to that in central Mali—where violence has become endemic and pastoralist-aligned armed groups are entrenched—hunters' groups interviewed for this study insisted that the government should arm them to provide local security, given that state agents are absent. It is worth noting that central Mali did not experience higher than normal levels of farmer–herder conflict before the country's crisis began in 2012 (Benjaminsen and Ba 2021).

6. AMPLIFICATION OF CLIMATE-FCV RISKS:

Presence of armed groups

The new dynamics generated by the presence of armed groups represent a crucial issue. It is the absence of state security in rural areas that generates a push for militarization; but such militarization, once underway, creates its own political dynamics and raises the risk of violence (Van Leeuwen and Van Der Haar 2016). Importantly, farmer–herder relations in the study area have improved as per the 2021 survey and violence has not been an issue in recent years. However, there are rumors—yet to be disproved—that the extremists are at least partially responding to pastoralists interest in gaining more access to protected area resources. Even in the absence of hard evidence or coordinated action by extremists and certain pastoralists, mere suspicion, in the presence of politically empowered and armed self-defense groups, could be a recipe for eventual intercommunal violence. Although a decisive majority of respondents to the August 2021 survey expressed their disapproval of the extremists, two respondents expressed strong approval, regarding them as responsive to pastoralists' grievances. If this limited opinion survey is representative, it would suggest that there is the potential for the KM to recruit locally.

Small arms and crime

Increases in crime, especially along major roads, and the circulation of small arms, which have plagued Mali since 2011, when the Libyan Gaddafi regime fell, significantly amplify the risk of violent escalation. The situation in the Central African Republic demonstrates that when insecurity becomes endemic, civilians feel impelled to arm themselves and, at times, align themselves with militias. Over time, the differences between politically oriented insurgents, self-defense militias, and ordinary criminal groups become indistinct and of little significance to local people (Vircoulon 2021). Climate change can add stress to inter-communal relations, now subject to insecurity and other livelihood stressors. However, the relationship among these factors, especially as triggers of violence, is decidedly nonlinear.

Insecurity and extreme identity politics

Insecurity and extrajudicial violence breed the conditions for extreme identity politics: yet another area of potential climate–conflict amplification. Central Mali already displays the characteristics of a nexus between land, violence and extremism. Since political power remains firmly grounded in land tenure relations in western Mali, the emergence of extreme identity politics could lead to hunters' groups or similar self-defense militias seeking to bar herders from accessing grazing areas or even to expel sedentary pastoralists who reside in the area. As long as some pastoralists continue to practice seasonal transhumance, this risk will intersect with climate-related environmental stressors and livestock mobility patterns.

7. POLICIES AND INTERVENTIONS TO ADDRESS CLIMATE-RELATED CONFLICTS (MITIGATION)

Inclusive political institutions

Local people on all sides of resource-related struggles emphasize the need for inclusive dialogue that improves governance and maintains social cohesion. Resource access lies at the intersection of governance and social cohesion as a critical arena for both corruption and livelihoods strategies. Democratic decentralization has led to important accomplishments in Mali, but natural resources have long been recognized as an area where it has failed. Corruption—specifically in the forestry sector—increases resource competition and reduces the legitimacy of the local authorities who must play a key role in confronting violent insecurity in their communities. Climate–conflict risks and the spread of armed groups point to the need for substantial reform of resource governance. First and foremost, this will require strategies to overcome the resistance bound to be mounted by political and economic actors unwilling to lose influence or access to rents.

Dispute resolution committees

Alternative dispute resolution mechanisms that are inclusive and effective must be maintained and strengthened. Resource-related disputes have always been part of life in rural western Africa and are nearly always resolved amicably. In spite of this, traditional authorities who facilitate dispute resolution can and do lose their legitimacy. Resource needs change, and rights of access consequently change, as illustrated by the increasing importance of tree branch cutting as a source of livestock fodder. Changing needs and livelihoods in the context of political uncertainty means that hybrid peace committees, established over the past 20 years, deserve to be supported and strengthened.

Resource conservation measures

The vehement reactions to illegal logging reveal not only that resource governance reforms are needed, but also that local residents need help through proactive resource conservation measures such as agroforestry. Technical barriers and customary land tenure norms greatly constrain the ability of local communities to address their resource needs through active management and planting of valuable indigenous tree species (for example, Pterocarpus erinaceous, Khaya senegalensis).

This would represent a shift away from past efforts that prioritized afforestation with exotic species, with disappointing results. An inclusive focus on indigenous agroforestry would also synergize with the Great Green Wall initiative to mitigate climate change. Measures to restore and rehabilitate degraded agro-pastoral ecosystems could strengthen local institutions, and dispute resolution committees, while creating new modes of shared resource access that better reflect 21st century environmental conditions.

8. RECOMMENDATIONS TIED TO MITIGATION OF CLIMATE–CONFLICT MECHANISMS

Based on the preliminary data that are currently available, this case study points to the following policy recommendations:

Protected forests, including national parks like the BBNP, will likely remain favorite refuges for armed extremist groups for many years to come. In order to prevent extremists from establishing themselves in these territories and increasing the risk of local conflict escalation, authorities at all levels must redouble their efforts to deny these groups such refuge. At the same time, authorities must deter extremist activities in local communities likely to garner legitimacy and recruitment opportunities. This study finds that local people strongly support territorial conservation measures even if they at times wish to have more access to protected resources. This is a potential win-win for security forces, conservationists and local people.

Policy makers should begin a deliberative process to identify ways in which local resource users can gain more access to protected resources without jeopardizing the principal goal, which is wildlife conservation. Candidate activities include sustainable branch pruning and rotational grazing for herders, and small game hunting and nontimber forest product collection for farmers. This strategy would enable these stakeholders to translate broad-based support for protected area conservation into improved surveillance and security within protected territories.

Finally, the western Mali/BBNP case study confirms that analysts and policy makers must avoid resorting to overly simplistic narratives based on standard political theories of grievance (such as "a lack of public services leads to extremist activity") and linear stimulus–response models that suggest resource access is a singular factor causing violent conflict. Notwithstanding huge environmental stress, including climate change, violence perceived to be about resources remains conflict between people and social groups. The politics of environmental change and violent conflict require a recognition of complexity and contingency, whereby trigger events can suddenly alter a local political context, raising the risk of escalation and the emergence of new forms of conflict. A policy designed to mitigate fragility-related violence can only prevent armed groups from succeeding as political entrepreneurs if it is informed by a nuanced understanding deeply grounded in local conditions.

CASE STUDY 3 - A QUALITATIVE ASSESSMENT OF CLIMATE-FRAGILITY RISKS IN CÔTE D'IVOIRE

Oli Brown , Charlotte Penel

ABSTRACT

Côte d'Ivoire has faced a number of challenging periods over the past two decades: in particular, a civil war from 2002 to 2007 and a political crisis from 2010 to 2011. These events took an enormous toll on the population but also stalled the development of the country. Since then, relatively high economic growth and a number of peacebuilding initiatives have helped Côte d'Ivoire move forward, but the country still faces serious challenges to its stability in the form of inter-communal or ethnic conflicts, political instability, and ongoing jihadist attacks.

At the same time, Côte d'Ivoire is particularly vulnerable to climate change. Climate models predict more frequent and intense droughts, floods, and coastal erosion, with serious consequences for the country's mostly rain-fed agricultural system, on which more than half of the population depend for their livelihoods. A growing literature demonstrates that climate change and conflict may not necessarily be isolated events. Although climate change may not be the primary reason for conflict it can be a factor, nonetheless. This research paper is focused on understanding the implications of climate change for conflict risks in the country and providing insights into ways that the country can address these risks. While this paper is primarily focused on Côte d'Ivoire and therefore has certain context-specific attributes, there are several similarities between Côte d'Ivoire and other Western African countries that share certain risks such as herder–farmer conflicts, offering insights into certain climate–conflict risks in this subregion.

1. INTRODUCTION

There has been ample research on the causes of conflicts and various variables have been found to have a causal relationship to conflicts. For example, Gur (1993) found that ethnic grievances are a key variable for the onset of conflicts, while Fearon and Latin (2003) uncovered a causal link between weak states and conflicts. Further research has found that civil

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wars can have a contagion affect and spill over to neighboring countries, creating further instability in the region, while Cederman, Weidmann and Gelditsch (2011) find that political and economic grievances affect the probability of war. More recently however, over the past decade, the literature on the impacts of climate change such as extreme rainfall variability (and other extreme weather events) has begun to tackle its relationship with conflicts. Climate change and conflicts, once viewed as separate challenges, are now acknowledged in the academic literature, and by key international and governmental actors, to be intrinsically interlinked. For example, Mach et al. (2019) have found that although other factors such as low state capacity and low socioeconomic development can be drivers of conflict, the intensification of climate change can be projected to increase the risk of conflict in the future. More recently, the Assistant Secretary-General of the UN warned that climate change is likely to create new conflicts and exacerbate existing conflict risks (UN 2020).

There are, however, still gaps in the research on how climate change can cause conflicts (Mach et al. 2019). Moreover, the effects of climate change are not homogenous. Although it is expected to affect all countries, the impact will not be felt equally. This is because some countries are more vulnerable than others to the impacts of climate change. For example, while Côte d'Ivoire emits 10 times less CO2 than the world average (World Bank 2018b), according to the ND-GAIN Country Index (2019), Côte D'Ivoire is the 47th most vulnerable country and the 35th least ready country to deal with climate change. Clearly, climate change impacts and climate–conflicts risks will differ according to the region or a country. Hence this case study on Côte d'Ivoire. The study look at the potential climate-fragility risks in Côte d'Ivoire, and then examine how the country can address these climate–conflict risks, and potential conflicts. While this paper is centered on one case study, aspects of this paper may serve as guidance for other West African countries that share similar challenges.

To understand climate-fragility risks in Côte d'Ivoire, the approach chosen is firstly to examine the literature on the postwar challenges the country faces in the socioeconomic, political, and national security spheres. This is followed by analyzing the literature on the climate context including the projections and key climate change impacts. These two strands of research will feed into solutions tailored to national needs that take account of important variables specific to the country. We used an eclectic range of sources, such as academic literature, local sources such as governmental reports from several sectors of Côte d'Ivoire, international and regional organizational country reports, as well as reports from civil society. Semi-structured interviews were also used to further help with this analysis. Because we used more than one type of source, triangulation (cross-checking) could serve to ensure reliability of the evidence, and preclude potential biases.

Based on the literature on climate change, as well as the context of current challenges faced by the country, as well as literature on potential climate–conflict risks, this paper finds that there are three potential climate-fragility risks: 1) Large-scale environmental migration contributing to community tensions; 2) the undermining of economic, health, and food insecurity, causing potential instability; and 3) the possibility of increased conflicts between herders and farmers. It is important to note however, that these are risks that can be averted through appropriate policy measures. The Côte d'Ivoire government has already been involved in addressing some of these issues such as through the creation of a Directorate for Climate Change and a National Climate Change Programme, as well as its implementation of strategies such as the National Strategy for Adaptation to Climate Change, and the National Strategy for Disaster Risk Management. This paper therefore suggests five policy actions that could help alleviate some of the identified climate conflict risks. In particular the government and international community should work together to:

1. Improve water and land management;
2. Deepen regional cooperation on climate-related risks;
3. Develop sustainable agricultural practices;
4. Improve data and monitoring tools; and
5. Develop a single authority on climate change adaptation.

In terms of structure, this paper will firstly provide some background information to the country, to illustrate the potential challenges the country is currently facing, and that may be vulnerable to conflict. This will be followed by examining the climate context including the current climate, projections, and the key climate impacts on Côte d'Ivoire. Using this information, the next section of the paper will identify the climate-fragility risks. To address the second aspect of the research question, on how the country can address these climate-fragility risks, we will outline the policy and institutional context of Côte d'Ivoire, as related to climate change. The paper will then examine possible ways to enhance the country's capacity to address climate-fragility risks in Côte d'Ivoire. The final section will evince the main findings of this paper and highlight possible future research avenues.

2. NATIONAL CONTEXT AND CURRENT CHALLENGES

This section will examine the national context, including the socioeconomic context, and provide a political and national security overview, to illuminate the challenges the country faces and how they may be exacerbated by climate change.

Côte d'Ivoire is a West African country that shares borders with Liberia and Guinea to the south, Mali and Burkina Faso to the north, and Ghana to the east. To the south of the country is the Atlantic Ocean where the country has more than 550 km of coastline (MINEDD, 2020). The north consists of plateaus, while the south is dominated by plains, and the northwestern region is the most mountainous region of the country, with Mount Nimba representing the highest mountain at 1,752 metres (MINEDD, 2020). There are four major rivers, which are the Bandama, Cally, Komoe and Sassandra, which flow into the Gulf of Guinea, as well as two important sources of water, which are Lake Kosou and Lake Buyo (Tomalka et al., 2020). The Volta River Basin is one of the largest river systems in Africa, covering an area of around 400,000 km2 and passes through the east of Côte d'Ivoire (Global Water Partnership 2011).

Côte d'Ivoire has one of the highest levels of biodiversity in West Africa, but it also has one of the highest levels of deforestation worldwide (Tomalka et al. 2020). The conversion of forests to agriculture is responsible for almost two-thirds of the deforestation (FAO Regional Office for Africa 2020). Population growth, as well as increased consumption of wood and charcoal, is leading to deforestation at a rate of approximately 92,000 hectares per year (MINSEDD 2017). Overall, the Ivorian forest has been reduced from 16 million hectares in 1990 to around 1.4 million hectares in 2012 (MINSEDD 2017), leading to soil degradation, biodiversity loss, and threats to food and water security (UNDP 2021).

2.1 SOCIOECONOMIC CONTEXT

Côte d'Ivoire is one of the largest economies in West Africa and is considered a lower-middle- income country (Tomalka et al. 2020). Its Human Development Index (HDI) value in 2019 was 0.538, which is low; however it has increased by 33.2 percent between 1990 and 2019 (UNDP 2020). From 2012 to 2019 GDP growth averaged eight percent, falling to 1.8 percent in 2020 as a result of the COVID-19 pandemic (World Bank 2021a). The agricultural sector is a particularly important part of the economy, employing two-thirds of the working population and accounting for 27 percent of the country's GDP (World Bank 2021b). Although around 50 percent of the population live in urban areas, most of the rural population is dependent on cash crops and subsistence agriculture, a sector that is particularly affected by climate change (African Development Bank 2018). The country is the world's largest producer and exporter of cocoa beans, accounting for 40 percent of global production (Tomalka et al. 2020).

Life expectancy is still quite low at 57.8 years in 2019 (Human Development Report 2020). Although poverty levels are still high, poverty fell from 46.3 percent in 2015 to 39.4 percent in 2020. However, the overall statistic obscures growing inequality: over the same period rural poverty rose by 2.4 percent (World Bank 2021a). In general, poverty rates are higher in the north and in rural areas than in urban and southern parts of the country (Federal Ministry for Economic Cooperation and Development, n.d.). Food insecurity, meanwhile, has declined from 12.8 percent in 2015 to 10.8 percent in 2018, but malnutrition and food insecurity remain a challenge, especially in rural communities and particularly in the western and northern regions of Côte d'Ivoire (World Food Programme 2021).

Côte d'Ivoire is faced with serious challenges with regard to gender inequality. In 2019, it had a gender inequality index of 0.638, which placed it at 153rd out of 162 countries. This is linked to issues such as high maternal mortality (617 deaths for every 100,000 live births), a low percentage of the female population having had at least some secondary education (17.9 percent), and only 48.2 percent of the female population being active in the labor force (UNDP 2020).

The population of Côte d'Ivoire is 25 million. More than 40 percent of the population is younger than 15 years old (Federal Ministry for Economic Cooperation and Development, n.d.). The country's rapid population growth (currently 2.6 percent per year) is a result of high birth rates as well as high immigration levels, due to an expanding economy and seasonal workers working on cocoa plantations (Tomalka et al. 2020). There is an immigrant population of around 2.6 million, mostly from Burkina Faso (1.4 million) followed by Mali (520,000) (Tomalka et al. 2020). These immigration levels are not completely accepted by the population and have previously been a source of tension (France Culture 2021), which flared up in the lead-up to the civil war. Most immigration flows are to rural areas of Côte d'Ivoire, in Sud-Comoé, Bas Sassandra, Moyen-Cavally, Moyen-Comoé, and Haut-Sassandra, which are all located in the south of the country (Bruni et al. 2017). The majority of the population lives in the south and on the Atlantic coast as opposed to the much drier north, mainly due to the drier climate in the north (Tomalka et al., 2020).

2.2 POLITICAL CONTEXT

Côte d'Ivoire gained independence from France in 1960. The country went through a civil war from 2002 to 2007, which began as ethnic and religious tensions grew with a north–south divide, against a backdrop of an economic recession in the early 1990s and the death of President Houphouët-Boigny in 1993 (Vinck et al. 2016). The economic downturn led many young Ivorians to move to rural areas where land had been taken up by migrants, which led to clashes between the two groups (INEE 2014). Resentment and xenophobia grew on both sides, which was made worse by exclusionary measures such as a policy of 'Ivoirisation' brought in under Henri Konan Bédié. This divided those considered 'true Ivorians' from 'Northerners' or 'migrant workers', even if the latter had lived for decades in Côte d'Ivoire (Genocide Watch 2012). Under this policy, Rural Land Law No. 98-750 1998 handed land ownership to those with Ivorian citizenship, creating further tension between indigenous landowners and foreign-born settlers (World Bank 2017).

A coup occurred in 1999, and Ivorian troops from the north (known as the Nouvelles de Côte d'Ivoire, led by Guillaume Soro) mutinied gaining full control of the Northern region (Genocide Watch 2012; BTI 2020). The southern force was led by the National Army (FANCI), aligned with President Laurent Gbagbo. The civil war ended with the Ouagadougou Political Agreement in March 2007 signed by Gbagbo, who became president, with Soro as prime minister. From 2010 to 2011 there was a postelection crisis that led to another civil war and left 3,000 deaths, a million internally displaced persons and 200,000 refugees in neighboring countries (Vinck et al. 2016), as both Gbagbo and former Prime Minister Alassane Ouatarra claimed victory.

Since the civil war, there has been a Commission for Dialogue, Truth and Reconciliation and a National Social Cohesion Programme to help lessen previous ethnic, religious, and political tensions; however the situation is still fragile (Konadjé 2018). In terms of democracy, the country is categorized as 'partly free', as governance is affected by a lack of transparency, ongoing corruption, and a judiciary that is viewed as not wholly independent (Freedom House, 2020).

There remain several challenges for the government as political instability persists. For example, the Democratic Party of Côte d'Ivoire of former president Bédié and Gbagbo's Ivorian Popular Front boycotted the 2020 presidential election, while the re-election as president of Alassane Ouattara (heading the Rally of the Republicans party), for a third consecutive term in 2020, was accompanied by deadly clashes resulting in the deaths of 87 people (World Bank 2021a). A dozen opposition party members who had rejected the results were arrested (Human Rights Watch 2020).

2.3 NATIONAL SECURITY OVERVIEW

Although the civil war and the post-election crisis have ended there are still ethnic, and social tensions, as seen from violent clashes in 2019 between two ethnic communities who are aligned to different political parties (International Crisis Group 2020). This demonstrates the strong link between political parties and their communities of origin as ethnicity continues to be highly politicized (Konadjé 2018). Moreover, former President Gbagbo returned to Côte d'Ivoire in June 2021, having been recently acquitted on charges of crimes against humanity at the International Criminal Court. This could create tension as civil society activists call for justice for the victims of the 2010–2011 post-election crisis and demand his arrest (International Crisis Watch 2021). Meanwhile former prime minister and rebel leader Soro has been sentenced to life in prison in absentia for allegedly plotting a coup against former ally President Ouattara, charges that Soro decries as being politically motivated (Reuters 2021). This has created tensions between supporters of Soro and Ouattara (Piccolino 2018).

There have also been further mutinies despite the process of disarmament, demobilization, and reintegration of ex-combatants, such as the 2017 mutiny in the town of Bouaké, a former rebel stronghold, by 5,000 soldiers who demanded better living conditions and a bonus payment, leading to other groups of soldiers demanding the same (Konadjé 2018). Most of the mutinies were initiated by former rebels who had been absorbed, with some difficulty, into the army (BTI 2020). It also illustrates the power of the military, as in the end the government acceded to their demands by paying the bonuses (Konadjé 2018); this has further frustrated supporters of former president Gbagbo (Piccolino 2018).

The northern region of Côte d'Ivoire and remote villages are more unstable, due to jihadist groups entering from neighboring countries, especially from Burkina Faso; they have begun to penetrate northern rural areas, recruiting new members, and gaining additional territory (Charbonnier 2021). This is due to the instability in Burkina Faso, Mali, and Niger, where violent extremism has begun to spill over into neighboring countries. The two main jihadist groups are the al-Qaeda in the Islamic Maghreb (AQIM) and the Islamic State Group. In 2016, there was a terrorist attack in Grand-Bassam in the south of Côte d'Ivoire where 19 people were killed, which was claimed by AQIM (Charbonnier 2021). In June 2020, there was another attack against the Ivorian army in Kafolo in the northeast, where 14 soldiers were killed (France 24 2021).

Lastly, despite the end of the civil war, land issues persist because of growing pressure on rural land for agricultural production, compounded by population growth, and migration due to climate change in the Sahel, meaning that new conflicts may arise between indigenous populations and migrants (World Bank 2017).

To summarize, although Côte d'Ivoire has enjoyed high economic growth and has become more stable in the post-war years, there are still several challenges that affect the socioeconomic, political, and national security of the country, including remnants of the civil war. These may, as a consequence, increase climate-fragility risks.

3. CLIMATE CONTEXT

This section will look at climate change projections and impacts, to help elucidate the specific and key climate-fragility risks in Côte d'Ivoire.

3.1 CURRENT CLIMATE

Côte d'Ivoire comprises a southern region covered by forests with a humid equatorial climate and a northern region that is mostly savannah with a dry tropical climate. There is generally high rainfall in the south, supporting the production of cocoa, cashews, and coffee (World Bank 2021). The average annual temperature in Côte d'Ivoire ranges from 24°C to 28°C, while annual precipitation ranges from 1,000 to 1,600 mm (Tomalka et al. 2020). In the south, in Abidjan, the mean annual rainfall is 1,800 mm, but in the southeast in Bondoukou, rainfall levels are much lower at 1,050 mm (FAO; ICRISAT; CIA 2018). The country generally has a rainy season from June to October, although this differs slightly between the northern and southern regions (World Bank 2021b).

Changing climate conditions in the country are not new. From 1979 to 2015 all regions of Côte d'Ivoire experienced a decrease in the frequency of rainfall, as well as a rise in the frequency of extreme rainfall events (African Development Bank 2018). The decline in rainfall, however, appears to have differed by region. Between 1940 and 2010, the largest decrease in rainfall was in Abidjan (28.9 percent), followed by Soubré (23.5 percent), while in Korhogo there has been a 7.7 percent decrease (FAO; ICRISAT; CIA 2018). The main natural hazards between 1900 and 2018 that Côte d'Ivoire has experienced in an average year were 14 epidemics, 11 floods, a drought and a landslide (World Bank 2021b).

These changes in climatic conditions are not, of course, unique to Côte d'Ivoire. According to the IPCC 6 (2021) report, across West Africa there has been an observed increase in river flooding, drying, and agricultural and ecological droughts.[8] Moreover, droughts have already affected West Africa, leading to migration from northern to southern regions, leading to increased tensions in agricultural lands (Cabot, 2016).

3.2 PROJECTIONS

Under the RCP[9]2.6 low emissions scenario, compared to pre-industrial levels, the nationwide prediction for 2050 is a temperature rise of approximately 2°C, while under a mid-scenario RCP 6.0 the temperature will increase by 2.2°C (Tomalka et al. 2020). Under a high emissions, business-as-usual scenario, RCP 8.5, the mean annual temperature will rise by 1.69°C (1.07°C to 2.66°C) in the 2040–2059 period, while annual precipitation will decrease by 6.15 mm (-317.02 mm to 327.17 mm) (World Bank 2021b).

Projected increases in temperature and precipitation vary by region. In general, the north will experience a greater increase in temperature than in the south (MINSEDD 2017). In the Komoe River Headwaters region, as well as the Central region, the average temperature is projected to increase by 1.5°C to 3°C by 2050, while the southern region is projected to increase by 1°C to 2.5°C by 2050 (African Development Bank 2018). Projections show that for the Komoe River Headwaters Region extreme rainfall may stay the same or may increase in the future, while for the southern and central regions the frequency of rainfall is projected to remain normal or may decrease, but 'the frequency of extreme rain events may remain constant or increase into the future' (African Development Bank 2018).

3.3 KEY CLIMATE IMPACTS

Climate change has been linked to floods, storms, landslides, droughts, heatwaves, bushfires, reduced river flows and surface water, shorter than average crop growing periods, increased exposure to water stress, reduced ecosystems and arable land due to degradation, and coastal erosion of up to three meters per year, which can rise to between 6 and 12 meters during storms (MINSEDD 2017). The World Bank estimates that the impacts of climate change between 2040 and 2100 could cost the country between CFAF 380 and 770 billion (US$ 0.6–1.38 billion) (Global Support 2020).

As the environment and climate varies across the country, the impact of climate change also differs according to the region of the country. The southern part of Côte d'Ivoire is prone to floods, as this region receives the highest rainfall and it especially affects Abidjan, which has poor sanitation infrastructure, exacerbating the problem (World Bank 2021b). The northern savannah region however is exposed to droughts, which are expected to worsen in the near future in terms of frequency and intensity (Tomalka et al. 2020; World Bank 2021b). Climate change through extreme weather events will have an

[8] An ecological drought is ¨an episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability, impacts ecosystem services, and triggers feedbacks in natural and/or human systems¨ (Crausbay, Ramirez et al. 2017).

[9] A Representative Concentration Pathway (RCP) is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC.

impact on people's livelihoods and on human settlements, particularly in densely populated urban areas. Those living in informal settlements will be more vulnerable because houses are often of poorer quality and in exposed areas such as near riverbanks and coastal zones (Tomalka et al. 2020).

MINSEDD's Third National Communication to the UNFCCC identified climate change impacting 11 sectors, six of which have been listed as 'very high vulnerability', namely agriculture/livestock, aquaculture, forestry, water resources, energy, and coastal areas. The other five are of medium or slight vulnerability and consist of fisheries, infrastructure (housing), transport (roads), public health, and gender (MINSEDD, 2017).

It is important to also highlight the multifaceted vulnerability of women to the effects of climate change. For example, only eight percent of women hold a land title or certificate of sale, compared to 22 percent of men. This limits their ability to protect their crops or adapt to environmental changes (MINEDD 2018). Another reason is that the poorest in the country are mostly women, who on average earn US$ 125 per month, while men earn US$ 240 (MINEDD 2018). Poorer households and those living in precarious areas will be more affected by disasters. A further reason is that climate change has been predicted to increase the transmission of water-borne and vector-borne diseases such as malaria, which particularly affect women, as there is inequality in the time dedicated to domestic work, which includes water supply and household hygiene, meaning that women are more exposed to these diseases (MINEDD 2018).

4. CLIMATE-FRAGILITY RISKS

This section will look into some of the climate–conflict risks that could affect the country, in particular how climate change could act as a threat multiplier. The following three climate-fragility risks in Côte d'Ivoire were identified from the literature: 1) large-scale environmental migration contributing to community tensions; 2) the undermining of economic, health, and food security, which could contribute to instability, as the government finds it more difficult to provide basic services; and 3) an increase in conflicts between herders and farmers. It is important to regard these as risks to be averted, rather than inexorable scenarios to confront.

4.1 LARGE-SCALE ENVIRONMENTAL MIGRATION CONTRIBUTING TO COMMUNITY TENSIONS

The first climate-fragility risks identified involve environmental migration as a factor that could lead to community tensions. Conflict over land was a key conflict driver behind the civil war. The issue has only partially abated and therefore remains a serious climate conflict risk, because climate change will play a role in migration through more extreme weather events such as intense and frequent droughts, bushfires, as well as desertification and land degradation.

The country is also projected to experience more flooding, which will force numerous families to migrate and economic activities to relocate (World Bank 2018a). By 2050, 85 million people in West Africa are predicted to be living in coastal cities, while approximately 6,500 square kilometers of the coastal areas could be severely degraded by rising sea levels (Foreign Policy 2021), which could also lead to forced migration. Already the former colonial town of Grand-Lahou is submerged, while Grand-Bassam is under considerable threat (World Bank 2018b).

Climate change has already played a part in migration. For example, cocoa used to be produced in the eastern part of the country (Abengourou, Niablé, Agnibilékro), but due to the reduction of forests, nonoptimal climatic conditions, as well as degradation of the land, cocoa production moved to the eastern central part of the country (MINEDD 2020). The cocoa plantations, however, were forced to move again, further to the southwest, as a result of severe weather conditions in the 1980s causing multiple bushfires, loss of crops and weaker agricultural production (MINEDD 2020). Climate change is predicted to increase temperatures which will affect the productivity of cocoa. This would force cocoa farmers to either adapt their farms or to migrate once again, leading to a potential exodus of farmers causing further land conflicts in new regions (MINEDD 2018).

In addition to population growth, the country faces high levels of internal migration from the center and north of the country to the southern forest areas, as well as from rural to urban areas, and immigration from other predominantly francophone West African countries drawn by the greater economic opportunities in Côte d'Ivoire (MINEDD 2020). As droughts become more frequent, there is increased migration from these drought-stricken rural areas to urban areas, weakening food security (MINEDD 2020). Due to dwindling natural resources, this can lead to land conflicts, a phenomenon that has already been occurring between indigenous populations and internal migrants, as well as international immigrants, and has become increasingly violent (MINEDD 2020). Thus, while climate change is not a singular cause of violence and conflict, climate change may contribute to these trends.

4.2 UNDERMINED ECONOMIC, HEALTH, AND FOOD SECURITY CONTRIBUTING TO INSTABILITY

According to the IPCC (2014) report there is a moderate likelihood that climate change may contribute to economic, health, and food insecurity, which are known causes of conflict. For example, increases in food insecurity can become a grievance that leads to conflict (Hendrix and Brinkman 2013). There is therefore a possible indirect link between these climate change impacts and the risk of conflict as government services are undermined, and jihadist groups take advantage of these vulnerabilities and recruit disadvantaged communities.

Firstly, climate change could hinder the progress that has been made in reducing poverty rates and push an additional one million people in Côte d'Ivoire into extreme poverty by 2030 (World Bank 2018b). This is primarily due to the coastal erosion that affects two-thirds of the country's coastal areas and threatens nearly 80 percent of the country's economic activities, as well as the negative effects on the cocoa sector, which provides an income to more than five million people and is endangered by rising temperatures (World Bank Group 2018). In Côte d'Ivoire, almost 40 percent of annual animal protein intake comes from fish (FAO 2021). Fishing, however, is threatened by rising sea temperatures, causing fish to migrate away from the region, as well as a reduction in the size and number of fish. It is predicted that by 2050 the maximum catch potential could be reduced by 30 percent or more in the Gulf of Guinea (World Bank 2019). This places more pressure on the availability of food and could increase the risk of malnutrition, while affecting people's livelihoods, because 16 percent of the coastal population in these countries depend on fishing (Igarapé Institute 2021). At the same time, fish in lakes and lagoons are also affected due to changes in freshwater flow, as well as the intrusion of increased levels of saltwater flowing into these areas (Rhodes et al. 2014).

Food insecurity is already a challenge for Côte d'Ivoire. Between October and December 2020, there were around 210,000 people (3.3 percent of the population) estimated to be in need of food assistance (FAO 2021). The growth of more than one in five children is stunted as a result of malnutrition (Global Nutrition Report 2020). This is particularly a problem in rural households where, according to a food security survey, 12.6 percent of rural households are food insecure. Food security could be put at further risk due to rising temperatures, less rainfall, and more frequent floods. Agriculture is vulnerable to climate variation as most food cultivation is rain-fed with only 0.2 percent of agriculture equipped for irrigation (Tomalka et al. 2020). The risk of food insecurity is particularly acute for women, mostly engaged in subsistence farming (MINEDD 2018, 21), as well as for settlements in northern parts of the country where malnutrition is already prevalent and where temperatures are projected to increase the most (FAO; ICRISAT; CIA 2018).

In terms of health security, Côte d'Ivoire already faces various diseases, such as malaria, with an estimated 7.7 million cases in 2019 (Severe Malaria Observatory, n.d.), while infectious diseases in general are the leading cause of morbidity and mortality (World Bank 2021b). Poor neighborhoods are particularly vulnerable to water-borne and vector-borne diseases (MINSEDD 2017). At the same time, the health care system, although it has been improving in recent years, has failed to provide universal health care. Owing to a lack of medical staff, long waiting times and poor quality provision, almost 80 percent of Ivorians, particularly in rural areas, rely instead on traditional medicine (Oxford Business Group 2020). These health challenges are predicted to be exacerbated by climate change as flooding and coastal erosion can contribute to the spread of diarrheal and vector-borne diseases (MINSEDD 2017). This causal connection between climate change and disease has already been felt during the flooding in Gagnoa in Korhogo in 2007 (MINSEDD 2017). Malaria is already highly prevalent, and due to rising temperatures it could expand into other regions of the country where cases have not been as high (World Bank 2021b). Rising temperatures could also increase the incidence of meningitis, especially in the north (Tomalka et al. 2020). This risk is further compounded by poor sanitation and inadequate water facilities (World Bank 2021b).

These types of vulnerabilities have been known to be exploited by jihadist groups; in West Africa, jihadist groups target local populations in underdeveloped rural areas (International Crisis Group 2019). In Côte d'Ivoire, the northern and northwestern regions already experienced higher poverty rates, currently 60 percent greater than in the coastal regions and southwestern region (International Crisis Group, 2019), and climate change could exacerbate this further, making these areas more vulnerable to jihadist groups seeking to exploit these local populations. Currently, homegrown links to al-Qaeda are not considered to be a high risk, and the 2016 Grand-Bassam attacks are thought to have come from foreigners living outside the country as opposed to local groups. However, in 2019 jihadist camps were found to be active in Comoé National Park in the north of the country (Counter-Extremism Project 2021). The Economic Community of West African States (ECOWAS), of which Côte d'Ivoire is a member, has been trying to tackle this threat by pressuring for a joint military operation, however the organization lacks the financial tools needed (International Crisis Group 2019).

Health, food, and economic security may therefore be further undermined, affecting the stability of the country, as a result of indirect climate change impacts, straining the ability of the government to provide services while also indirectly contributing to jihadist recruitment in vulnerable rural communities.

4.3 INCREASED CONFLICTS BETWEEN HERDERS AND FARMERS

The third climate-fragility risk is linked to more frequent conflicts between herders and farmers as natural resources are depleted. In West Africa there has been a southward migration of herders from the Sahelian area such as from Mali and Burkina Faso toward coastal countries such as Ghana and Côte d'Ivoire as a result of climate change impacts, specifically recurrent droughts that were particularly frequent from the 1960s to the 1980s (Cabot 2016). Although farmer–herder conflicts are not new, climate change is likely to lead to longer and more frequent and intense droughts each year, elevating competition between herders and farmers for access to water resources and pastureland. This could exacerbate and contribute to more frequent conflicts (Cabot 2016). This tension is further aggravated as farmers have been expanding their area under cultivation, which has led to more pressure on natural resources (Cabot 2016). The northern region is particularly vulnerable to conflicts due to already low rainfall and rivers drying up in the dry season (MINSEDD 2017). For example, in 2016 a conflict between herders and farmers in Bouna, in the northeast, led to at least 27 people being killed and thousands displaced (Nnoko-Mewanu 2018). The problem is compounded by the fact that although most of the population has access to potable water, this is concentrated in urban areas to which only 69 percent of the rural population has access (FAO; ICRISAT; CIA 2018). Conflicts between herders and farmers over water points or due to the loss of crops in the dry season have been increasing and are expected to be exacerbated by climate change (MINSEDD 2020). Thus, while climate change is not the primary cause of conflicts, the lack of rainfall translates into less access to natural resources and water, which can cause more friction (MINEDD, 2020).

5. POLICY AND INSTITUTIONAL CONTEXT

This section will now examine what type of policies and institutions exist that are focused on addressing the impacts of climate change, with the objective of understanding what measures should be implemented to better ensure climate-fragility risks are mitigated.

5.1 INSTITUTIONAL BODIES AND LAWS

The main institution responsible for climate change and the environment is the Ministry of Environment, Urban Sanitation and Sustainable Development (MINEDD). The Ministry includes a General Directorate for the Environment, which has several environment and climate change bodies including the Directorate of the Fight against Climate Change (DLCC), Directorate for Ecology and the Protection of Nature, and the Directorate of Environmental Quality and the Prevention of Risks. There is also the National Agency of the Environment (ANDE), which is also under MINEDD, and is responsible for the execution of the projects and environmental programs. The Directorate for Climate Change monitors policies that contribute to climate change mitigation and adaptation (Global Support 2020). Another important institution is the Ministry of Water and Forests, which is responsible for the implementation and the monitoring of the government's policy on water and forest protection (Ministry of Water and Forests, n.d.). The Ministry includes a Forestry Development Agency (SODEFOR) that is entrusted with rehabilitation of the forests of the State and their management and exploitation in a sustainable manner (SODEFOR 2021).

Côte d'Ivoire has an Environment Code (1996), which is supposed to ensure that all development projects are informed by environmental assessments. This Code is currently being revised to keep it in line with its international obligations such as the Paris Agreement, as well as to update it in light of the effects of climate change (Feukeng 2019). There is also the Water Code (1998) that affirms that the state is in charge of water management, including the provision of drinking water.

In terms of regional organizations, Côte d'Ivoire is part of the Economic Community of West African States (ECOWAS) that promotes economic cooperation and human security and includes an ECOWAS Warning and Response Network (ECOWARN), a monitoring mechanism for 'conflict prevention, management, resolution, peace-keeping and security' (ECOWAS, 2021a). ECOWAS also has a Water Resources Coordination Centre (WRCC) that implements the West African Water Resources Policy to manage water resources in the region; this could help alleviate regional tensions over these resources. ECOWAS also includes a Directorate of Political Affairs and Peace and Security (PAPS), and a Regional Agricultural Investment Programme (RAIP) (ECOWAS, 2021b). Lastly, there is a regional peacebuilding nongovernmental organization, WANEP, established in 1998, that focuses on conflict prevention and peacebuilding and works with ECOWARN to improve human security (WANEP, n.d.).

5.2 NATIONAL PLANS, PROGRAMMES, AND STRATEGIES

Côte d'Ivoire has been actively involved in implementing numerous plans, programs, and strategies to combat climate change, as well as for sustainable development. While this has helped the country better prepare for climate change, there are some limitations. Most of these documents are sectoral policies and climate change is not factored into all national planning initiatives (Global Support 2020), while according to a local source not all of these documents are implemented due to problems such as a high turnover of staff and a lack of resources. Moreover, there is a lack of initiatives that connect climate change and conflict.

One of these sectoral programs is MINEDD's National Drought Plan 2021–2022 that is focused on establishing a drought monitoring and early warning system, assessing the vulnerability and risk of drought in the country, and implementing measures to limit the impacts of droughts (MINEDD 2020). There is also a National Strategy for Climate Smart Agriculture (NCCSA), National Strategy for Sustainable Conservation and Biological Diversity (SNDD), and the National Strategy for Disaster Risk Management (RRC). Côte d'Ivoire also produced its first National Agricultural Investment Plan (PNIA), which covered the period 2012–2016 and had a US$ 3.2 billion budget that was mostly focused on agricultural production as opposed to adaptation (Green Climate Fund 2019). The country is now implementing its second PNIA (2018–2025) that includes a strategy to 'increase resilience, develop agro-ecological approaches, improve production technology and promote women's access to land' (Green Climate Fund, 2019).

There have also been several initiatives to move beyond sectoral policies and into national planning. For example, the MINEDD National Climate Change Program (PNCC) was created in 2012 and is responsible for 'coordinating strategies to tackle climate change, as well as implementing the country's climate policies' (Global Support 2020). It also includes a gender focal point. In 2014, the PNCC established a National Strategy for Adaptation to Climate Change (SNACC) (2015–2020), while MINEDD is also currently building its first National Adaptation Plan, which began in 2017. It is supported by the UNDP and the Green Climate Fund, which has provided US$ 2.4 million to the Plan (UNDP 2019).

In terms of international commitments, Côte d'Ivoire submitted its first Nationally Determined Contribution in 2016, which is focused on mitigation and includes key adaptation targets, which are: 1) Building water security through initiatives such as Integrated Water Resources Management (GIRE); 2) Reducing agricultural vulnerability and building resilience such as through the Agricultural seed development plan (SNDCV); 3) Fighting against deforestation; and 4) Developing resilience by working against coastal erosion (UNFCCC 2016). Some progress has been made with this fourth key target through Law No. 2017–3, which is focused on sustainable development of the coastline and increasing the resilience of communities and ecosystems. This, however, will require long-term investment including establishing a warning system for the coastline (World Bank 2018b). Côte d'Ivoire is currently preparing its second NDC.

Côte d'Ivoire has submitted three National Communications to the UNFCCC with a fourth one expected to begin this year. The country also completed its first Biennial Update Report in 2018. Côte d'Ivoire is supported by the UN's Peacebuilding Fund (PBF), which has been providing financial support to sustain peace in Côte d'Ivoire since the end of the political election crisis (2012) and has so far allocated US$ 42 million to the country. The PBF has been targeting sensitive areas, in particular, in the west and center of the country, which has experienced high displacement, followed by the return of populations, which aggravated tensions in the communities (United Nations 2018).

It is thus evident that Côte d'Ivoire already has several policies and institutional bodies that try to address climate change impacts and receives support from the international community. There are, however, several measures that could strengthen the country's capacity to address specifically climate–conflicts risks, in particular those identified in section 4, which will now be examined.

6. ENTRY POINTS TO ADDRESS CLIMATE-FRAGILITY RISKS

Côte d'Ivoire faces several challenges, such as high levels of poverty, political and socioeconomic instability, as well as threats from jihadist groups. Climate change is thus not the only challenge the country faces, however climate change may act as a threat multiplier and some of these impacts are already being felt. It is thus important to address these risks by strengthening the country's resilience to climate change. The following measures are some potential pathways.

6.1 IMPROVE WATER AND LAND MANAGEMENT

As has already been identified by the World Bank and in Côte d'Ivoire's Third Communications UNFCCC, water management is key to adapting to the impacts of climate change. Water management is required to adapt to more intense and frequent droughts, as well as flooding events in coastal and urban areas prone to flooding (such as Abidjan). It is important however, not only to protect infrastructure and settlements, but also to protect water resources that can be contaminated by saltwater. Additionally, as more droughts are likely in the future, improved management of water resources would help alleviate food insecurity, and water-borne diseases, while also building resilience to climate-related risks. Improving water management is also important to avoid water-related conflicts, as well as help mitigate forced migration, and thereby decrease possible intercommunal tensions. As highlighted by the Côte d'Ivoire government, this could include initiatives such as building a drought monitoring and early warning system (MINEDD 2020), and improving land and housing development to help mitigate this challenge (World Bank 2021b).

6.2 DEEPEN REGIONAL COOPERATION ON CLIMATE-RELATED RISKS

Strengthening regional cooperation through regional organizations such as ECOWAS to adapt to the effects of climate change could help Côte d'Ivoire and its neighbors, as West Africa shares many of the same climate related risks. For example, West Africa is considered to be particularly vulnerable to climate change likely to negatively impact the agricultural sector, affecting food security (United Nations 2019), as well as coastal erosion. Moreover, under a 2°C rise in temperature, the change in GDP for West Africa ranges from a yearly -9.79 percent to 1.35 percent (UNFCCC 2020). A regional approach would also be beneficial to work out joint solutions for incoming climate migration to ensure regional stability and to safeguard the human rights of migrants.

6.3 IMPLEMENT SUSTAINABLE AGRICULTURAL PRACTICES

Agriculture is not only important to sustain livelihoods, but it is also essential for food security. The sector however is particularly vulnerable to climate change due to the lack of adaptive capacity to deal with climate variability, and extreme weather events such as droughts, rising temperatures, and more frequent floods (Tomalka et al. 2020). One of the reasons for this low adaptive capability is that poorer farmers, women, and youth have less access to resources such as information on irrigation, seeds, markets, and equipment (MINSEDD 2017). With the support of the international community, regional organizations such as the African Union or ECOWAS, and the Ministry of Agriculture and Rural Development, giving these vulnerable groups access to these resources could help alleviate climate change risks such as food and economic insecurity, which can be drivers of conflict. Future development projects also need to ensure that investments in crops are climate resilient. This includes measures such as planting crops that require less water in drought-prone areas and expanding irrigation, where climate appropriate, to reduce rain-fed practices that are particularly vulnerable to climate change variability; this could in turn reduce forced migration.

6.4 IMPROVE DATA AND MONITORING TOOLS

A way to improve responses to climate change is to strengthen data and monitoring tools, which can help the country better prepare for extreme weather events. The country already has three main early warning institutions: 1) A National Inter-Ministerial Disaster Risk Management Platform established in 2012, which leads emergency responses; 2) SODEXAM that provides 24- and 48-hour weather forecasts; and 3) The Directorate of Hydrology, created in 2018, responsible for the management of hydrological data. Although these national tools provide much needed early warning systems to prepare for extreme weather events, there are various limitations, as identified in the Volta Flood and Drought Management (2021) report. One of the main limitations is that the early warning systems in place are mostly only focused on Abidjan, meaning that the rest of the country lacks the tools to deal with extreme weather events (Volta Flood and Drought Management 2021). A second limitation is that there is no standardized central repository of information on disaster risks and impacts, leaving it difficult to make informed decisions on climate change impacts (Volta Flood and Drought Management 2021). Third, there is only sparse information at the national level that could support impact-based early warning assessments, illustrating where the vulnerabilities are, such as effects on social groups, infrastructure, and economic sectors (Volta Flood and Drought Management 2021). Further investments in these institutions, to remedy these shortfalls, would help improve the early warning system in the country.

6.5 ASSIGN A FOCAL POINT ON CLIMATE CHANGE ADAPTATION

While there are various sectoral policies on climate change, there is a lack of coordination between national and subnational levels, while not all local and national plans take climate change into account (Global Support 2020). There are also low levels of public engagement on climate change issues from local civil society and business actors, making it more difficult to implement climate change policies (World Bank 2018b). Developing a focal point on climate change adaptation could help ensure that all future policies consider climate change impacts and interconnect climate change adaptation policies, as well as identifying climate conflict risks. A focal point could also serve as a platform for local and international actors to engage with the government in preparing for the effects of climate change such as climate-fragility risks.

7. CONCLUSION

This paper provides insights into the types of climate-fragility risks Côte d'Ivoire faces, as well as potential avenues that the country can take in addressing these risks. Although Côte d'Ivoire has experienced economic growth and improved its position since the civil wars, in areas such as poverty, access to food and water, and other livelihood conditions, it still faces certain challenges, some of which may be exacerbated by climate change, and could become an indirect driver of conflict. The first of these climate-fragility risks identified in this paper is large-scale environmental migration contributing to community tensions. As climate change is projected to increase extreme weather patterns such as flooding, droughts, as well as sea-level rising leading to coastal erosion, and higher temperatures, many inhabitants will be forced to migrate, which could potentially lead to more community tensions. This is of particular concern in a context where migration—alongside ethnic tensions—has already played a part in the past civil war, and some of these elements are still present today. The second climate-fragility risk is the undermining of economic, health, and food security, which could impact on stability in the country, as government services deteriorate; jihadist groups could profit from this and recruit disadvantaged communities. The third main climate-fragility risk is the possibility of increased conflicts between herders and farmers, as natural resources dwindle, leading to more conflict over these resources.

While the government has several policies and institutional actors involved in addressing climate change, the paper found five entry points that could help address climate-fragility risks and further develop the government's ability to address climate–conflict risks. The first of these is to improve water and land management to avoid stresses with regard to water resources such as between herders and farmers, as well as forced climate migration due to droughts, flooding, or coastal erosion. The second entry point is deepening regional cooperation on climate-related risks, in particular on issues such as environmental migration, to ensure regional security is upheld. The third policy approach is implementing sustainable agricultural practices, which would in turn help improve food and economic security, and reduce forced environmental migration, factors that have been identified as drivers of conflict. Fourth is improving overall data and monitoring tools which would help inhabitants be more prepared for extreme weather events. Fifth is the development of a focal point on climate change adaptation to act as a central point to ensure that all policies consider climate impacts, such as climate–conflict risks, and also to act as a platform through which various local and international actors can find ways to address these risks.

In terms of future research avenues, although this paper highlights some common climate–conflict risks in West Africa, research that examines other Western African countries and takes more of a regional approach to identify specifically regional climate-fragility risks could help these countries more effectively tackle these shared risks using regional tools such as ECOWAS. Furthermore, there is a paucity of literature on climate–conflict risks in Côte d'Ivoire, and while this paper addresses this gap to an extent, further research that engages in extensive fieldwork and develops more data in the country would help strengthen understanding on this subject. Finally, further tailored research is needed on countries that are particularly vulnerable to climate change; this would help mitigate damaging climate–conflict risks that may affect the country in the near future.

CASE STUDY 4 - CLIMATE IMPACT PATHWAYS AND FRAGILITY, CONFLICT, AND VIOLENCE RISKS IN NIGER

Bruno Charbonneau, Peter Läderach, Marc-André Boisvert, Tatiana Smirnova, Grazia Pacillo, Alessandro Craparo, Ignacio Madurga

1. INTRODUCTION

Studies on the connections between climate variability and conflict dynamics in the Sahel have steadily increased since the mid-2000s. This paper focuses on Niger and the regions of Tillaberi and Tahoua. These regions depend on rain-fed agriculture and livestock, making Nigerien pastoralists and smallholders particularly vulnerable to climate variability—especially droughts and floods. They also face considerable risks of fragility, conflict, and violence (FCV) with local, national, and regional roots in the transnational dynamics of the Malian conflict that began in 2012. As such, Niger's Tillaberi and Tahoua regions present a critical case study on the relationship between climate change and FCV in West Africa, connecting local grievances to transnational threats. This work describes the multifactorial processes and dynamics of regional destabilization and climate change in Niger, where various actors threaten local resilience and conflict management mechanisms.

We proceed from the general to the specific. First, we briefly examine the literature on the relationship between climate change and armed conflict, and then on that relationship in the context of the Sahel. This allows us to anchor a general discussion of climate–conflict debates in the historical context of the Sahel, thus highlighting the inherent politics of the academic and policy fields of "climate security". Second, we present an overview of the multiple impact pathways through which climate change and variability tend to act as a threat multiplier in Niger. We emphasize the effects of climate change and variability on local governance practices and mechanisms—on how Nigerien adaptation, mitigation, and resilience to climate change affect or transform Nigerien conflict management mechanisms, processes, and practices. These mechanisms, processes, and practices were built historically through consensus, collaboration, competition, and sometimes conflict, but the climate crisis imposes new stresses, aggravated by an accelerated timeline for their necessary transformation. In the third section, we analyze the current and deteriorating security situation. The regional context of the increasing destabilizing effects of transnational armed group activities and significant international military forces (French, American, European, UN) engaging these armed groups has strained or ruined local conflict resolution mechanisms; this bodes ill for efforts to build a climate-resilient peace. The relationship between the climate crisis and conflict dynamics must now be considered—and tackled—in a context where modes of governance are routinely called into question, when not comprehensively upended by violent extremist groups or by the military interventions of international actors.

We conclude that—despite the role of climate change as a potentiator of FCV risks—historical legacies and political processes and practices have a crucial impact on how state and local communities face, respond to, or ignore the climate crisis. A climate change focus should thus not overshadow politico-historical analysis. The Niger example demonstrates that climate-induced tensions do not necessarily lead to armed conflict. It illustrates that the ways states, people, and communities react to climate variability largely depend on power structures and relationships. Niger also evinces the significant challenge that arises when transnational conflicts mesh with local dynamics, hampering efforts to address the climate crisis.

2. CLIMATE CHANGE AND SECURITY

Over past decade or so, climate change has been increasingly characterized as a security issue. The UN Security Council acknowledges that climate change can act as a "threat multiplier", aggravating certain stresses that are often at the heart of conflicts such as poverty, high unemployment, weak institutions, and inadequate access to information or resources (UN Secretary-General 2009). Yet there is no consensus on the nature of the climate change–security or the climate change–conflict relationship. Policy statements, think tanks reports, and academic debates depict different conceptions and understandings of the relationship, and thus often disagree on the formulation of appropriate policy responses (Busby 2021; McDonald 2013).

3. BRIEF LITERATURE REVIEW ON THE LINK BETWEEN CLIMATE AND CONFLICT

A prominent approach revolves around the threat that climate change poses to the security of the state. From a state-centric or national security perspective, this approach draws upon early 1990s research that emphasized climate, demography, resource scarcity, and environmental stresses as conducive to armed conflict (see Kaplan 1994; Homer-Dixon 1999; and for a critical engagement with its evolution see Dalby 2009 and 2020; Swain and Öjendal 2018). The approach was embraced by the United States (the Pentagon) and several American think tanks that pointed to the notion of a "threat multiplier". Others talk in terms of a "risk multiplier", "risk amplifier" or "conflict catalyst" (Ivleva et al. 2019; CNA Military Advisory Board 2014; Dion 2016). Overall, the "threat multiplier" approach focuses on how states could adapt to the effects of climate change (CNA 2007; Busby 2007). Several academics challenged this approach on the basis that it foregrounds military threats and responses, and thus carries the danger of securitization or militarization. Hence, it is often considered ill-suited to address the complex relationships and dynamics between climate and security (van Schaik et al. 2020; Brzoska 2009), while critics argue that it might even lead to powerful states waging endless wars in fragile states (Rogers 2021).

Experts have criticized the "threat multiplier" approach for its inaccuracies and its recourse to causal explanations (for an example, see the debate on Syria: Selby, Dahi, Fröhlich, and Hulme 2017). While the policy and think tanks worlds still sometimes draw on causal models that policy makers then use to justify decisions (Charbonneau and Smirnova 2021), there is greater awareness not only of the risks of climate change, but the shortcomings of a search for direct causal links. Climate change can exacerbate existing socioeconomic and political conditions, vulnerabilities, and risks that are generally linked to conflict and violence. Indirect causal pathways are another approach that points to the effects of climate change on agriculture, economic growth, migration flows, or state capacity (Koubi 2019; Barnett and Adger 2007; Mobjork, Krampe, and Taris 2020). Yet the identification of indirect causal pathways is only a first step that must be followed by in-depth conflict analysis, given that conflict can occur without links to climate change, and, equally significantly, climate change challenges and stresses do not necessarily lead to conflict (Burke, Hsiang, and Miguel 2015).

For instance, adverse climatic conditions and extreme weather events can reduce economic output and growth, and negatively impact agricultural production and productivity. This then has detrimental effects on socioeconomic and sociopolitical relations (Hidalgo et al. 2010; Burke, Hsiang, and Miguel 2015; Schlenker and Lobell 2010; Hsiang, Meng, and Cane 2011; Lobell, Schlenker, and Costa-Roberts 2011). Developing countries that are highly dependent on the agricultural or livestock sectors are thus more at risk (Burke, Hsiang, and Miguel 2015; Dell, Jones, and Olken 2014 & 2012). Other examples are climate-related disasters that have become the most relevant factor influencing migration, accounting for 61.5 percent of total displacements, compared to 38.5 percent induced by armed conflict (Institute for Economics & Peace 2019). Migration is thus chiefly an adaptation strategy by which people cope with changing climate conditions (Mobjork, Krampe, and Taris 2020; Reuveny 2007), but the community and policy response to such migration has been argued to factor into conflict dynamics (Barnett and Adger 2007; Reuveny 2007; Swain 1996).

The responses to—and the effects on human security of—climate change partly depend on state capacity and preparedness (Ubelejit 2014; Barnett and Adger 2007). Climate change and variability are likely to hinder the administrative capacity of the state to act, increasing the costs of the public provision of goods and services, and weakening the state's ability to analyze and manage risks and crises, and to respond to the needs of citizens and to resolve social conflicts. In those contexts, the provision of essential goods and services such as water, education or health care could be curtailed, further impacting human security (Barnett and Adger 2007; Adger et al. 2014; Ubelejit 2014). In several ways, this could induce a negative feedback loop whereby fragile states that cannot respond effectively to climate variability see their vulnerabilities worsen (Ndaruzaniye et al. 2010), and their capacities to resolve or prevent conflict deteriorate (Adger et al. 2014; Stewart and Fitzgerald 2001; Ndaruzaniye et al. 2010; Ivleva et al. 2019).

4. BRIEF REVIEW OF THE LITERATURE ON CLIMATE AND CONFLICT IN SAHELIAN COUNTRIES

Despite greater awareness of the relationship between climate change, security, and armed conflict, the academic field of "climate security" has yet to offer insights into what precisely to do about it, notably in the context of fragile states with low capacity and fragmented political systems (Busby 2021; McDonald 2021). In the case of Sahelian countries,[10] this lack of insights is evident both in policy terms (or often lack of policy) and in the reactions to the climate war/security narrative of many Sahelian specialists.

For several Sahelian country experts (in the social sciences), the climate change or climate security narrative overshadows other causes and crowds

[10] The Sahel is defined in different ways by different people, governments, and organizations. For our discussion, we limit it to the G5 Sahel organization comprising Burkina Faso, Chad, Mali, Mauritania, and Niger.

out political-historical analyses (Benjaminsen 2016). By contrast, the International Crisis Group published a briefing that argued that in Mali, Niger, and Burkina Faso, the theory "that global warming is leading to a reduction in available resources and, consequently, an increase in violence" does not seem to be supported by the evidence. The ICG accepts that climate change contributes to the transformation of the region's agro-pastoral systems, but "the direct relationship sometimes posited between global warming and dwindling resources, on one hand, and growing violence, on the other, does not help policy makers formulate appropriate responses" (ICG 2020).

Nevertheless, the Sahelian nexus between climate, desertification and conflict still resonates among policy makers, and continues to feed into the securitization of climate change and "threat multiplier" approaches (Benjaminsen and Svarstad 2021, 184–201; also Selby and Hoffman 2014). Climate-induced resource scarcity and biosphere degradation and overexploitation are commonly associated with conflict. However, as Nobel prize winner and economist Elinor Ostrom—who studied the interaction of people and ecosystems throughout her career—showed, the management of scarce resources can lead to cooperation between groups of people, even without government intervention (Ostrom 1990). Conflict is far from preordained.

The idea that "the Sahel is caught in a vicious cycle of land degradation and drought" dates back to the colonial period (Benjaminsen and Hiernaux 2019) and was consolidated during the droughts of the 1970s and 1980s, notably by international humanitarian NGOs (Mann 2015). It should not be surprising then that, when it comes to discussing climate change and policy in the Sahel, the climate–desertification–conflict narrative persists, despite the climate research that shows increasing rain patterns and the greening of the Sahel (Fensholt et al. 2017). Conversely, skepticism regarding that climate security narrative derives in part from the demonstrable resilience of the Sahelian vegetation to drought (Hiernaux et al. 2021), also partly from the securitization effect that too often identifies Peuls (Fulani) with terrorist groups (Kulesza 2021), and more generally from the casual oversimplifications that gloss over historical roots, political dynamics, power relationships, and the political economy of conflicts (ICG 2020).

As the following section shows, using the case of Niger, farmer–herder or intercommunal conflicts in the Sahel have not primarily been driven by increasing resource scarcity, identity politics, demographics, climate change, or indeed a combination of the foregoing. These variables do of course play a role, and climate change is already transforming the physical environment, the biosphere, and human structural conditions (for agriculture, water access, grazing rights, land tenure, and so forth). However, Sahelian specialists argue that ultimately, if and when a conflict turns violent, it is necessary to analyze its historical roots, the political economy of land tenure and governance, the power relations and structure that mediate relevant social, economic, and political friction, and the political ecology of local governance (Benjaminsen and Ba 2019; Bøås and Strazzari 2020).

5. NIGER – IMPACT PATHWAY ANALYSIS

Niger is highly vulnerable to climate disruptions with relative low levels of readiness (University of Notre Dame 2019). The climate in Niger is expected to become more erratic and projected to see rises in temperatures, increases in rainfall variability, intensity, and number of floods (BMZ 2017; USAID 2017). These climate stressors will critically impact Niger's political economy, which is dependent on climate-sensitive sectors such as agriculture, livestock and fisheries (USAID 2014b; FEWS-NET 2005).

Indeed, agriculture alone contributes to 39.2

percent of Niger's GDP and employs more than 80 percent of the workforce (BMZ 2017). Rainfall variability is impacting crop production which, in turn, is having a negative effect on food availability (FEWS-NET 2019). Increased temperatures and rainfall variability negatively impact water availability as well as forage (water points) and pasture production, reducing livestock productivity and calving rates (USAID 2017; FEWS-NET 2019). Some of Niger's main staple crops will be affected by climate disruptions as the large majority is rain-fed agriculture while less than one percent of the cropland is irrigated (BMZ 2017). The production of millet and sorghum will continue to be negatively affected by rainfall variability and rising temperatures (USAID 2017; 2018; FAO 2020; Ben Mohamed, Van Duivenbooden, and Abdoussallam 2002). This is of particular concern because millet and sorghum represent roughly 85 percent of Niger's total food production and provide 80–90 percent of the citizen's metabolic energy requirements (Ben Mohamed, Van Duivenbooden, and Abdoussallam 2002). Likewise, the yields of certain cash crops like groundnut and cowpea are likely to decrease in the coming years (Van Duivenbooden, Abdoussalam, and Ben Mohamed 2002).

Climate change and variability will continue impacting farmers and pastoralist communities in northwestern Niger where they already live with other vulnerabilities such as food insecurity, poverty, and high levels of violence. Agadez, Tillaberi and Tahoua are among the regions most affected by food insecurity and malnutrition, with the northern pastoralist zones of Tillaberi and Tahoua and the western part of Agadez being the most affected by deficits in quality and quantity of food consumption (FAO 2019). Poverty rates in Tillaberi and Tahoua are 43.2 percent and 38.5 percent respectively (Razafimandimby, Nguyen, and Nshimiyimana 2020).

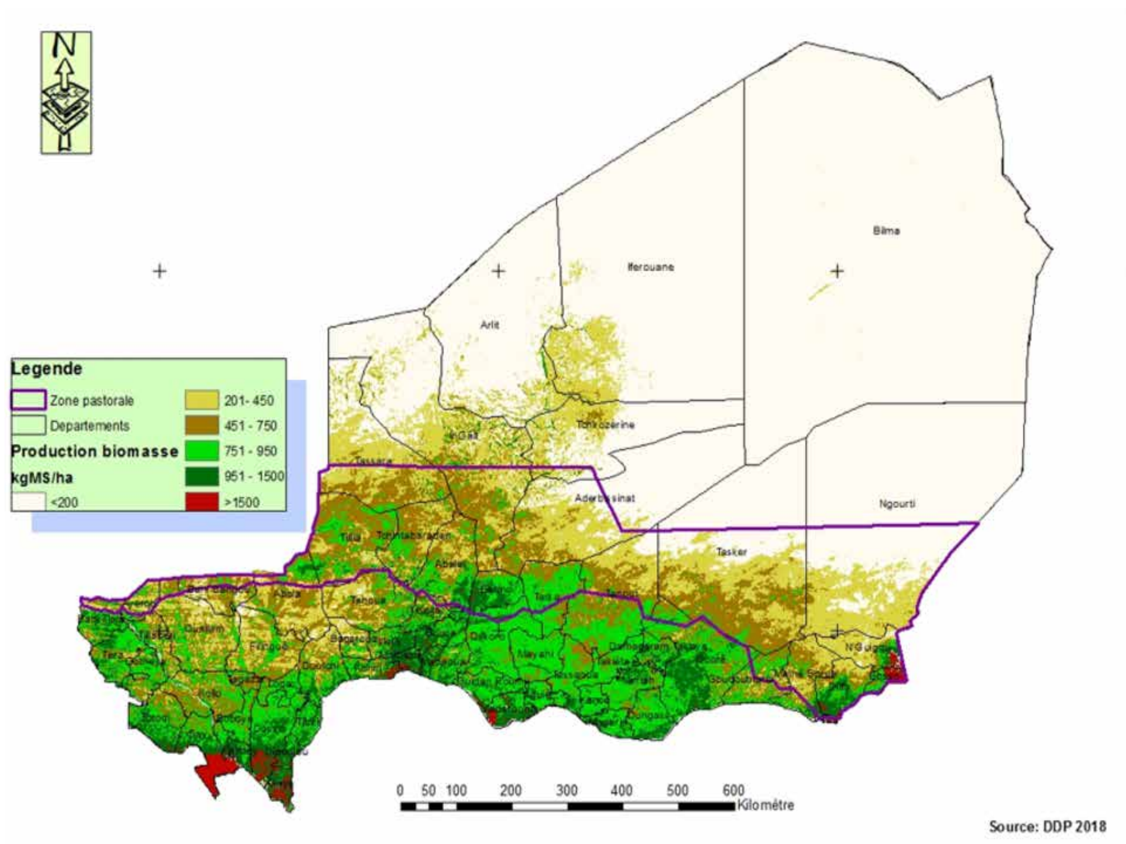
6. IMPACT PATHWAYS

The analysis of the consequences of climate disruptions on agriculture, livestock, and fisheries must be combined with an analysis of Niger's political economy and its history punctuated by military coups (1974, 1996, 1999, 2010) and armed rebellions (Tuareg 1990–1995 and 2007–2009; Toubou in the mid-1990s, 2006, and 2016). The colonial history of Niger and postcolonial struggles for power—at local, national, regional, and international levels—explain the durability of structures of social and regional inequalities. These struggles have left bordering areas (such as Diffa, Tillaberi, Tahoua, and Agadez regions) relatively marginalized, with limited access to basic state services, but deeply integrated within regional political economies of borderlands and peripheries with Mali, Burkina Faso, Libya, and Algeria (and countries of the Lake Chad region for Diffa). Marginalization from central state authority (Niamey) also meant the reinforcement of processes and structures of localized and transnational systems of governance and conflict resolution mechanisms (Mohamadou 2018; Olivier de Sardan, J.-P., Tidjani Alou 2009).

One of the most important and politically sensitive issues for communities living in these areas is access to land and water points. These are critical resources both for farmers and herders. Pastoralist communities have historically coped with climate variability by migrating southwards during the dry season in search of better pasture, while staying or moving back north during the rainy season. Transhumance is a means of livelihood, but also an important form and source of identity, a set of practices that reinforce social ties between different pastoralist communities such as Peul (Fulani), Tuareg, Arabs, Toubou, but also between pastoralists and farmers. The access to land and water points has been regulated by public policies and traditional customary law. The latter is important in cases of disagreement and inter- or intra-community conflicts. However, government policies have tended to favor the development of agriculture, thus often undermining pastoralists' access to land, and partly impeding their mobility as an essential tool of adaptation (De Sardin, O., Mohamadou 2019; Mohamadou 2004; McKune & Silva 2013; Thébaud & Batterbury 2001).

Law Nº 61-5 of 1961 established a demarcation for pastoralist activities (the so-called "pastoral zone"), forbidding agriculture in that area (Figure 2.4.1). However, increasing land pressure in the south and the rise in rainfall in the 1960s and 1990s pushed farmers northwards, leading to an expansion of agriculture (USAID 2014b), and thus creating contested de facto "grey" areas. The expansion of agriculture often occurred at the expense of livestock corridors and pastureland delineated in Law Nº 61-5, leading to tensions (USAID 2014a; 2014b; UNOWAS 2018). A Rural Code was developed in 1993 to institutionalize a legal framework that would manage natural resources and mitigate the effects of climate variability. However, its implementation was highly deficient, and led to herder communities (especially Tuareg and Peul) believing that Niamey could not or did not want to protect their livelihoods (USAID 2014a; 2014b). These issues combined with frustrations over political representation and economic policy, notably revenue sharing from uranium production, and

FIGURE 2.4.1 Biomass distribution map and pastoralist zone (Niger, 2018)



Source: Niger Ministry of Agriculture and Livestock (2018)

Note: kg de matière sèche par hectare = kilograms of dry matter per hectare (kgDM/ha); purple line on map demarcates areas with pastoralist activities.

the effects of the pollution on local communities (Benjaminsen 2008; Gregoire 2011; Maloca 2016; Mongay Font and Alonso Meneses 2002).

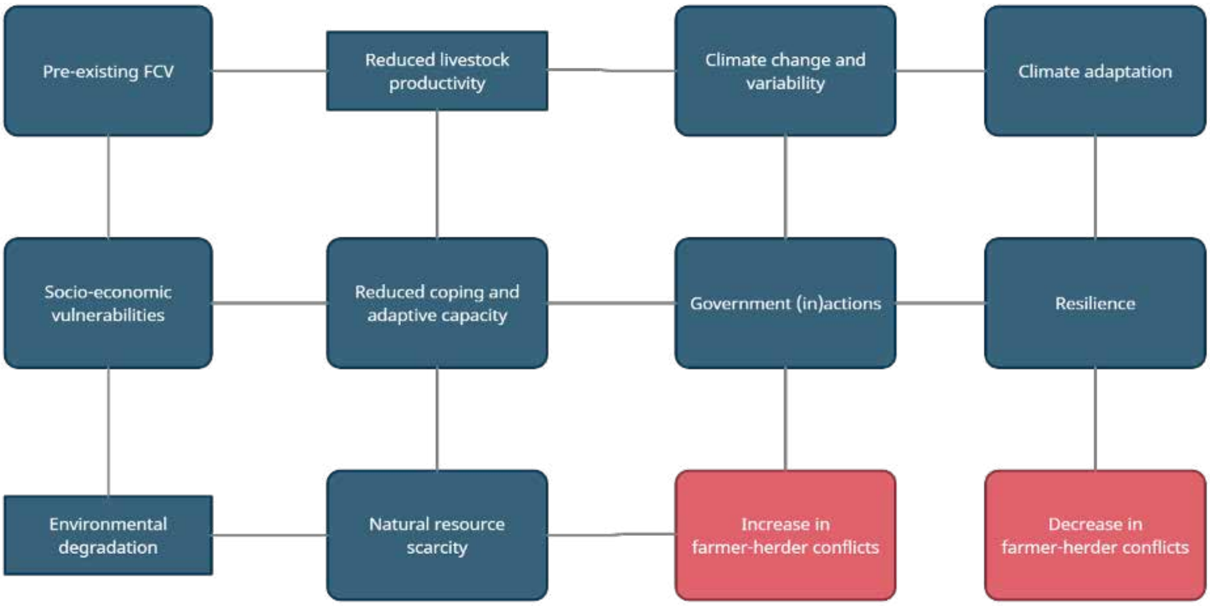
The political stage was thus set decades before the Tuareg uprising of the 1990s. Though the historical context explains much about the roots of the 1990s rebellion, the immediate causes were the unequal distribution of social, economic, and political resources derived from the uranium extractive industry. It was also a moment of important political transformation for Niger. Following the military suppression of the student demonstration of 9 February 1990, political authorities announced the beginning of a multiparty system (December 1990) and the organization of the National Conference (July–November 1991). The 1995 Peace agreement promised financial and technical support for the Northern regions as an integral part of the decentralization process. However, its implementation met with serious difficulties and exacerbated feelings of abandonment. Another rebellion broke out in 2007; it was settled two years later.

The rebellions in the Agadez region, the uprisings of Toubou pastoralists in the areas of Manga and Kawar, and the relative instability of the Tillaberi region in the mid-1990s led to the formation of self-defense groups by Peul who also felt politically and economically marginalized. Years of consultations were needed prior to adoption of Ordinance No. 2010-029 of 20 May 2010 on pastoralism. One of its major contributions was the recognition of pastoral mobility by Article 3, stipulating that "mobility is a fundamental right of pastoralists, nomadic pastoralists and transhumant herders" and that "this right is recognized and guaranteed by the State and the local authorities". However, the Ordinance is still poorly implemented. As of 2017, only 14 decrees had been passed (IOM, 2017). Furthermore, definitions of "point d'attache" or "the right to land" remain unclear in practice. Judgments on the "right to land" or access to water points are at times handed down on a "case by case" basis by local chiefs whose legitimacy may be in dispute. Local chiefs are perceived as instruments of the central government, of a political party, or armed groups. Questions over the legitimacy of national and local authorities are particularly problematic in the Tillaberi and Tahoua regions (ICG 2020).

Since 2010, both the security and the climate situations have continued to deteriorate. Adverse climate conditions affected fodder production in 2019, leading to a 11.3 million ton fodder deficit that especially impacted the center-west of Tillaberi and Tahoua (FAO 2020). The scarcity of pasture increasingly forces certain herders to sell some of their livestock during the dry season at a lower price in order to buy fodder to feed their remaining animals—which temporarily solves the problem but depletes pastoralist income in the long-term. Considering the existing imbalance between supply and demand of animal feed, rising prices negatively impact herders' income (Bøås, Cissé, and Mahamane 2020; UNOWAS 2018). It should be underlined that the annual trend in the Sahel and West Africa region is for agricultural land to expand by three to six percent, usually affecting grazing areas and progressively reducing the transit corridors ("couloirs de passage") (Kamuanga et al. 2008). Reducing pasture areas can force pastoralists to move southwards into agricultural zones earlier—before harvest—damaging crops, and aggravating farmer–herder tensions (UNOWAS 2018).

In this context, there are several pathways that can exacerbate existing socioeconomic risks and vulnerabilities, and by extension FCV risks in Niger, but also several points of intervention for adaptation strategies (see Figure 2.4.2). Hence, there is an enormous need for developing adaptation strategies that reduce people's climate vulnerability, because it affects livelihoods (Heinrigs 2010). However, as we elaborate in the next section, the capacity to adapt to the effects of climate change and variability has been undermined by the levels of violence and insecurity that erode the coping capacity of states, communities, and individuals (Adger et al. 2014; Stewart and Fitzgerald 2001; Ndaruzaniye et al. 2010). The ongoing transnational violence in the Western regions of Tillaberi and Tahoua, and the state's reliance on counterterrorist tactics are undermining the efforts of local communities to implement survival strategies and conflict resolution (DNPGCA 2020; FAO 2020). Among other things, the influx of refugees from Mali—around 60,000—as well as a subsequent increase of internally displaced persons (IDPs) in Tillaberi and Tahoua regions, up to almost 140,000—further overburden social systems (UNHCR 2021b).

FIGURE 2.4.2 Conflict Impact Pathways



7. NIGER – CONFLICT ANALYSIS OF TILLABERI AND TAHOUAYS

This section is dedicated to understanding how conflict dynamics impacted modes of governance in the regions of Tillaberi and Tahoua; two neighboring yet separate administrative regions that share a social, political, and economic context, and that face similar patterns of conflict. Risks and vulnerabilities in these regions, despite local roots, are tied to transnational dynamics that are more complex than an opposition between local and global. In this context, prior to deeper examination of the two regions, it is important to understand transnational and transregional dynamics that influenced the conflict (see table below).

TABLE 2.4.1 Sources of Conflict in the Tahoua and Tillaberi regions

Local level	
Access to resources	Access to water points and grazing lands entails potential conflict for herder–farmer relations, while the water points and grazing land evolve and shift due to climate change.
Struggles for local governance	Modes of governance are being challenged by changing power relations, notably due to new actors, especially armed groups.
National level	
Defending sovereignty	Niger's government faces insurgencies and conflicts in the tri-border area, in the southeast (Nigeria-Chad), and to the northeast (Libya).
Insecurity and the state's policy-making autonomy	Niger's government is working to contain or eliminate the threat of armed groups, partly through numerous partnerships with international and regional states that can limit its policy-making autonomy.
Civil-military relations	More international security intervention and actors translate into more "security rents" for which Nigerien military and political interests compete. Overall, such rents have encouraged counterterrorist approaches and solutions, at times leading to the indiscriminate use of force by Nigerien security forces against civilian populations.
National level	
Fighting Jihadist groups	ISGS and JNIM compete for control over territories and population, offering—to some extent—alternative modes of governance, and thus challenging the state's legitimacy.
Curbing international migration	Increasing external pressure (from Europe) on Niger to control, manage, and reduce migration flows is transforming patterns of mobility in Northwestern Africa.
Defense of kin communities	Borderland communities and livelihoods transcend borders, requiring interstate cooperation and regional conflict management and resolution mechanisms.
Control of traffic routes	The regional political economy is dependent on changing traffic routes for both licit and illicit goods. Control over those routes involve, in part, a game of hide-and-seek involving criminal and armed groups and state and international security forces (with the increasing use of drones for intelligence, surveillance and reconnaissance activities).

First, the meaning of "local" cannot be limited to the political borders set at independence (Boilley 2019). The division of communities by the Mali–Niger border has not cut important social and economic ties that communities maintain. On several occasions, just as humans and cattle cross borders daily, conflict between communities crossed and spread beyond the official border. In 2018, the Malian region of Menaka saw a spike in violence: from June to December 2018, 32 percent of the violent incidents (involving 27 percent of civilians killed) had spilled over to Niger as kin communities protected themselves (ACLED 2021).

Second, conflict actors are also often "violent entrepreneurs" (Bøås, Cissé, and Mahamane 2020) with transnational connections and reach. In the Tillaberi and Tahoua regions, armed groups affiliated to the Islamic State in the Greater

Sahara (ISGS)—and, to a lesser extent, to al-Qaeda in the Islamic Maghreb (AQIM)—provide limited governance in their areas of operations (Raineri 2020). Their presence can be perceived as "glocal" (Raineri 2020), given that despite their adherence to global jihad, they maintain and rely on solid connections to the local, pulling strings and influencing local dynamics. They can use violence, but they also exploit existing fault lines to pursue their objectives and build local legitimacy. They depend on the proximity or connections between strongholds: they spread slowly like rhizomes, moving from stronghold to stronghold in attempts to expand into new areas (Frowd 2020).

Thirdly, and following from the above, conflict dynamics in the Tillaberi and the Tahoua regions are linked to other conflicts and transnational dynamics. Agadez is one key center as it attracts merchants, traffickers, criminals, and terrorist groups, and is a center for funding and recruitment (Raineri 2018; Raineri and Strazzari 2021; Harmon 2014). The centrality of Agadez in regional and transborder dynamics—as a pole along the Libya–North Mali corridor—partly explains why international actors have focused their efforts on "stabilizing" Agadez through interrupting vital routes between Mali and Agadez, as they pass through Tillaberi and Tahoua. In this context, transnational and transregional dynamics means that actors that have no interests or a limited footprint in the Tillaberi and Tahoua regions still impact local dynamics, even if they have no intention of doing so. Few global actors understood this impact on local dynamics in the two regions until the conflict became conspicuous (Harmon 2015; Frowd 2020; Raineri and Strazzari 2021).

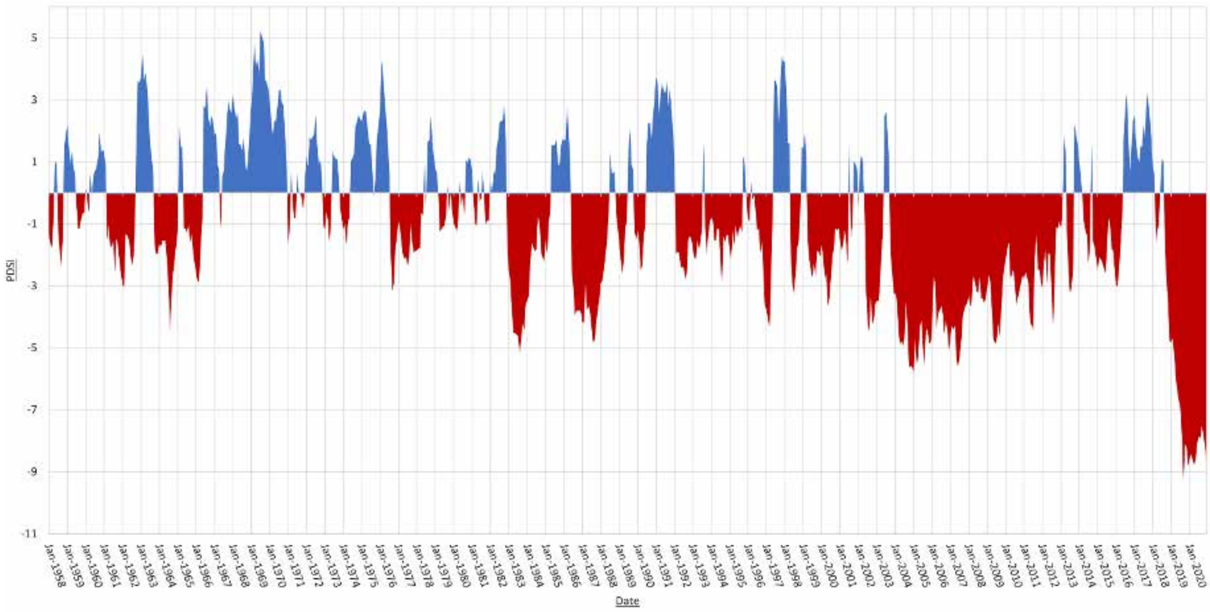
Conflicts in the Sahel are often framed as a confrontation between local and global actors, but the existence of a transnational dimension is crucial to understanding the deterioration of the situation.

8. NIGER – CONFLICT ANALYSIS OF TILLABERI AND TAHOUAYS

As described in the previous section, the Tillaberi and Tahoua regions have developed at the periphery of state governance; meaning that gaps remain in governance, infrastructure, and security (Bøås, Cissé, and Mahamane 2020). Nevertheless, they have also developed local modes of governance that are potential sources or mechanisms of resilience to climate change, but that have been challenged by transregional and transnational actors.

Data show that Tillaberi and Tahoua have been at the forefront of extreme weather (Fiorillo et al. 2018), with decades of cycles of droughts and floods that have progressively worsened. The index below (Figure 2.4.3) illustrates the extent and severity of drought in Tahoua from 1958, with both of these metrics increasing in intensity from the year 2000 onwards. The index is relevant to both farmers and herders, capturing temperature, precipitation and evapotranspiration. Despite the deterioration, before 2012 the respective communities had developed numerous tools to mitigate inter and intra-community conflicts. Local communities built and managed their own conflict resolution mechanisms and governance instruments. Since the 1990s, tensions have led to cycles of violence between the Tuareg, Dahoussak, Peul, and Zarma communities. On multiple occasions, local youth took up arms to defend their respective community's welfare (Crisis Group 2019; interviews with community leaders, 12 November 2018) regarding resource management (especially land and water access). National peace settlement mechanisms, including the Haute Autorité pour la Consolidation de la Paix (HACP), observed these crises, but remained largely uninvolved, as traditional leaders took the lead in solving disputes (interview with governmental officials, Niamey, November 2018). As such, customary and religious leaders have been at the center of a governance system that ensures conflict settlement mechanisms and a fair distribution of resources—even though these local modes of governance are not infallible.

FIGURE 2.4.3 Palmer drought severity index (PDSI) for Tahoua, 1958–2020.



Although communities have not uncommonly experienced conflicts, prior to 2016 they were contained and short-lived. In Niger, armed conflict and violence exploded when the Malian conflict started spilling over, notably from Menaka and Gao. New sources of tension came from the Menaka border in early 2016, as rumors of attacks setting Dahoussaks against Peuls in Mali spread to Niger (interview with local chief, Niamey, 13 November 2018). With tensions simmering between communities, violence broke out on 11 July 2017, when two Malian armed groups—the Mouvement pour le Salut de l'Azawad (MSA) and the Groupe d'Autodéfense Touareg Imghad et Allié (GATIA)[11] —launched a series of deadly transborder raids against Nigerien Peul communities, notably one in the Aderamboukane market. "Operation Akawal" was presented as an action to contain terrorism (interviews with local leaders, Niamey, 12 November 2018). From that moment on, Niger's Peul leaders accused the government and international forces of supporting Malian armed groups to the detriment of Nigerien citizens.

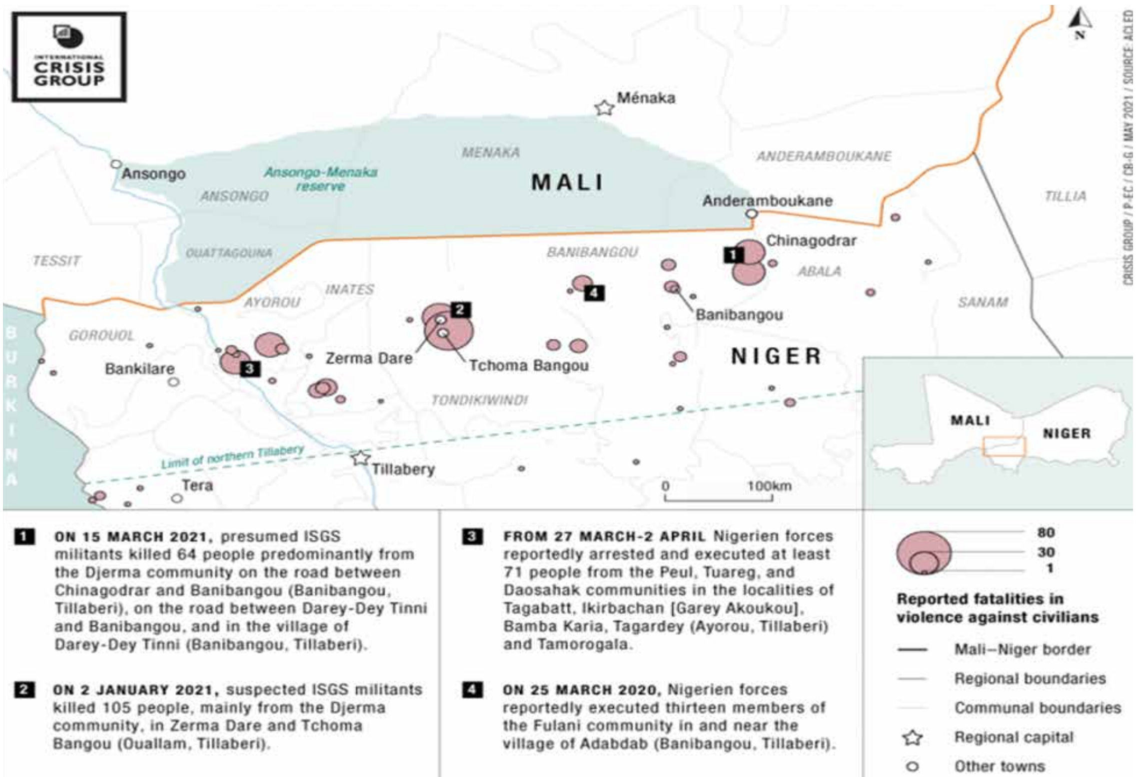
At the time, in 2017–2018, the collaborative actions of the French Barkhane force were increasingly interpreted and perceived by local communities

[11] GATIA is a Malian Tuareg-led armed group and a signatory of the 2015 peace agreement. MSA was created in 2016 as a splinter group of the Mouvement National pour la Libération de l'Azawad (MNLA), one of the Tuareg armed groups that started the 2011–2012 Tuareg rebellion.

as biased, and supportive of the GATIA and MSA. In May 2018, Tuaregs, allegedly linked to the GATIA, kidnapped and killed Peul herders. The resulting chain reaction benefited ISGS, whose recruitment among Peul communities skyrocketed. In November 2018, Nigerien soldiers kidnapped a Tuareg leader whose alleged links to ISGS demonstrated the complexity of affiliations of armed actors. ISGS launched another wave of retaliation that led to the attack on the Inatès military base in April 2019. From November 2018 to March 2019, reported fatalities from attacks against civilians rose by 500 percent compared to the same period in 2017 (ACLED 2019).

Conflict moved from isolated villages to more densely inhabited places. On 10 December 2019, another attack against a military post near Inatès brought the conflict to new heights. This attack on a location with roughly 30,000 inhabitants signified a significant transformation of conflict dynamics and levels of violence (Crisis Group 2019). Several weeks later, in January 2020, another attack occurred on a military position in Chinagodrar, killing at least 89 soldiers. Both attacks were claimed by the ISGS. This triggered a cycle of retaliation. In July 2020, the Commission Nationale des Droits de l'Homme (CNDH) reported more than 100 summary executions by the Niger military (CNDH 2020). The civilian toll increased, as communities faced attacks from both security forces and armed groups. Through January–March 2021, a number of violent security incidents implicating armed militias groups were reported both in the Tillabery and Tahoua regions (WhatsApp discussions 2021, Protection Cluster/ Niger Officer, June 2021). In March 2021, an attack by the ISGS in Banibangou killed an estimated 58 civilians. It was followed by several others that led to significant internal displacements as the crisis spread quickly, notably in the Tahoua region which had until then seen relatively little violence.

FIGURE 2.4.4 Reported fatalities in violence against civilians



9. FRAGILE CONFLICT RESOLUTION MECHANISMS

Prior to the start of the Malian conflict in 2012, intercommunal conflicts were rooted in livelihood concerns: between herders and farmers, and between herders who must share grazing fields and water points. Cattle theft was perceived by locals as the most important security threat because the economic impact could ruin a family (interview with Peul leaders, Niamey, 13 November 2018; WhatsApp conversation, 12 February 2021). Processes of distribution and sharing resources are a crucial function of local governance, with, in some instances, codified practices interpreted by traditional leaders. Governance, in this context, seeks to ensure a fair allocation of resources among competing livelihoods.

Security actors have emphasized ethnicity as a narrative that ostensibly explains the violence and conflicts. Nigerien authorities have focused and instrumentalized ethnic identities, often pointing out that ISGS predominantly recruits among Peuls. Soldiers taking part in one of the several Niger Armed Forces missions, Operation Dongo[12], have been accused of eagerly "seeking vengeance" rather than trying to appease communities (Jeune Afrique 2017), thus contributing to the growing alienation of Peul communities. Our field interviews and research show that divisions along ethnic lines can be distractions, often simplistic, obscuring the ideological and political instrumentalization of ethnicity. Several leaders of ISGS are Dahoussak and Djerma, among other examples of diversity within groups (ICG 2021; local analyst in WhatsApp conversation, 12 October 2019). While ISGS recruitment occurs primarily in herding communities, jihadists have sedulously identified contentions within farming communities for recruitment purposes. Identifying and targeting existing tensions over allocation of resources has been the core recruitment strategy of the ISGS. ISGS has succeeded in instrumentalizing tensions over resources, the youth's lack of economic opportunities, and generational divides—the better to offer alternatives, including the use of violence, to traditional conflict mechanisms. Malian armed groups have also taken sides and reinforced ethnic cleavages, thus nurturing widening gaps between communities and enabling narratives of ethnic revenge.

The Tillaberi and Tahoua regions faced jihadist attacks before 2017, but these were few and external to local dynamics. The targets were governmental offices or military bases, not civilians. From 2013 until 2016, alleged MUJAO[13] elements were accused of conducting several strikes, notably against the Ouallam prison in 2014. Things started to drastically change when Malian-based armed groups, the MSA and GATIA, crossed the Nigerien border to chase alleged terrorists in the summer of 2017. While taking the side of the Dahoussaks, they committed several abuses that exacerbated intercommunal tensions and helped ISGS local recruitment in Northern Tillaberi (Clingdael 2017; The New Humanitarian 2019). Increasing competition over access to water and grazing lands had already created significant frictions (Communauté Peul, communiqué 2018). While the MSA and GATIA acquired military experience and weapons from the Malian conflict, the ISGS had also refined its tactics on the Lake Chad "front". This was reflected

[12] This operation was launched in 2016 in collaboration with US special forces to curtail jihadist activities.
[13] The Movement for Unity and Jihad in West Africa—MUJAO from its French acronym—was one of several jihadist movements that controlled the north. MUJAO was an Al-Qaeda affiliate that successfully controlled the Gao region from March 2012 until the French Operation Serval forced them to abandon their position. MUJAO was believed to recruit primarily among local Peul and Songhay communities.

in the use of improvised explosive devices (IEDs). Scarcely used before 2019, the number of exploding devices increased significantly in the Tillaberi region, with striking similarities to operations and devices seen in Eastern Niger and Nigeria (ACLED, 2019; Niger Military, WhatsApp conversation 2021).

The Nigerien government has struggled to respond adequately and prevent the deterioration of the security situation, while its armed forces are being accused of exactions on civilians. The state's limited presence and failure to curb violence have had the adverse side-effect of contributing to the dynamics of violence and conflict. The Nigerien military has even proved unable to stop attacks on its positions, suffering important casualties. The Nigerien state has committed important resources and launched several military operations, including operation Kouffra 3[14], in collaboration with Barkhane, GATIA, and the MSA. Its military is allowed to pursue terrorist groups into Mali as part of the G5 Sahel. Yet, Nigerien security forces have maintained a minimal presence in the tri-border area, while being constantly accused of supporting one community against another. Rather than alleviating violence, the central government became the main target of jihadist attacks, with multiple deadly attacks against military positions. A Nigerien officer summarized the situation by stating: "we end up with this kind of situation when politicians do not take decisions" (Niger Officer, Niamey, 15 November 2018). In the early 2010s, the Nigerien government passed several orders and decrees to protect pastoralist access to resources, but ultimately continued to select who was deemed a legitimate actor for negotiation, thus often bypassing local and traditional actors who might have more legitimacy in the eyes of local communities. Under these conditions, HACP mediation has struggled to achieve conflict resolution (WhatsApp interview, Niger analyst, 19 September 2019).

10. COMPETING MODES OF GOVERNANCE?

The climate crisis brings particular challenges to Niger's conflict management and resolution mechanisms. The post-2012 conflicts and increasing violence are immediate policy concerns with dire consequences for the resilience of regions like Tillaberi and Tahoua. More precisely, armed conflicts and the worsening of the regional security situation point to the transformation of modes of governance. National and local systems of governance have been largely unable to respond to violent extremist actors who have corroded social contracts and destabilized intercommunal relations of power.

So far, ISGS maintains its influence through terrorist activities, delivering little in terms of governance beyond the promise of protection. The killing of the chief of Tchomabangou in November 2019 represented a shift in local perception, as the Djerma community leader refused to pay zakat (alms) to the ISGS. Since then, the ISGS lost ground in Tillaberi and Tahoua to rival jihadist group JNIM, while Barkhane's airstrikes decapitated the organization's leadership. Several reports show that the ISGS does not have the capacity or the ambition to enforce governance beyond the zakat, but still sees muzzling local opposition and terrorizing locals as a viable strategy to remain dominant in the area (Crisis Group 2021). Meanwhile, civilian deaths at the border increased, with a rising percentage of the population believing that the Nigerien state also

[14] It is one of the many operations involving different actors. These includes Operation Haw-Bi and Kouffra 1 and 2, as well as ad hoc operations in collaboration with US forces, G5 Sahel and Nigerien troops.

deploys terrorist-like tactics, thus contributing to intercommunal tensions (local leader, WhatsApp conversation, July 12, 2021).

Traditional chieftaincies have, on several occasions, attempted to stop Nigerien youth from taking up arms and joining the ISGS, but, so far, such efforts have failed to curb the spiral of violence. The call for conflict resolution is drowned out by the violence of the ISGS and Malian armed groups. In the Tahoua region, the inability of both traditional leaders and national government to guarantee the protection of communities, especially as cattle theft has increased, has led to the creation of several self-defense militias whose loosely organized role became a serious alternative to consensual methods of governance (WhatsApp conversation, 28 July 2021). As such, local actors demonstrate that they are not without agency, that they are not passive victims or silent bystanders, and that they can show resilience by adapting and creating new modes of governance.

The case of the Tillaberi and Tahou regions highlights how transnational threats can erode localized modes of governance, but also how communities can adapt despite important challenges and limited resources.

12. CONCLUSION

The extent to which climate variability and stresses affect conflict dynamics in Niger's Tillaberi and Tahoua regions is difficult to assess, given that: 1) Sahelian countries have lived with and endured climate variability for centuries; and 2) Niger's current instability, insecurity, and armed violence find their immediate causes in the ongoing Malian conflict. Climate variability has always been the background context of the political and economic development of postcolonial Niger, and thus difficult to distinguish analytically.

Nevertheless, based on our analysis of conflict dynamics and the security situation, it seems reasonable to assume that the transformation of that background, induced by climate change, can prolong or exacerbate current conflict dynamics, just as it can create new ones—or at the very least cause mass human suffering and misery. To resolve or prevent armed conflicts will require building ecosystem resilience based on the complex interrelationships of biosphere and human systems. Given that a degree of climate change is "locked in", it is imperative to develop FCV risk analyses that inform policies and programs for ecosystem resilience—that is, the capacity of ecosystems to sustain life across time and space. The focus on ecosystems would yield policies and programs that bridge the biosphere and human systems.

13. WHAT NEEDS TO BE DONE

1. CLIMATE SECURITY RESEARCH: GATHER DETAILED EVIDENCE TO UNVEIL THE COMPLEXITY OF CLIMATE AND SECURITY FOR INFORMED DECISION-MAKING.

This will require not only regular and detailed analyses of the main impact pathways that link climate and security, to enrich our knowledge of the complex, context-specific, socially variable, and dynamic pathways through which climate affects the risk of conflict, but also the creation of decision-support tools that provide real-time evidence at a high temporal and spatial resolution on the climate–security nexus.[15]

2. CLIMATE SECURITY PROGRAMMING: INCREASE THE SENSITIVITY AND RESPONSIVENESS OF PROGRAMS AND INVESTMENTS TO CLIMATE SECURITY.

Despite growing recognition of the role of climate as a threat multiplier, current adaptation, development, and peace interventions have not yet integrated these emerging challenges into their programmatic agenda (Brown et al. 2021; Sherman & Krampe 2020; Läderach et al. 2021). This is particularly problematic because solutions that do not directly consider climate security risks can negatively impact people and communities, reinforcing vulnerabilities and inequalities and increasing conflict potential (Krampe 2019). There is a need to develop regional, national, and subnational guidelines to integrate climate security risks into programmatic planning throughout the stages of a project life cycle. These guidelines could help in gaining an adequate understanding of the contexts and identify appropriate climate security sensitive strategies that integrate climate adaptation and peacebuilding approaches into environmental programming. Moreover, these guidelines will inform the design and implementation of integrated programming recommendations for specific contexts, improving interventions, research, policies, and investments to mitigate and prevent conflicts and reduce people's inequalities and vulnerabilities.

3. CLIMATE SECURITY POLICY: BETTER ARTICULATE THE ROLE OF FOOD SYSTEMS IN THE CLIMATE CRISIS.

For policies seeking to address pre-existing social, economic, or political insecurities to remain responsive to shifting climatic and ecological contexts—and to increase climate resilience—it is imperative that policy frameworks detect and evaluate how insecurities interact with climate change and variability. 'A New Climate for Peace', a report commissioned by the G7 foreign ministries, identifies the unintended effects of climate policies as one of seven core climate-fragility risks. It argues that adaptation projects risk bringing down unintended negative effects on to the economy and political stability, particularly in already fragile settings. In these contexts, the integration of a land, food and water systems lens that is sensitive to climate security will prove crucial in ensuring coherence. Thus Climate Security Policy Coherence guidelines could support national and local policy-makers on how to increase coherence across climate and peace programming to enhance the effectiveness of climate adaptation strategies in a gender-sensitive and socially equitable manner.

[15] One set of tools responding to the need for rapid, real-time, but also accessible data and evidence is the Climate Security Observatory (CSO), one of the solutions proposed in Action Track 5 of the UN Food Systems Summit (UNFSS) Humanitarian-Development-Peace nexus, to be developed by CGIAR in partnership with multiple international and national stakeholders across Africa, Latin and Central America, and Southeast Asia.

CASE STUDY 5 - HOW AID MAY OVER-TARGET AGRICULTURAL NEED: INSTRUMENTAL-VARIABLE MEDIATION ANALYSIS OF CLIMATE–AID–VIOLENCE LINKS IN NIGERIA

Justin Schon

ABSTRACT

Can development projects mediate climate–conflict links? Responding to fears that climate change will increase violence, I consider in this study whether development projects are capable of mediating the effects of climatic conditions on violence. Drawing on the insight that agriculture is a critical channel through which climate change could increase violence, I examine the effect of agricultural productivity on violence. Using instrumental variable (IV)-mediation analysis with 0.5-degree grid cells (approximately 2,500 km2), I find that agricultural productivity increases violence. This counter-intuitive effect exists because aid projects target less agriculturally productive locations and aid reduces violence, so the indirect effect of agriculture on violence is positive via aid. The IV strategy suggests that it is climate-driven agriculture specifically, as opposed to the human inputs to agriculture, which drives this process. Climate–conflict links do exist, but they exist primarily in locations that are neglected by aid. Aid targeting may be neglecting agriculturally productive locations that have other needs and grievances. In addition, it is temperature anomalies, not precipitation anomalies, that significantly affect agricultural productivity, aid targeting, and violence in Nigeria.

1. INTRODUCTION

Global environmental change is occurring at an alarming rate. Reports from the Intergovernmental Panel on Climate Change (IPCC) show scientific consensus that global temperatures have risen by 1°C since the 19th century, and that global temperatures will continue rising at an increasing rate unless checked by massive policy interventions.[16] While these changes do not yet produce clear and consistent links between climatic conditions and conflict, the strength of climate–conflict links may change over time (Mach et al. 2019 & 2020). Marginalized communities are likely to suffer particularly severe consequences from climate–conflict links (Koubi

[16] See the August 2021 report as an example: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

2019; Fjelde and von Uexkull 2012). In response, many governments, international organizations, and nongovernmental organizations (NGOs) hope that aid and development projects can reduce vulnerability and prevent violence from emerging in response to climatic conditions (Mitchell and Pizzi 2020; Messer 2010). This yields the question: Can aid projects mediate climate–conflict links?

The intuition is simple: Aid may help people build resilience and adapt to harsh climatic conditions, so it may reduce the degree of violence that occurs in response to climate change. This argument builds on the view that aid reduces violence (De Ree and Nillesen 2009), since it specifies that aid reduces violence that results from climatic conditions. In fact, aid in general has already been found to consistently increase violence in contexts that are already unstable, and poorly managed aid projects can have a violence-inducing effect (Zürcher 2017; Findley 2018). It is therefore critical to use aid before a location becomes insecure, in order to try and prevent violence from emerging. Recognizing that the potentially violence-inducing effects of climate change are only going to become more severe, it is valuable to know now whether aid can successfully help prevent climate change from leading to violence.

The primary test of this argument involves instrumental variable (IV)-mediation analysis (Dippel, Ferrara, and Heblich 2019; Dippel et al. 2019). This technique uses an instrumental variable to address endogeneity of a treatment variable with a mediator and outcome. In this analysis, the instrument is climate anomalies, the treatment is agricultural productivity measured with Normalized Difference Vegetation Index (NDVI) data, the mediator is geo-coded aid projects, and the outcome is violence. This analysis allows me to causally identify the effect of variation in agricultural productivity—as predicted by climatic anomalies—on violence via aid projects. I argue that the analysis meets its key assumption—that the treatment is endogenous with the mediator and outcome for the same reason—because both aid and violence can be higher in locations with low agricultural productivity as groups attempt to respond to the needs and grievances that result from food shortages and income losses (Collier and Hoeffler 2004; Raleigh, Choi, and Kniveton 2015).

The results support existing intuition, but they also add important nuance. Higher levels of vegetation and higher numbers of aid projects started in a given year reduce violence. This applies to both violence against civilians and battles. Climate anomalies also matter, but it is temperature anomalies specifically, not precipitation anomalies, that really count. This is consistent with findings such as from O'Loughlin, Linke, and Witmer (2014). In particular, higher temperature anomalies reduce vegetation, increase aid projects, and reduce violence. These results are connected by the observation that aid projects target locations with less vegetation, and those aid projects reduce violence. This means that, counterintuitively, locations with less climate stress receive less aid, and that increases violence.

These findings provide a clear implication that aid projects reduce violence in Nigeria, but they also reveal that aid targeting in Nigeria neglects the needs of communities whose agricultural output is not suffering from temperature anomalies. Existing development and aid efforts in Nigeria are therefore effective at reducing violence, but more attention is needed in communities with needs that are unrelated to agricultural shortfalls.

This paper proceeds as follows. First, it provides background on climate–conflict links and the possible role of aid in reducing climate-induced violence. This includes discussion of how we should expect these processes to unfold in Nigeria specifically. Second, it describes the methods and data. Third, it presents the findings. Fourth, it discusses the implications of those findings. Fifth, the paper concludes with a summary of the argument and findings, suggestions for future research, and a description of policy implications.

2. DIRECT CLIMATE–CONFLICT LINKS

In a recent review of research on climate–conflict links, Mach et al. (2019) find that there is a consensus among researchers that climate does affect armed conflict, but that other factors are far more important. They also observe that the mechanisms of climate–conflict links remain unclear. In addition, they observe that increasingly severe consequences of climate change could tighten the link between climatic conditions and conflict.

Two key measures of climatic conditions, temperature and precipitation, drive considerations of climate–conflict links. For both measures, it is arguably anomalies—deviations from long-term trends—that matter (Mueller, Gray, and Kosec 2014; Jackson et al. 2019). For precipitation–conflict links, there is debate over whether high or low precipitation anomalies matter—that is, flood or drought respectively. Hendrix and Salehyan (2012) find that high levels of precipitation increase conflict by making rural areas inaccessible and increasing opportunity for rebellion. A related argument focusing on food security comes from Koren (2018), who finds that it is food abundance that fuels violence, not scarcity. On the other hand, drought may increase conflict through the resultant resource scarcity (von Uexkull 2014).

Analyses of links between precipitation and conflict often do not consider broader water systems that also include groundwater and surface water (Taylor et al. 2013). These three forms of water combine to form the complete picture of water availability (Stevenson 2019). In fact, it may be groundwater shortages that increase conflict, not low precipitation (Döring 2020; BBC News 2009). These nuances of water systems, however, are extremely difficult to combine into a coherent analysis, so it is possible that researchers have yet to successfully complete analyses of water–conflict links that account adequately for the subtleties of water systems (Böhmelt et al. 2014).

Temperature, meanwhile, may have a more straightforward link with conflict (Burke et al. 2009). O'Loughlin et al. (2012) find that high temperatures increase conflict and that precipitation at any level does not influence conflict. Eberle, Rohner, and Thoenig (2020) support the temperature–conflict link with the caveat that it is particularly strong in areas with possible farmer–herder conflict, showing that a 1°C increase in average temperature increases violence by 54 percent in areas populated by farmers and herders. Hsiang, Burke, and Miguel (2013) argue that higher temperatures can increase human aggression, which aggregates from individual-level effects up to group-level dynamics that increase violence. Breckner and Sunde (2019) also find a significant positive effect of temperature on conflict for the 1975–2015 time period across the African continent. Rural and agricultural areas drive the observed effect of temperature on conflict.

Nigeria provides a useful case study to examine climate–conflict links (Sayne 2011). From 2000–2019, Nigeria accounted for roughly half of all violence against civilians in West Africa, based on the author's calculations using data from the Armed Conflict Location and Event Dataset (ACLED) (Raleigh et al. 2010). Nigeria offers an intuitive example of how precipitation yields inconsistent results in analyses, since the south tends to suffer from problems with flooding, whereas the north suffers from problems with drought (Akande et al. 2017). An additional complication to precipitation–conflict links is that high precipitation may contribute to dense foliage, which may provide cover for insurgent groups like Boko Haram to operate (Hendrix and Salehyan 2012; Olaniyan 2018). Meanwhile, farmer–herder conflict, which Eberle, Rohner, and Thoenig (2020) highlight is a particularly salient form of high temperature-induced conflict, is a prominent form of conflict in northern Nigeria (Audu 2013; Nonye Onyima and Iwuoha 2015).

Taken together, it may be the combination of high temperature and low precipitation that has caused especially severe challenges in northeastern Nigeria (Obioha 2008; Apata 2011). Relatedly, higher temperatures are associated with lower agricultural productivity, whereas higher precipitation is associated with higher agricultural productivity (Ayinde, Muchie, and Olatunji 2011).

3. INDIRECT CLIMATE–CONFLICT LINKS

Engaging with criticism of the asserted temperature–conflict link is instructive as analysis of the link continues. Buhaug (2010) engages directly with Burke et al. (2009) with a series of statistical tests and argues that there is no robust evidence for a temperature–conflict link. Instead, Buhaug argues that poor national economy, ethno-political exclusion, and the collapse of the Cold War system are far more important factors. This analysis, however, operates at the country-year level. It does not include a subnational analysis, which may be more capable of detecting climate–conflict links. Wischnath and Buhaug (2014) obtain similar findings in an analysis of climate–conflict links in Asia. Their analysis goes beyond country-year analysis to also examine grid cell-years, and it still does not find a consistent effect of temperature or precipitation on conflict. Buhaug et al. (2015) consider that climatic conditions may affect violence through agriculture and conduct a country-year analysis of the effect of food production on violence. They find that climatic conditions do affect food production, but food production does not affect violence.

This argument that climatic conditions affect conflict through agriculture is important. Aside from Buhaug et al. (2015), many researchers find a significant effect of climatic conditions on violence via agriculture. For example, Crost et al. (2018) emphasize the nuances of this agricultural channel in an analysis of conflict dynamics in the Philippines. The findings on the drought–violence relationship from von Uexkull (2014) stress that the relationship is strongest in agricultural areas that rely upon precipitation. I argue that a subnational analysis of the agricultural channel of climate's effect on conflict is the most appropriate test, since it can capture localized social and environmental dynamics. This yields the following hypothesis:

H1: Higher agricultural production reduces political violence.

If agricultural production reduces violence, then economic assistance may help prevent conflict when agricultural production falls (Brinkman and Hendrix 2011; Marktanner and Merkel 2019). This possibility motivates the use of aid as a tool to prevent conflict. One component of assessing the likelihood of this possibility is to understand more broadly how aid is related to conflict and violence.

Unfortunately, within active conflict zones, aid tends to increase violence (Wood and Sullivan 2015). It can also contribute to the destabilization of insecure areas that are on the edge of experiencing violence. In stable, secure settings, meanwhile, aid can reduce violence (Zürcher 2017). Humanitarian food aid specifically reduces the onset and duration of civil conflict, especially in Africa (Mary and Mishra 2020). In post-war Nepal, De Juan (2020) finds that aid reduces anti-government violence and increases violence against nonstate actors in the short-term. Lyall, Zhou, and Imai (2020) use evidence from Afghanistan to argue that aid can increase support for the government, but it increases support because it demonstrates resolve and competence rather than by improving economic livelihoods.

Considering the perpetrator rather than the target, Wood and Sullivan (2015) find that aid increases rebel violence in conflict zones and does not have a strong relationship with state violence. Areas with high ethnic heterogeneity and low-quality state institutions had the largest effects. Kaila, Singhal, and Tuteja (2020) use an analysis from Indian counterinsurgency to argue that complementary security and development programs can be especially effective in reducing violence. Regardless of whether aid reduces violence by actually helping people or by increasing support for the government, existing research yields the following hypothesis:

H2: Higher aid levels reduce violence in stable, secure locations.

Another aspect of understanding the role of aid is to understand where aid efforts are targeted. A key challenge of evaluating the consequences of aid is that aid is not allocated randomly, and the patterns of aid targeting could influence its relationships with other factors (Findley 2018). If aid does not respond to climatic conditions, or climate-induced changes in agricultural productivity to be precise, then it may fail—as a matter of design—to mitigate climate–conflict links rather than because of any failure of implementation (Buhaug et al. 2015). Briggs (2017) uses geo-coded aid and survey data and finds that aid does not go to locations with the poorest people. Kotsadam et al. (2018) analyze development aid and infant mortality in Nigeria and suggest that their finding of a negative relationship between aid and infant mortality may exist due to aid projects targeting locations that already had lower infant mortality rates.

These findings of aid going to locations with less need may emerge due to political considerations influencing aid targeting (Briggs 2012; J.A. Harris and Posner 2018). Brass et al. (2020) argue that a combination of need and politics drives development decisions in Ghana, and they offer the suggestion that politics may become more prominent when bureaucrats have less complete information about local needs. Given that over 70 percent of Nigeria's population makes its income from agriculture, this study contends that at least some portion of decision-making in aid targeting in Nigeria is based on agricultural needs.[17] This yields the following hypothesis:

H3: Higher agricultural productivity reduces aid.

If available evidence supports H2 and H3, then it is possible for these effects to yield the opposite observable implication from H1. Without aid, communities may suffer economically, even if they have relatively productive agriculture. They may have other needs unrelated to agriculture too. This may mean that if higher agricultural productivity leads to less aid, then that will lead to more violence. This possibility is represented by H4:

H4: Higher agricultural productivity increases political violence via a reduction in aid.

4. METHODS AND DATA

An examination of how agricultural productivity affects the allocation of aid projects and violence must confront several endogeneity problems. Low agricultural productivity could plausibly motivate the allocation of aid projects (Briggs 2017). Meanwhile, aid projects could also affect agricultural productivity (Duflo, Kremer, and Robinson 2011). Many processes link agriculture with violence, which may involve low agricultural productivity reducing opportunity costs or increasing grievances that contribute to violence (Collier

[17] See http://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance/en/ (Accessed August 24, 2021)

and Hoeffler 2004), high agricultural productivity creating targets for violence or fueling armed groups (Koren 2018), and violence itself may diminish agricultural productivity (Adelaja and George 2019). In addition, aid and violence can influence each other, with plausible processes leading to aid increasing violence by creating a target or being mismanaged and fueling grievances, aid decreasing violence by reducing grievances or increasing opportunity costs to participate in violence, or violence affecting aid allocation (Zürcher 2017; Findley 2018). With all of these possibilities, instrumental variables are valuable tools in obtaining unbiased estimates of key causal effects.

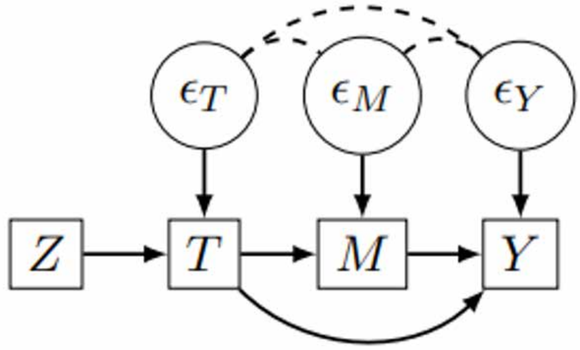
This study conducts its analysis in three steps. First, it uses temperature and precipitation anomalies to examine direct effects of climatic factors on agriculture, aid allocation, and violence. This step provides first stage regression results for the three components of the IV-Mediation analysis where temperature and precipitation anomalies are used as instrumental variables for aid allocation and agriculture. Second, results from those two IV models are reported—providing unbiased estimates of the causal effect of agriculture on aid and violence, as well as of aid on violence. Moreover, using agriculture as a key independent variable allows the study to emphasize the effect of climate-driven agriculture, which is critical for considerations of the causal effects of climatic factors and climate change (Buhaug et al. 2015). Third, the study uses instrumental variable-mediation analysis to examine how aid projects mediate the effect of agriculture on violence. The instrumental variables in these models address endogeneity and allow the models to focus on the direct effect of agriculture on violence, and the indirect effect of agriculture on violence via aid projects (Dippel, Ferrara, and Heblich 2019).

Instrumental variables (IVs) require two key assumptions. First, the instrument must be correlated with the treatment variable, or avoid the weak instrument problem. Second, the instrument must only be correlated with the outcome through its effect on the treatment or be excludable (Angrist and Krueger 2001). I report F-statistics and the first-stage regressions to support the assumption that the instrumental variables are correlated with the treatment. I report Hansen's J-statistics to support the assumption that the instruments are excludable.

Adding mediation analysis, IV-Mediation analysis maintains the assumptions of IV models with respect to both the mediator and the outcome. In addition, it adds the assumption that the treatment is endogenous with the mediator and the outcome for the same reason. This assumption replaces the sequential ignorability assumption from standard mediation analysis (Dippel, Ferrara, and Heblich 2019; Dippel et al. 2019). In these models, I again report F-statistics. The assumption that the treatment is endogenous with the mediator and the outcome requires theoretical justification. It cannot be evaluated with a diagnostic statistic.

The equations for the IV-Mediation analysis are displayed in Figure 2.5.1 (Dippel, Ferrara, and Heblich 2019, 2). I add an additional component to the model: grid cell fixed effects. Grid cell fixed effects allow me to address the possibility of omitted variable bias by controlling for time-invariant covariates (Angrist and Pischke 2008). There are many factors, such as terrain, whether a location is urban or rural, and ethnic group composition that can be considered constant during the relatively short 2003–2014 time period that is the focus of this study's analysis. Grid cell fixed effects allow me to account for these factors and focus on the key model variables (O'Loughlin et al. 2012; Eberle, Rohner, and Thoenig 2020; Cottier and Salehyan 2021).

FIGURE 2.5.1 IV-Mediation Analysis, Equations and Diagram



$$T = f_T(Z, \epsilon_T),\ M = f_M(T, \epsilon_M)$$
$$Y = f_Y(T, M, \epsilon_Y)$$
$$Z \perp\!\!\!\perp (\epsilon_T, \epsilon_M, \epsilon_Y)$$

In terms of this study's IV-Mediation analysis, agriculture is the treatment, aid is the mediator, and violence is the outcome. I argue that climate-driven agriculture is endogenous with aid because low agricultural yields may increase aid as a response to need and aid may affect agricultural productivity (McArthur and Sachs 2019). For violence, low agricultural yields may increase violence as a response to the need that generates grievances and lowers opportunity costs (Collier and Hoeffler 2004), while violence may decrease agricultural productivity by destroying crops and interfering with efforts to grow crops (Adelaja and George 2019). In both parts, low agricultural productivity creates economic needs that may lead to more aid and violence, and then aid and violence may both affect agricultural productivity. Temperature and precipitation anomalies therefore address endogeneity by isolating the climate-driven components of agriculture, thereby addressing feedbacks of aid and violence onto agriculture.

This logic holds for IV models on their own where agriculture is the treatment. For IV models where aid is the treatment, the instrumental variables emphasize aid allocation that is responding to climate-driven needs. In this way, there is a similar logic underlying both sets of IV models.

The analysis examines 316 grid cells with 0.5 degree by 0.5-degree dimensions, or roughly 2,500 km2. I use the grid cells from our climate data (described in the section on Independent Variables), since they can most cleanly incorporate all of the data. Data on aid projects goes through 2014, and data on vegetation starts in 2003, so most models examine the 2003–2014 time period. Some models that do not include aid projects examine 2003–2020.

5. DEPENDENT VARIABLES

The primary outcome of interest is violence. To measure violence, this study uses the Armed Conflict Location and Event Data Project (ACLED), which uses media reports and a variety of other sources to identify and geo-code violent events. The two main dependent variables are counts within each grid cell-month of the number of events involving the targeting of civilians (Violence Against Civilians) and battles (Battles) respectively.

There are known biases in ACLED regarding the types of events included, over-reporting of events in more populated areas, and inconsistencies in coding over time and space. These problems are more severe with ACLED than its most widely used alternative, the Uppsala Conflict Data Program's Georeferenced Event Data (UCDP GED) (Eck 2012). Nevertheless, ACLED's more generous inclusion criteria allow it to detect a large number of violent events omitted by the UCDP GED. This is particularly valuable for an analysis where a large number of observations have values of zero (Raleigh et al. 2010). In addition, many of the violent events that occur in response to climatic conditions may not reach the thresholds of organized violence that predicate inclusion in the UCDP GED (Sundberg and Melander 2013). ACLED includes some of these events, increasing its value for this analysis.

6. INDEPENDENT VARIABLES

The key climate variables, which are used as treatment variables in Table 2.5.1 and instrumental variables in all other models, are temperature and precipitation anomalies respectively. These variables are calculated from the gridded data from the University of East Anglia's Climatic Research Unit (CRU) (I. Harris et al. 2020). In this dataset, grid cells are 0.5 degrees by 0.5 degrees, so their area is roughly 2,500 km2. CRU obtains data from weather stations and relies on stations that can provide data over a long time series. Its most recent data product covers the period 1901–2020. For each month in each year, I calculate z-scores for rolling 30-year windows using the roll package in R. This procedure yields measures of temperature and precipitation anomalies for each month. To match other variables that have an annual frequency, I aggregate these anomalies to the annual level by selecting the values from the month when vegetation as measured by NDVI was highest. This allows me to use measures of precipitation and temperature from the peak of each grid cell's growing season, similar to the method used in Schon et al. (2021) and many other studies. CRU is very strict about only including weather stations that have substantial temporal coverage. Schultz and Mankin (2019) show that the CRU data includes data from fewer weather stations in its estimates from countries that experience more violence, which biases its temperature anomaly estimates downward. Their results show that Nigeria, especially northeast Nigeria, is affected by this bias, albeit not by as much as a large portion of the African continent. For this analysis, that bias should yield a particularly strict test of climate–conflict relationship.

I measure agricultural productivity with the Normalized Difference Vegetation Index (NDVI), which is a remote sensing measure of greenery. NDVI has values from -1 to 1, although locations on land will have values from 0 to 1. I use data from the MODIS Terra satellite for monthly NDVI measures for 1 km grid cells. I aggregate this data up to the 0.5 degree by 0.5 degree grid cells by taking the average NDVI value within each month for all 1 km grid cells that fit within the 0.5 degree by 0.5 degree grid cell. I then aggregate to the annual level by taking the maximum NDVI value for each grid cell in each year. Again, this allows me to focus on the peak of each grid cell's growing season.

I measure aid projects with the Aid Information Management Service (AIMS) data for Nigeria, as coded by AidData (AidData 2016). Aid projects from 1998 to 2014 are geo-coded and coded for a variety of characteristics. I calculate counts of aid projects in each grid cell-year based on the Start Year of each aid project. I also restrict the data to aid projects with a geo-precision level below four. This follows the example from Kotsadam et al. (2018) and Briggs (2018).

7. FINDINGS

Table 2.5.1 displays the regression results. Table 2.5.1 treats Temperature Anomaly and Precipitation Anomaly as independent variables and considers their effect on Violence Against Civilians, Battles, Aid Projects, and NDVI. Table 2.5.2 uses Temperature Anomaly and Precipitation Anomaly as instrumental variables for NDVI, in order to examine the causal effect of NDVI on Aid Projects, Violence Against Civilians and Battles. Models 1 to 3 in Table 2.5.2 show the results for 2003–2014, and Models 4 and 5 show the results for 2003–2020. Table 2.5.3 uses Aid Projects rather than NDVI as the treatment variable. Tables 2.5.4 and 2.5.5 show results from the IV-Mediation Analysis. The main results are displayed in Figure 2.5.2.

FIGURE 2.5.2 IV-Mediation Results

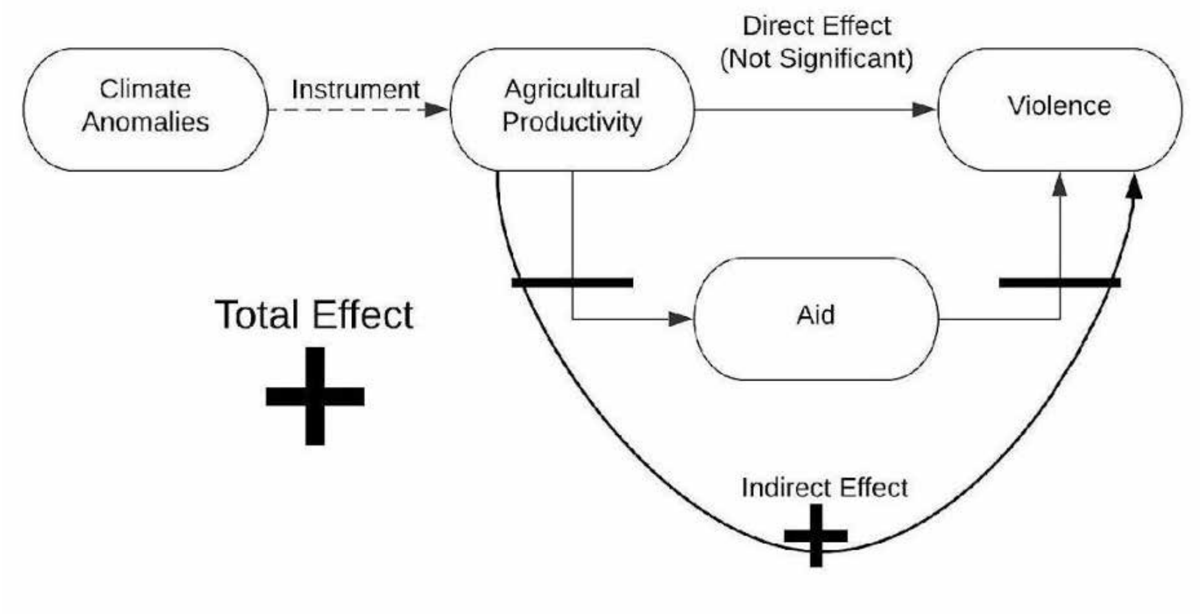


Table 2.5.1 shows that Temperature Anomaly has a statistically significant negative coefficient across all models except model 5. Higher temperature anomalies for a given grid cell-month are correlated with fewer civilian-targeting events, fewer battles, more aid projects, and less vegetation. Precipitation anomalies are not significantly correlated with any of these factors.
Table 2.5.2 shows that higher vegetation reduces aid projects and increases battles and civilian-targeting events, although the relationship with battles is not robust to expanding from 2003–

2014 to 2003–2020. These results come from using temperature and precipitation anomalies as instrumental variables, so they can be interpreted as causal estimates.

Table 2.5.3 shows that aid projects reduce civilian targeting and battles. These results must be considered alongside the results from Table 2.5.1 and Table 2.5.2; it may be surprising to see that more vegetation, which suggests greater agricultural productivity, is correlated with more violence. Yet, if aid projects are allocated to areas with less vegetation, suggesting lower agricultural productivity, then aid may be responding to agricultural challenges and leaving other challenges unaddressed. This makes H4, hypothesizing that higher agricultural productivity increases violence via a reduction in aid, particularly important.

Tables 2.5.4 and 2.5.5 present the results of an IV-Mediation Analysis that explicitly tests this possibility. This analysis shows that agricultural productivity does not actually have a direct effect on violence, regardless of whether it is civilian-targeting or battles. Instead, agricultural productivity increases violence indirectly via the allocation of aid projects. In Table 2.5.5, an examination of this indirect causal pathway supports the findings from Tables 2.5.1 to 2.5.3 that higher agricultural productivity reduces aid projects, and that fewer aid projects are correlated with more violence. The positive indirect effect therefore comes from the combination of two statistically significant negative relationships.

TABLE 2.5.1 Effects of Temperature and Precipitation Anomalies, Grid Cell Fixed Effects and Clustered Standard Errors

	(1) Violence Against Civilians (2003–2020)	(2) Violence Against Civil-ians (2003–2014)	(3) Battles (2003–2020)	(4) Battles (2003–2014)	(5) Aid Projects (2003–2014)	(6) NDVI (2003–2014)
Temperature Anomaly	-0.182***	-0.163***	-0.068**	-0.122***	1.078***	-0.182**
Precipitation Anomaly	(0.029)	(0.029)	(0.025)	(0.032)	(0.236)	(0.064)
	0.025	-0.011	0.007	-0.015	0.033	0.006
Constant	(0.017)	(0.017)	(0.019)	(0.019)	(0.140)	(0.038)
	0.565***	0.380***	0.485***	0.326***	0.972***	63.613***
	(0.011)	(0.012)	(0.010)	(0.013)	(0.094)	(0.027)
Observations R-squared Number of Grid Cells	5,597	3,742	5,597	3,742	3,742	3,742
	0.007	0.005	0.001	0.004	0.009	0.004
	316	316	316	316	316	316

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05

TABLE 2.5.2 IV Analysis of NDVI Effects, Grid Cell Fixed Effects and Clustered Standard Errors

	(1) Aid Projects	(2) Violence Against Civilians	(3) Battles	(4) Violence Against Civil-ians (2003–2020)	(5) Aid Projects (2003–2014)
NDVI	-5.859**	0.880**	0.650*	1.491*	0.528
	(2.144)	(0.340)	(0.272)	(0.709)	(0.337)
Observations	3,742	3,742	3,742	5,597	5,597
Number of Grid Cells	316	316	316	316	316
F-Statistic	7.44	6.69	5.71	4.41	2.44
Hansen'sJ-statistic	0.074	0.186	0.382	2.761	2.163

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05

TABLE 2.5.3 IV Analysis of Aid Effects, Grid Cell Fixed Effects and Clustered Standard Errors

VARIABLES	Violence Against Civilians	Battles
Aid Projects	-0.151***	-0.112**
	(0.042)	(0.038)
Observations	3,742	3,742
Number of Grid Cells	316	316
F-statistic	12.83	8.62
Hansen's J-statistic	0.054	0.213

VARIABLES	Violence Against Civilians	Battles
Aid Projects	**-0.151*** **	**-0.112** **
	(0.042)	**(0.038)**
Observations	**3,742**	**3,742**
Number of Grid Cells	**316**	**316**
F-statistic	**12.83**	**8.62**
Hansen's J-statistic	**0.054**	**0.213**

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05

TABLE 2.5.4 IV-Mediation Analysis, Grid Cell Fixed Effects and Clustered Standard Errors

	Violence Against Civilians	Battles
Total Effect	0.805**	0.594*
	(0.302)	(0.254)
Direct Effect	-0.026	-0.006
	(0.018)	(0.017)
Indirect Effect	0.831*	0.600+
	(0.390)	(0.316)
Observations	3,792	3,792

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.10

TABLE 2.5.5 IV-Mediation Analysis of Violence: Mediator and Outcome Estimates, 2003–2014
Instrument is Temperature Anomaly; Treatment is NDVI; Mediator is Aid Projects

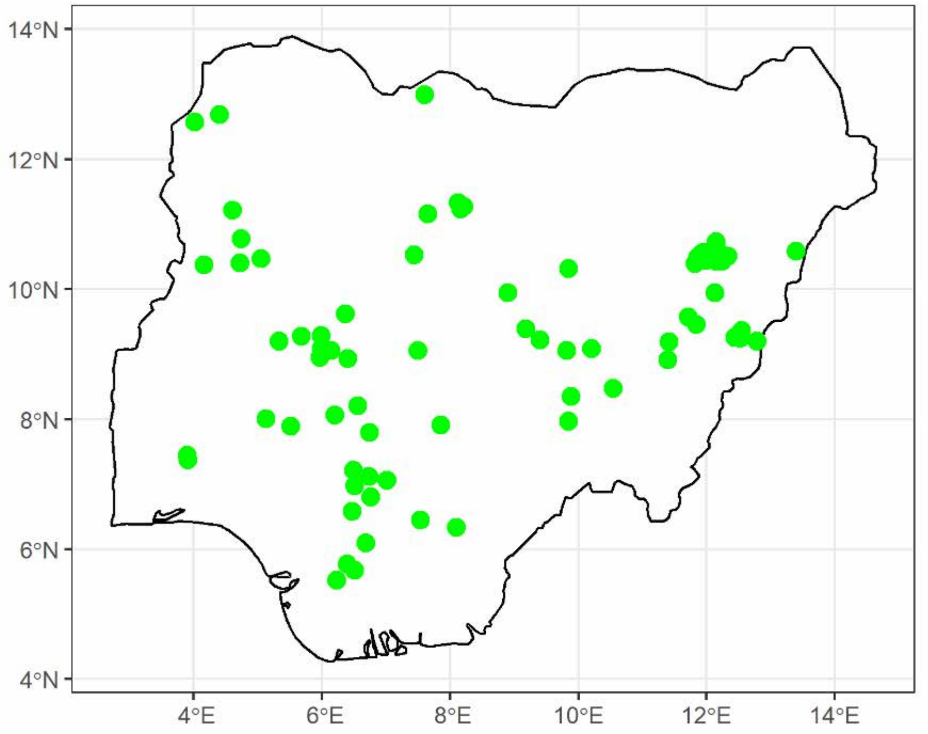
	Outcome 1: Violence Against Civilians				Outcome 2: Battles			
	Mediator Equation		Outcome Equation		Mediator Equation		Outcome Equation	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Treatment	-5.56**	2.02	-0.03	0.02	-5.56**	2.02	-0.01	0.17
Mediator			-0.15***	0.04			-0.11**	0.04
N	3792	3792	5.71		4.41			2.44
F-Statistic (T on Z)	8.172	8.172	0.382		2.761			2.163
F-Statistic (M on Z | T)	16.301	16.301						

8. DISCUSSION

Taken together, these results show that higher agricultural productivity increases violence, but due to the indirect mechanism of harsh climatic conditions increasing allocations of aid. Where climatic conditions allow higher agricultural productivity, communities receive less aid. In those communities, higher violence levels occur.

These results suggest the possibility that aid allocation neglects nonagricultural need. This possibility is difficult to test fully, but there are several sources of support for it. First of all, the results already explicitly show that aid targets locations with lower NDVI values. In addition, Figure 2.5.3 shows that aid projects explicitly targeting the agricultural sector cover a similar

FIGURE 2.5.3 Aid Projects Targeting the Agricultural Sector



spatial distribution to that of the full set of aid projects. Aid projects targeting agriculture also comprise about 25 percent of all aid projects. Many more aid projects that do not explicitly target the agricultural sector may still implicitly be responding to agriculture-based needs (such as economic aid that is useful in economic downturns caused by low agricultural productivity).

An important feature of these results is that temperature anomalies, and not precipitation anomalies, drive the results. Higher temperature anomalies harm agriculture and prompt higher aid allocations. The direct effect of temperature anomalies on violence is negative, but the full set of results suggests that this is due to aid allocations interrupting the climate–conflict link. The results cannot be regarded as a reason to ignore water fluctuations. Instead, they highlight that temperature and precipitation need to be considered as climatic conditions that could be destabilizing when they deviate outside normal ranges.

To enter a caveat, aid projects have not been allocated to northeastern Nigeria, as shown in Figure 2.5.4. This is the most violent region of the country, and it is where state capacity is lowest (Adelaja and George 2019). Before recommending aid projects in this region, however, it is necessary to acknowledge that aid projects pose a particularly high risk of actually fueling violence in regions that are already violent and insecure (Wood and Sullivan 2015; Zürcher 2017). The violence-reducing effects of aid may therefore be most likely to exist in other parts of Nigeria, where insecurity is not entrenched.

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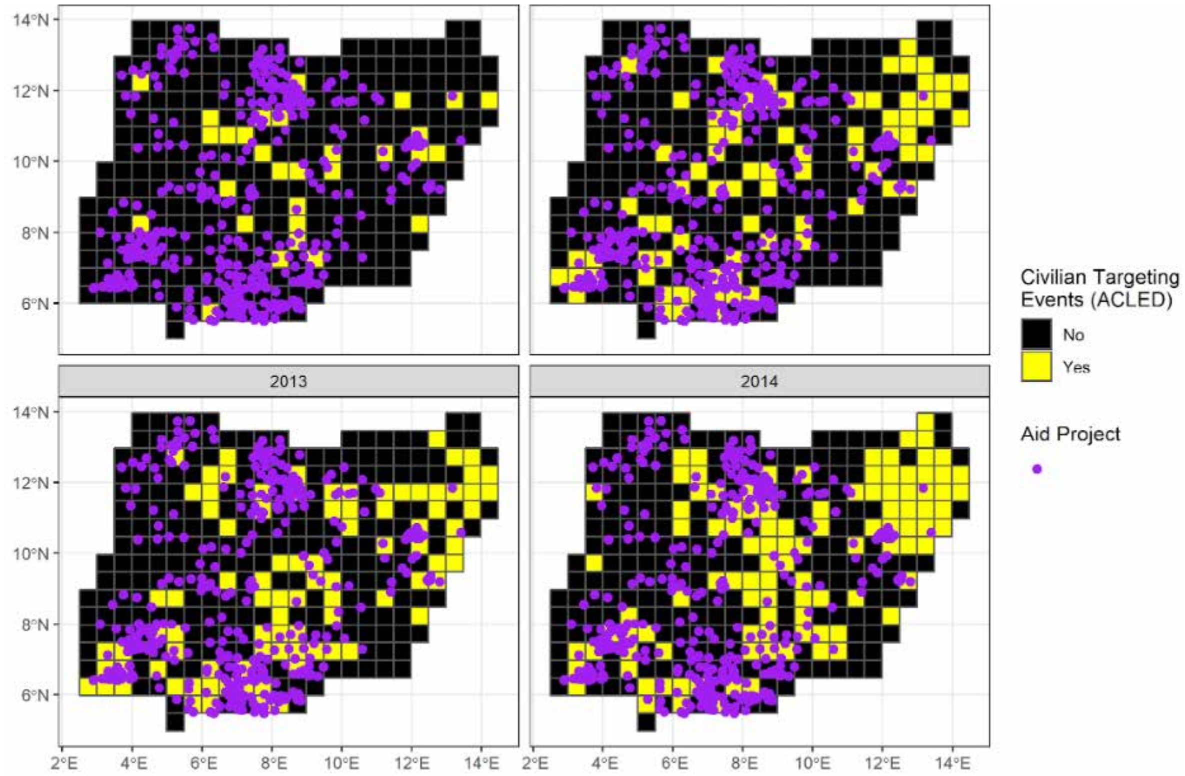
FIGURE 2.5.4 Aid & Civilian Targeting, 2011–2014



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Climate change is poised to affect conflict most directly through its effects on agriculture. Contrary to many analyses that highlight the effect of precipitation fluctuations on agriculture, this study shows that temperature can also affect agriculture. Moreover, by instrumenting for agricultural productivity with climatic factors, this study highlights the role of climate-driven agricultural productivity, as opposed to human inputs that affect agriculture.

This study already identifies effects driven by temperature anomalies, and IPCC estimates show that the world has only seen a 1°C increase in global temperatures.[18] Global warming is expected to continue increasing over the next few decades, likely at an accelerating pace. This warming process may have especially severe consequences due to nonlinear effects on local

[18] August 2021 IPCC report.

climate systems (Scheffers et al. 2016). Fortunately, continuing to target aid projects in locations that are harmed by climate change has the potential to prevent strong climate–conflict links from forming. Locations that already have entrenched conflict and insecurity, however, will need other solutions.

This paper finds evidence for climate–conflict links in Nigeria, fueled specifically by temperature anomalies, but adds a critical finding that aid projects can successfully prevent climatic conditions from increasing violence. It confirms that climatic conditions can harm agricultural productivity and that aid responds to agricultural shortfalls. With IV and IV-Mediation analyses, it provides causal evidence for these relationships.

Future research could build on this study in a variety of ways. First, all of the data sources have coverage in additional countries. Cross-national work that explicitly considers subnational processes is a valuable contribution for the study of climate–conflict links and how aid may interrupt those links. Second, there is a need to consider the interaction of other processes, such as migration. People move around in response to changing climatic conditions, economic opportunities, violence, and other factors, so there may be important interacting processes influencing the climate–conflict links that are of interest (Kaczan and Orgill-Meyer 2019). Third, explanatory analyses like the one conducted in this paper should inform predictive modeling efforts, since there is great value in predicting future conflict patterns as well as explaining previous conflict patterns (Dorff, Gallop, and Minhas 2020).

There are a few main policy implications. It is encouraging that aid can reduce violence, and that aid is responsive to climate-induced agricultural shortfalls. Now, more work is needed to address needs in areas that are agriculturally productive but may be struggling for other reasons. In addition, the capacity of aid to reduce violence should not be extended to the implication that aid projects in Nigeria's northeast will reduce violence. Conflict is already entrenched in northeastern Nigeria, so it is arguably more likely to increase violence than to decrease it in that region.

There is then a broader implication: Climate change and global warming pose serious threats. While it is clear that temperatures are already bound to increase substantially in the short to medium term, resolute action now could minimize the damage from climate–conflict links in the long term.

2.3 DISCUSSION

Collectively, the five case analyses enrich the conclusions of the quantitative modeling in three important respects. One, they provide information about how climate change and anomalies translate into conflict outcomes. Whereas the machine-learning models identify patterns of associations in the data, they do not by themselves identify the social, economic, political, or institutional pathways through which these patterns likely connect to conflict, fragility and violence outcomes. The case studies, by examining the social, institutional, climatic, and political economic context of the country and of specific instances of conflicts, provide a better understanding of how climate-related variables connect to hypothesized impact pathways. Thus, for example, a number of studies suggest that higher temperatures reduce agricultural output, undermine livelihoods, increase food insecurity, and thereby make it more attractive for some households to engage with armed insurgent groups. The studies thus clarify both the supply-and demand-side interactions related to the links between climate change and conflict.

Two, they identify additional variables that are in evidence in the studied cases, and that may potentially have generalizable causal effects on conflict, and their patterns of interactions and relationships with climate and conflicts. Such additional variables include institutions, policies, and governance, interactions among different ethnic and social groups, degree of social cohesion, levels of deprivation and economic well-being, food prices and changes in demand for and supply of food, and levels and patterns of migration, among other key variables. Data on these variables are limited: existing for some countries but not for other countries, for some regions in a country but not for other regions, for some years but not for other years. Absence of consistent data across spatial units and over time makes it difficult to model how climate variables, such as temperature and precipitation, affect impact pathways associated with these variables. But the in-depth analysis of these pathways in specific cases points toward areas where additional data collection and creation efforts can lead to more systematic causal estimation of the channels through which climate change affects conflicts. Availability of such data can also help identify the magnitude of effects of climate change on conflict through different channels whereas the case study analyses tend to be more informative about whether impact pathways exist and if so, the direction of relevant impacts.

Finally, the case studies point more specifically toward policy and programmatic interventions that may dampen the negative effects of climate stresses on socioeconomic and political relationships and thereby on conflicts. They do so in two ways. On the one hand, they provide a more textured elaboration of the socioeconomic and institutional pathways through which climate risks lead to conflict. By implication, addressing these pathways can also help mitigate the risks that climate change poses for conflicts. For example, greater climatic variability in contexts with substantial governance deficit is associated with greater violence. Supporting interventions that strengthen institutions can plausibly offset the negative effects of climate change risks. But some of the studies also directly examine how development interventions may mitigate climate-linked conflict risks. For example, Schon (2021) shows that agricultural contexts with higher levels of international aid to support improved agricultural productivity are characterized by lower levels of conflict. The plausible corollary of this finding would be that broader targeting of agricultural aid has the potential to mitigate conflicts risks more broadly.

3 GENERATING CLIMATE AND CONFLICT VULNERABILITY CLUSTERS

3.1 BACKGROUND

Vulnerability, broadly defined, refers to the extent to which a community is susceptible to a hazard, and the extent to which it may be able to cope with the effects of that hazard (McCarthy et al. 2001, IPCC 2022). Measurements of vulnerability combine data that represent the likelihood a community will be exposed to a hazard, how sensitive the community is to the hazard, and its capacity for adapting to the hazard. Together, these three parameters comprise vulnerability (Adger 2006). Conceptually, and in its measurement, vulnerability is multidimensional.

In addition to being multidimensional, quantifying vulnerability to joint hazards—such as climate change and violent conflict—is not straightforward. A very large body of research seeks to operationalize vulnerability for decision-making purposes by representing its magnitude through an amalgam of variables representing exposure to hazards, susceptibility or sensitivity to the hazard, and recovery or coping capacity of the entity experiencing the hazard. Such indices, mapped spatially, contribute to an understanding of differences in levels of vulnerability across space. They are less effective, however, in helping identify how different sources of vulnerability can be addressed—because the index combines multiple sources from which vulnerability stems.

Although many indices present information on climate change vulnerability (de Sherbinin et al. 2019), such indices suffer from several shortcomings. First, they predetermine the nature of vulnerability through the mathematical structure of an index. This is problematic because people and places often experience the same phenomenon differently. For example, increased precipitation may generate livelihood-related benefits in one setting, such as improved agricultural yields or access to water; in another setting, however, the same amount of increased precipitation may result in livelihood-related harms, such as flooding or increased risk of crop disease. Thus, vulnerability indices that treat data on climate change in a uniform and unilateral fashion can be misleading. Second, indices that treat all dimensions of vulnerability in an equivalent manner confuse the specific responses that different aspects of vulnerability require. Vulnerability owing to high exposure or sensitivity requires different policy responses than vulnerability from low adaptive capacity. Even if there were an index that accurately captured climate change vulnerability in the West African setting, violent conflict remains an important driver of vulnerability, as well. Accounting for climate change as well as conflict vulnerabilities makes index creation exceedingly difficult. Thus, in this research, we seek to generate climate change and conflict clusters and interpret them using vulnerability profiles.

The profiles approach to vulnerability groups different observations according to their similarities and differences across multiple variables. This approach combines open access spatial data that represent climate change and conflict vulnerability, machine-learning algorithms that cluster small areas based on vulnerability data, and domain knowledge to select clusters and write vulnerability profiles. In contrast to vulnerability indices that measure the magnitude of one type of vulnerability, vulnerability profiles describe different types of vulnerabilities across a region in language that is usable and transparent.

3.2 METHODS

3.2.1 DATA

To identify areas vulnerable to climate change and conflict in different ways in West Africa, we generated a regional dataset on climate change exposure, sensitivity, and adaptive capacity. Many of these variables are consistent with the dataset for modeling conflict occurrence. However, there are important differences, such as downscaled climate projections to 2100. Annex A provides information on variable descriptions and their categorization as exposure, sensitivity, or capacity to adapt to conflict or climate change. In general, exposure variables consist of: changes in climate based on previous temperature and precipitation measurements as well as downscaled climate estimates from 2020 to 2100; the number of conflicts categorized as Battles and Remote Violence, Violence Against Civilians, and Riots or Demonstrations; and total fatalities attributed to conflict. Sensitivity variables consist of population, population change, NDVI in 2020, majority land cover in the cell for 2020, land cover change 2000 to 2021, total forest loss from 2000 to 2020, and travel time to surface water in 2020. Adaptive capacity variables consist of nighttime light emittance and change in nighttime light emittance (2000 to 2020), travel time to the nearest populated place, road length within the cell, and whether the cell is on an international border.

3.2.2 GENERATING VULNERABILITY CLUSTERS

Using a set of variable reduction and variable weighting techniques combined with hierarchical agglomerative clustering, we group five-km grid cells across 16 nations in West Africa by their exposure, sensitivity, and adaptive capacity to climate change and conflict. We use mixed principal component analysis to generate principal components for exposure, sensitivity, and adaptive capacity variables. This step reduces the dimensionality of our dataset and provides a method for clustering grid cells based on the extent to which they vary from one another according to principal components that relate to exposure, sensitivity, and adaptive capacity variables. We also weight the principal components by the total variance they represent within each of the vulnerability categories, in order to cluster more effectively on principal components most meaningful for understanding differences in vulnerability across grid cells.

Due to the sample size of grid cells (n=273,132), we select the six principal components within each vulnerability category that are most representative of the underlying data. Thus, for this research, we select six principal components within each of the three vulnerability categories, providing 18 principal components upon which to cluster the data. It is important to note that this methodology weights equally the three categories of vulnerability.

We run hierarchical agglomerative clustering within operational World Bank regions. We use Euclidean Distance and Ward's Connectivity settings to efficiently cluster grid cells within each region based on their standardized, numeric data. The regions include the Gulf of Guinea, the Lake Chad Basin, the Sahel, and the Westernmost nations of West Africa. After clustering, we generate dendrograms, silhouette plots, and elbow plots to evaluate valid cluster sizes within four regions relevant to World Bank operations. We visualized between two and four cluster group options for each region, depending on the extent to which different cluster sizes maximized similarities for grid cell data within groups as well as differences between groups. Then, working within the project team and drawing on expertise from World Bank partners, we chose one cluster size for each region on which to base our results. The naming of the clusters is numerical and is intended to identify and distinguish unique vulnerability clusters. All grid cells that fall within a vulnerability cluster will share that cluster's number.

3.3 RESULTS AND DISCUSSION

Assessing projected climate change across West Africa maintains many of the trends observable from 2000 to 2020. Temperature changes are projected to be the most severe in the arid north of the region, with the least amount of projected temperature change in the coastal south (Figure 3.1A). Precipitation changes from 2020 to 2100 are determined regionally. The southeast and southwest areas of West Africa are projected to see increases in precipitation, while a band across the northern portion of the region demonstrates a marked decrease in precipitation (Figure 3.1B).

For each region, we found a unique number of climate change and conflict vulnerability clusters. We present information on where these different clusters are within their respective region (Figures 3.2 to 3.5). In the supplemental information, we provide summary statistics for each cluster (n=53) within the four subregions (Annex A.3, vulnerability clusters and data profiles). Below, we begin by describing basic patterns in subregional vulnerability clusters before presenting a set of vulnerability profiles relevant to World Bank operations in West Africa.

3.3.1 REGIONAL TRENDS IN CONFLICT AND CLIMATE CHANGE VULNERABILITY CLUSTERS

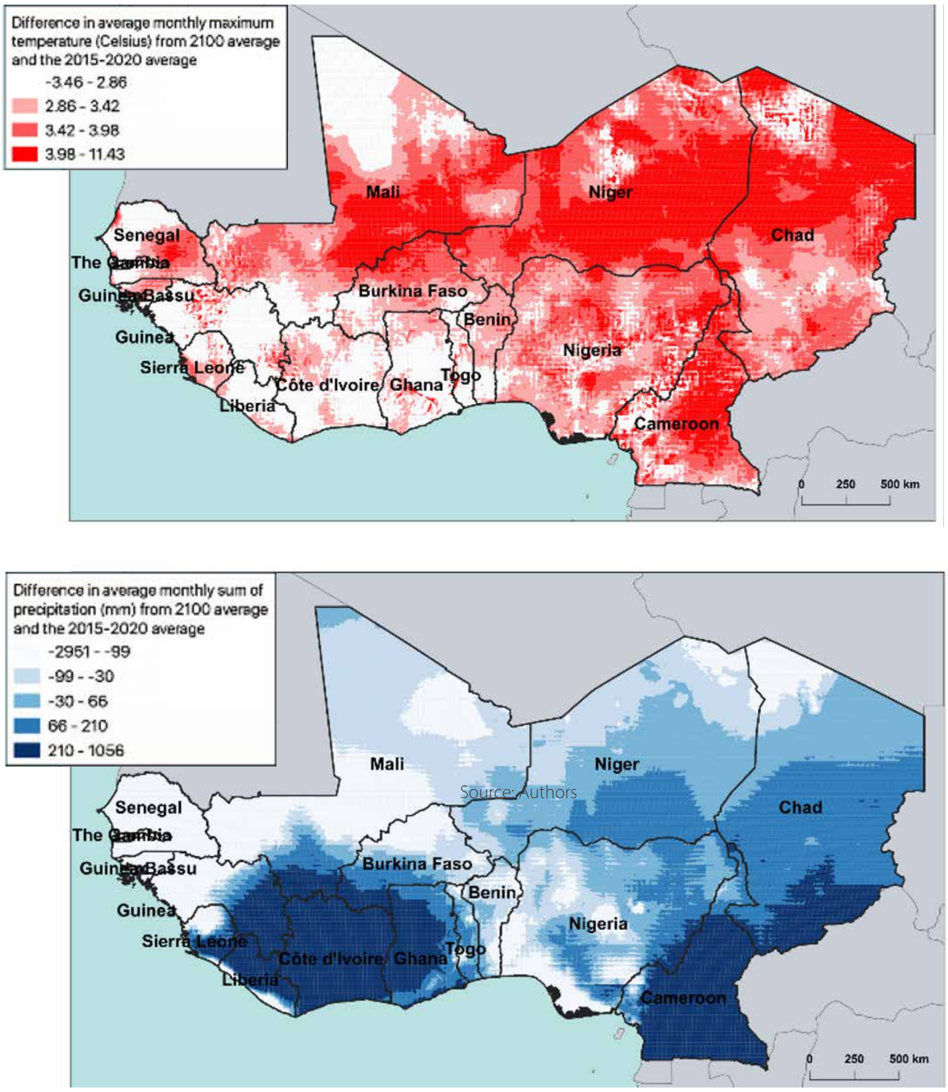
Generating regional vulnerability clusters can assist with identifying variation in predicted changes in climate alongside conflict between 2000 and 2020. As demonstrated by the vulnerability clusters, urban West Africa is susceptible to vulnerabilities different from those for rural West Africa. Urban clusters have higher levels of endemic conflict but are predicted to face comparatively less temperature and precipitation change from 2020 to 2100. Even where urban areas face similar or high levels of predicted temperature or precipitation change, infrastructure can moderate the negative effects of exposure and reduce vulnerability. However, such moderation by infrastructure is contingent. For example, urban infrastructure may moderate the effects of temperature increases through better availability of water, electricity, and air-conditioning. But temperature increases may have a greater effect if accompanied by loss of green cover in urban areas. Though we generally recognize nighttime lights, road networks, and distance to surface water as contributing to a population's capacity to adapt to climate change, this may not always be the case. Thus, working at local scales and in consultation with communities will enable more informed, locally relevant assessments of vulnerability and is therefore of critical importance to identify climate vulnerabilities that are not visible in large-scale statistical modeling.

Rural regions defined by high levels of conflict, projected increases in temperature and decreases in precipitation, as well as little electrical or water infrastructure will be at particular risk in West Africa. Highlighting where such clusters exist within regions will be critical to addressing conflict as well as promoting climate-smart adaptation. For the most part, these clusters are inland, often adjacent to international borders, and occur in each region. Though their sensitivity as measured by total population or population change is less, these clusters also face greater challenges for adaptation due to little infrastructure and poor connectivity.

For the Sahel Region, we identified an optimal cluster size of 19. In the Sahel Region, Cluster 2.5, which represents a ring of periurban cells surrounding Bamako and Ouagadougou represent an intersection of endemic conflict (mean conflict fatalities per cell = 14.94) and projected climate change (mean maximum monthly temperature change 2100–2020 = 3.25°C; mean maximum monthly precipitation change 2100-2020 = 0.01 mm). Clusters 1, 1.1, and 1.2 in the Liptako Gourma area also represent an important set of vulnerabilities, with a high level of conflict, some of the greatest projected temperature increases and precipitation decreases (see detailed overview of Sahel clusters in Table 3.2 below; summary statistics for all clusters are contained in Annex A).

In the Lake Chad Region, there are 15 vulnerability clusters. Cluster 2.1, found mostly in central as well as southwest Nigeria, experienced large increases in population, high levels of conflict, and is projected to experience more than 3°C of average maximum monthly temperature increases with a notable decrease in precipitation (mean = -16.43 mm). Similarly, Cluster 1, which defines the northern region of Nigeria, experienced high levels of battles and remote violence as well as violence against civilians, and it is projected to experience an average increase of 3.4°C in average monthly maximum temperatures from 2020 to 2100, and minimal changes in precipitation (11 mm). However, the urban regions surrounding Lagos, across southern Nigeria, and surrounding Yaounde that comprise Clusters 3 and 3.1 contain the greatest average amount of violent endemic conflict, increases in temperature, and some of the greatest decreases in precipitation within the region. Though Clusters 3 and 3.1 are marked by greater infrastructural capabilities, such as nighttime light emittance and road networks, their high levels of exposure and sensitivity render them particularly vulnerable to climate change and conflict.

FIGURE 3.1 Projected difference in monthly maximum temperature, 2100–2020 (A); and projected difference in monthly sum of precipitation 2100–2020 (B)



Source: Authors

The Gulf of Guinea region contains 12 vulnerability clusters. Among these, urban clusters include Clusters 3, 3.1, 5, and 5.1. All of these clusters have elevated conflicts, increases in violent conflict, and similar temperature as well as precipitation increases. Cluster 6, which defines northern Benin, is projected to face the greatest temperature increase as well as the greatest precipitation decrease of any cluster in the region.

The Westernmost region of West Africa contains nine clusters. Urban clusters 1 and 2 face the greatest vulnerability from combined conflict occurrence and projected climate change, in addition to the largest growth in population. Cluster 1.1, which covers most of Guinea, is predicted to face some of the greatest decreases in precipitation in addition to a modest rise in temperature.

FIGURE 3.2 Climate Change and Conflict Vulnerability Clusters in the Sahel Region. Note that the naming of clusters is purely for identification and is unrelated to the distribution of characteristics that generate the clusters.

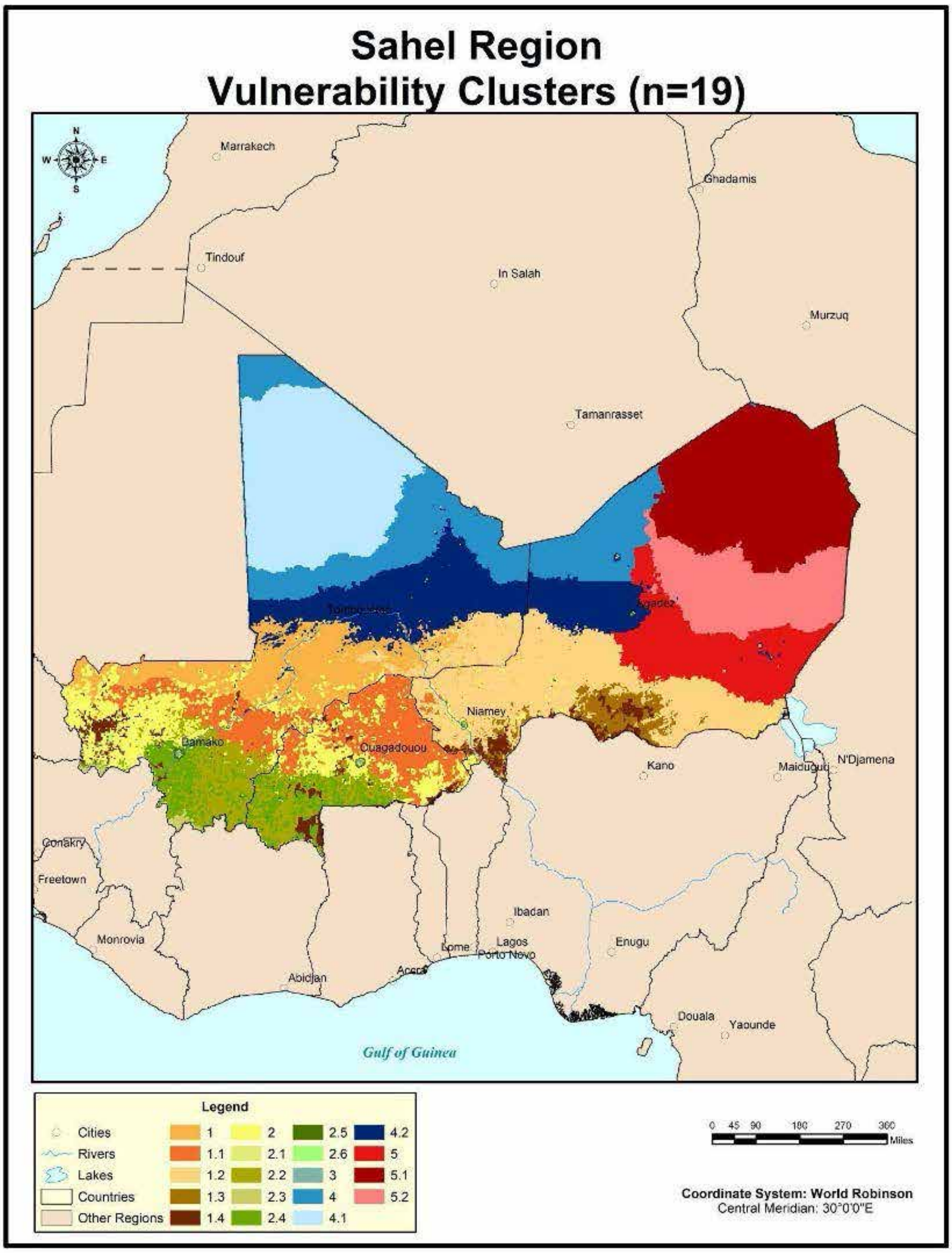


FIGURE 3.3 Climate change and conflict vulnerability profiles in the Lake Chad Region. Note that the naming of clusters is purely for identification and the value of the clusters themselves are unrelated to the distribution of characteristics that generate the clusters.

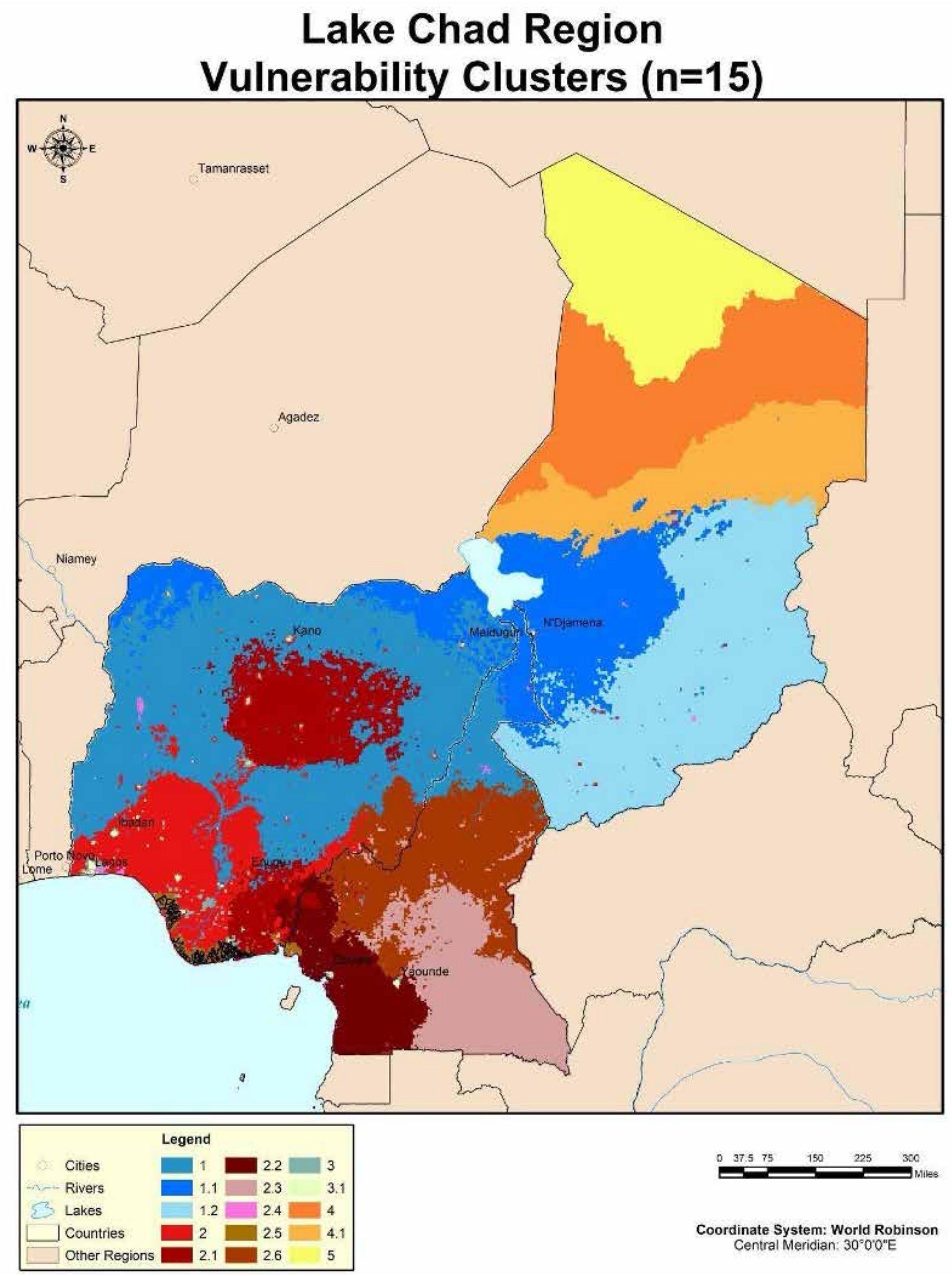


FIGURE 3.4 Climate change and conflict vulnerability profiles in the Gulf of Guinea Region. Note that the naming of clusters is purely for identification and the value of the clusters themselves are unrelated to the distribution of characteristics that generate the clusters.

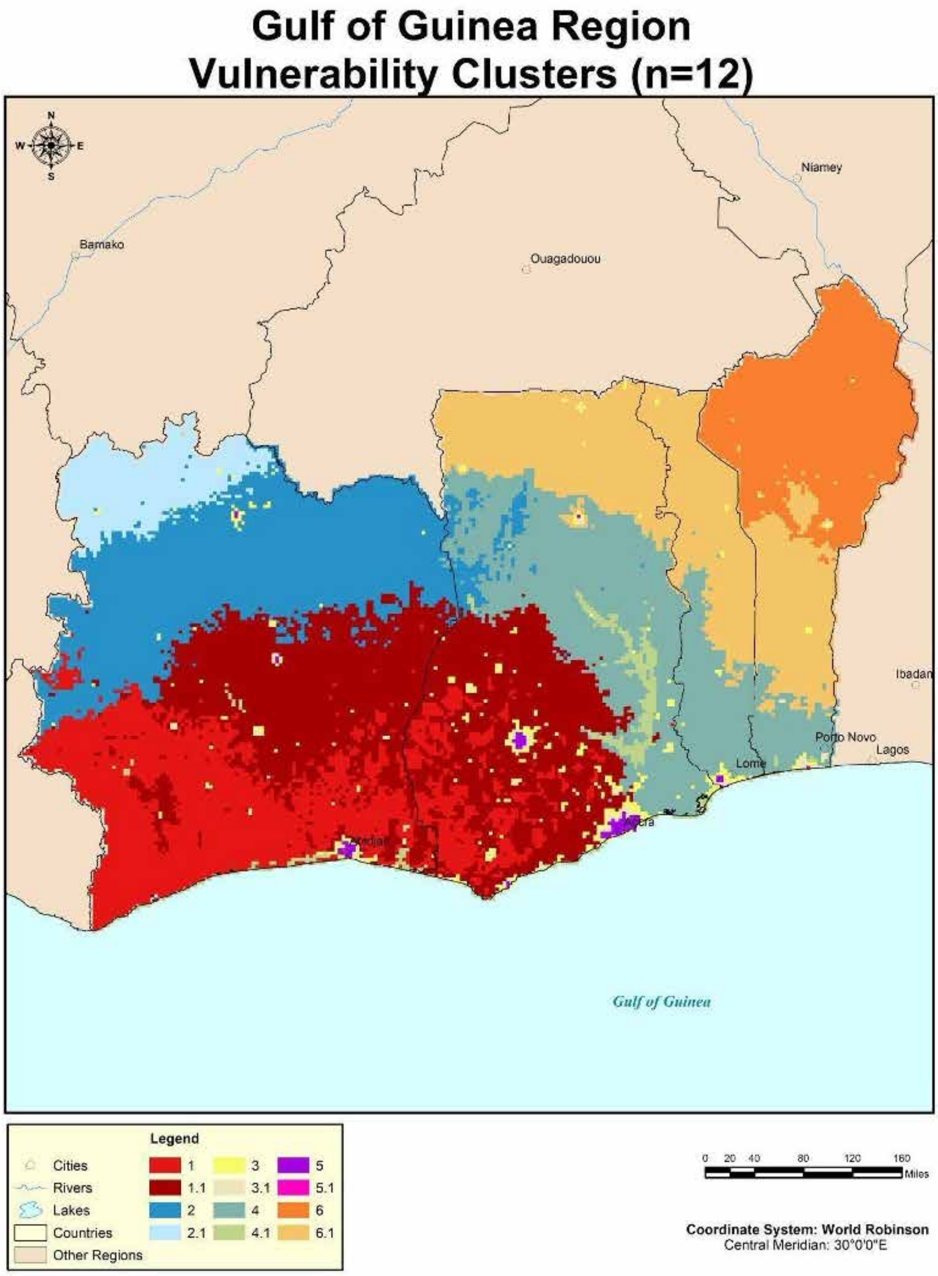


FIGURE 3.5 Climate change and conflict vulnerability profiles in the Westernmost Africa Region. Note that the naming of clusters is purely for identification and the value of the clusters themselves are unrelated to the distribution of characteristics that generate the clusters.

3.3.2 VULNERABILITY PROFILES AND ADAPTATION STRATEGIES

Governments and agencies at different levels, civil society organizations, and households and communities are recognizing the escalating threat and urgency of climate change impacts and how they increase vulnerability—especially for those who are already poor and living in marginal environments. The multiplier effects of climate change on conflict drivers make it even more important to identify effective adaptation strategies that increase the capacity to cope with climate risks, mitigate future conflict threats, and increase the prospects for human and societal wellbeing. Tying together information about climate change and conflict pathways with regional, district, or village vulnerabilities is critical when identifying what adaptation strategies might best improve human well-being and resilience.

The ensuing discussion considers the relationship between vulnerability profiles and six adaptation strategies that have met with success in dryland environments. We drafted vulnerability profiles for vulnerability clusters that define ongoing World Bank project locations. We pair these profiles with a small number of strategies common to dryland regions around the world. The pairing and discussion aim to illustrate how an understanding of vulnerability profiles can support development decision-making rather than providing a comprehensive suite of adaptation strategies suited to each vulnerability profile identified in our analysis. The discussion of vulnerability profiles, as also of adaptations, is thus relatively general.

Existing scholarship and project-funded work on climate-linked adaptation identifies a large number of responses that can be deployed to address climate risks and impacts. We selected the adaptation examples through a review of research on household and community adaptations and documents for adaptation projects supported by the Global Environmental Facility and the Adaptation Fund. The selected adaptations meet three criteria: 1) they are being practiced at the local level; 2) they occur in several locations in response to climate-linked vulnerability, thus providing some preliminary evidence in favor of broader adoption across contexts, and 3) they improve at least two of the three objectives of risk reduction, conflict threat mitigation, and/or wellbeing improvements. Table 3.1 summarizes this information on each adaptation strategy. We note at the outset that the effectiveness of observed climate adaptation strategies in mitigating climate-related conflicts is unclear. What is promising, however, is that many of these same adaptation strategies target the mechanisms through which climate impacts are hypothesized to translate into conflict. They dampen resource competition; they reduce the likelihood of migration; or they strengthen institutional mechanisms that may help resolve grievances and tensions.

Addressing vulnerabilities in the clusters below should, focus on reducing any existing violent conflict while attending to climate change vulnerabilities. Though some clusters contain comparatively little violent conflict, all clusters contain some element of climate change vulnerability. Note again that individual clusters are distinguished as numbers and that these numbers are unrelated to the distribution of the variables used to identify the cluster in the analysis. Providing information such as the vulnerability profiles, below, can empower decision-makers and communities to make decisions about the comparative importance of different hazards, and the nature of climate change within a cluster. These profiles should not be interpreted as a replacement for community-driven development, but rather a complement to processes that incorporate local voice and knowledge.

TABLE 3.1 Climate Change Adaptation Strategies

Adaptation Strategy	Description
Support for climate-resilient agricultural practices	There is very broad range of activities that have been supported by adaptation interventions in the agricultural sector. They cover all stages and aspects of agricultural production. Some target improvements in production by focusing on the different inputs needed to undertake production. Support for drought or salinity or heat-tolerant, short-duration, pest resistant, or genetically improved crop varieties, seed multiplication plots, or drip irrigation technologies are all documented to improve output or reduce risks. Other interventions have targeted on-farm agricultural practices once inputs are secured. Diversification of income and production portfolios can mitigate some risks in location. Other interventions concern postproduction harvesting and storage, transportation, and marketing activities. And in some cases, specific interventions relate to the infrastructure that underpins agricultural production—whether finance, communications and transport, price information, labor supply, or agricultural support policies. The goals of such interventions are twofold: reduce climate-related risks, and increase agricultural productivity and output.
Landscape restoration	Adaptation projects that support restoration of vegetation, tree cover, and use of these resources to supplement household incomes are widespread, and for good reason. Rural households can plant trees even around their homestead, but improved tree cover in agricultural fields and around settlements can also contribute to the supply of fodder and firewood, supplement food supply, provide small amounts of timber to households, and enhance soil fertility depending on choice of species.
Water supply improvements	One of the most important targets of climate adaptation in dryland regions is improvement in water supply, both for drinking and for animals, but also for agricultural purposes. Adaptation related to water use for agriculture can target both supply (through provision of small or larger scale irrigation) and demand (through provision of precision irrigation). Interventions that focus on water services to support adaptation and improve output typically require relatively large investments, either in the form of capital supplied by donor-funded projects or from governments, and in the shape of labor from beneficiaries.
Climate information sharing	Improved climate information can support timely responses to climate risks and more effective adaptation. It is true that early optimism about how information services can help improve adaptation has dampened because of variable coverage of information sharing arrangements, limited interest in information services among stakeholders, and uncertainty associated with climate information. More effective institutional mechanisms to share information, particularly about disasters but also for adoption of novel agricultural practices, use of alerts or prompts through mobile devices, and stronger community involvement in risk assessment and management through scenario exercises can improve the overall effectiveness of shared information. Support for participatory demonstration plots, farmer field trials, and exchange visits are an effort to involve stakeholders more directly in information sharing through participation and demonstration activities.
Disaster risk preparation and planning	Adaptive interventions include development of risk assessment and guidelines, both at the community level and beyond. Such planning is of use both in relation to slow onset disasters such as droughts or sea-level rise, but also for rapid onset disasters such as rainfall events, floods, or storms.

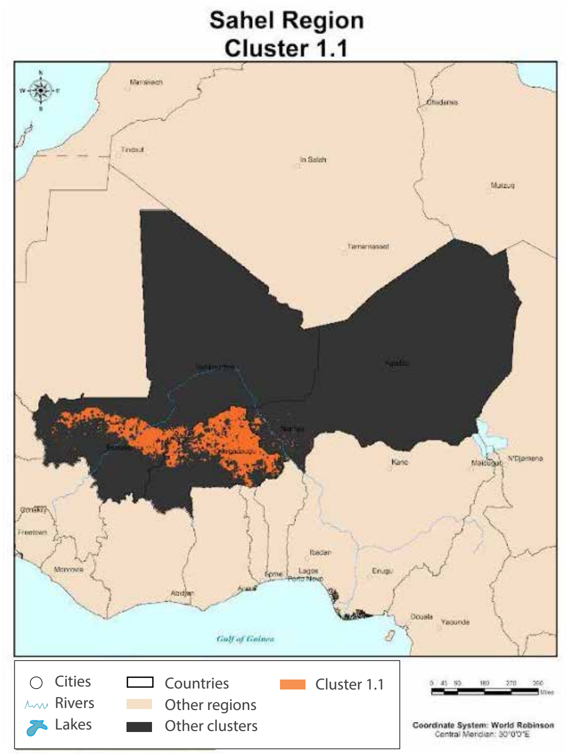
Stakeholder Training	Elements of training programs in diverse arenas are part of many external interventions to support adaptation to climate risks. Forestry, water infrastructure management, agricultural and livestock resilience, development of risk assessments and planning and many other sectors have seen diverse training efforts by externally supported projects for adaptation. Farmer Field Schools are one common way to support adaptation through directed training for farmers that can at times involve farmers themselves as trainers. Training programs ultimately seek to ease the transition after external support ends and aim at enabling self-organized targeting of the mechanisms through which climate impacts can translate into conflict.

TABLE 3.2 Overview of selected Sahel Region Vulnerability Clusters

Sahel Region, Cluster 1.1

Cluster 1.1 in the Sahel Region is dominated by the border region between Mali and Burkina Faso, with the majority of grid cells in Burkina Faso. This cluster is 174,250 km2 with a mean population of 44.9 people/km2. From 2000 to 2020, the population in this cluster grew at an average of 18.8 people/km2. The change in average maximum temperature between 2020 and 2100 is predicted to be 3.66 °C, with a decrease in annual precipitation of 114.83 mm. Conflict deaths per 1,000 inhabitants was 0.29. For such a rural region, this represents a comparatively high number of conflict fatalities.

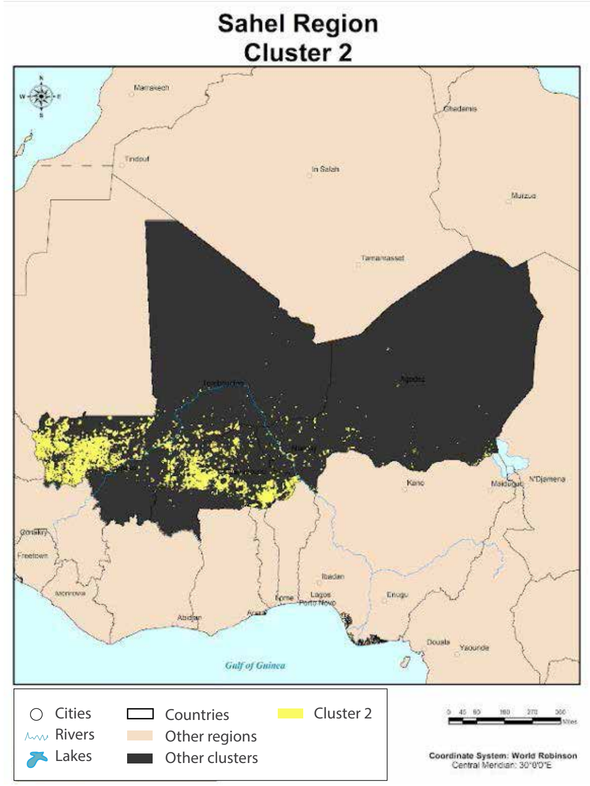
Adaptation efforts that address the spread of violent conflict while promoting resilient agriculture and ensuring continued water supply will be critical.



Sahel Region, Cluster 2

Cluster 2 in the Sahel Region covers an area of 191,375 km2, with most grid cells in Mali and Burkina Faso. Much of this cluster occurs on or near international borders, the most common land type is grassland, and the cluster contains the third greatest tree cover loss in the region. Between 2020 and 2100, average monthly temperature is expected to increase by 3.5°C, and annual precipitation is projected to decrease by 164.06 mm. These climate impacts are some of the most severe for this region, and they are compounded by exposure to violent conflict. Cluster 2 contains the third highest level of mean conflict deaths per grid cell (1.28 per 1,000 people) in the Sahel Region. One of the defining qualities of this cluster is the high number of conflicts in cells with comparatively low population densities. With an average population density of 46.5 people/km2 that grew by 20.8 people/km2 from 2000 to 2020, this region contains a high ratio of conflict deaths to total population. This cluster also has the second longest average travel time to surface water in the region among clusters that are not sparsely populated desert (that is, primarily desert land cover with < 4 people/km2).

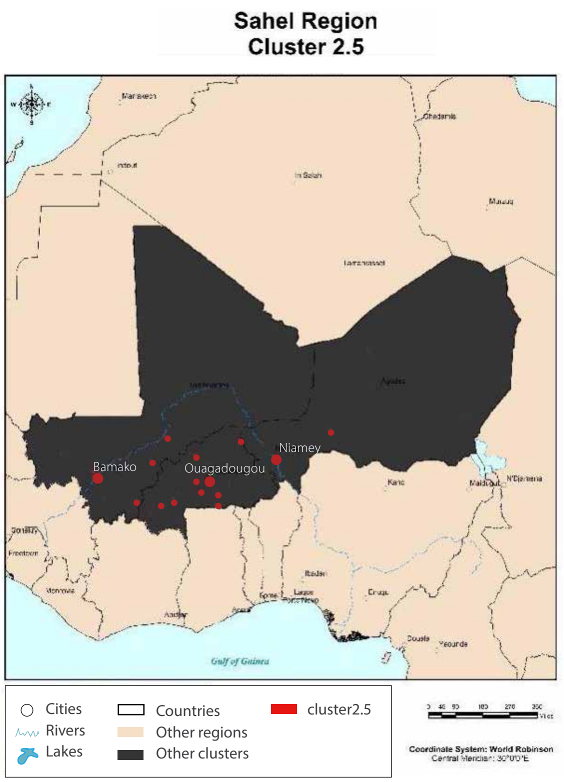
For this cluster, it will be important to address violent conflict by empowering local stakeholders and ensuring continued water supplies and storage, as well as preparing for droughts.



Sahel Region, Cluster 2.5

Cluster 2.5 in the Sahel Region covers an area of 5,450 km2, with most grid cells in Mali. This cluster is dominated by peri-urban grid cells with grassland comprising the dominant land cover. Between 2020 and 2100, average monthly temperature is expected to increase by 3.3°C, but with precipitation almost unchanged. Cluster 2.5 contains the second highest level of mean conflict deaths per grid cell (14.9 per 1,000 people) in the Sahel Region. This cluster contains the second greatest population (690.9 people/km2) and the second greatest increase in population within the region (436.2 people/km2). Cluster-level infrastructure is similarly low relative to the population, with the second longest average travel time to surface water (that is, excluding cells that are primarily in desert areas).

Addressing violent conflict is of critical importance in this region. Doing so in a way that trains local people to contribute widely to services and goods production in a peri-urban region will be of chief concern.

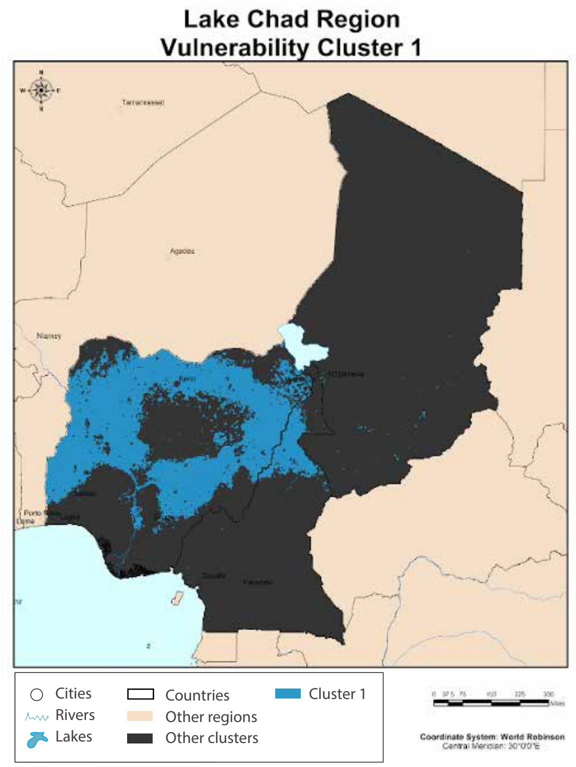


Note: To improve visualization, Sahel Cluster 2.5 is depicted in red. In the regional map, Sahel Cluster 2.5 is depicted in green.

Lake Chad Region, Cluster 1

Cluster 1 in the Lake Chad Region covers an area of 500,800 km2, with most grid cells in northern Nigeria and Cameroon. Much of this cluster occurs on or near international borders, and the most common land type is cropland. Between 2020 and 2100, average monthly temperature is expected to increase by 3.4°C, and annual precipitation is projected to increase by 12.0 mm. Cluster 1 contains the third highest level of mean conflict deaths per grid cell (1.8 per 1,000 people) in the Lake Chad Region. A defining quality of this cluster is the high number of average conflict deaths in cells outside predominantly urban clusters. This cluster has the highest average conflict fatalities of any rural cluster in the region. The average population density in this cluster is 126.4 people/km2 and it grew by 58.7 people/km2 from 2000 to 2020.

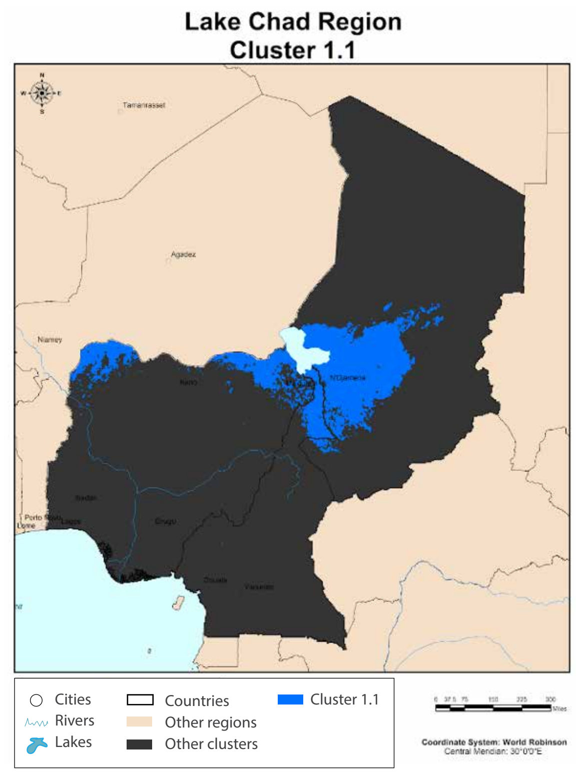
Addressing violent conflict, migration, and resilient agriculture will be important in this cluster, given the prediction of increased maximum temperatures and unchanged precipitation.



Lake Chad Region, Cluster 1.1

Cluster 1.1 in the Lake Chad Region covers an area of 279,700 km2, with grid cells around Lake Chad in Nigeria as well as Cameroon. Much of this cluster occurs near international borders and the most common land type is grassland. Between 2020 and 2100, average monthly temperature is expected to increase by 3.5°C, and annual precipitation is projected to increase by 110.9 mm. Cluster 1 contains 0.4 conflict deaths per 1,000 people. The average population density in this cluster is 38.5 people/km2 and it grew by 17.7 people/km2 from 2000 to 2020.

Working with stakeholders to develop adequate responses to high population growth in this region will be important to ensure climate-smart development addresses conflict vulnerabilities.



Gulf of Guinea Region, Cluster 2

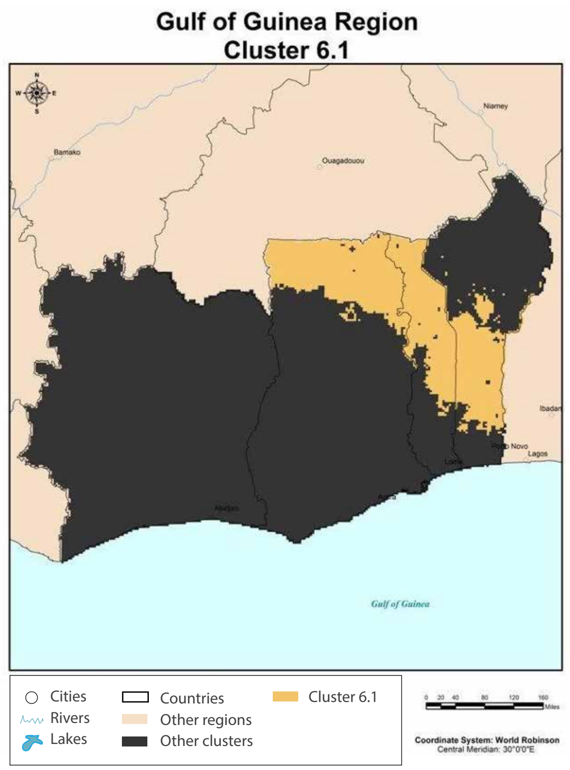
Cluster 2 in the Gulf of Guinea Region spans northern Côte d'Ivoire and extends into Ghana. This cluster is 156,725 km2 with a mean population of 69.9 people/km2. From 2000 to 2020, the population in this cluster grew at an average of 21.8 people/km2. This cluster had the fourth greatest level of forest loss in the region. The change in average maximum temperature between 2020 and 2100 is predicted to be 2.54°C, with an increase in annual precipitation of 538.5 mm. This represents one of the greatest increases in annual precipitation of any cluster in the region. The average number of conflict fatalities per 1,000 inhabitants was 0.04, and this cluster contained the second longest average travel time to surface water in the region.

Adaptation strategies aimed at landscape restoration hold promise for mitigating potential impacts from increased rainfall, offsetting rising temperatures, and contributing to resilient local livelihoods.

Gulf of Guinea Region, Cluster 6.1

The Gulf of Guinea cluster 6.1 is located mostly in northern Ghana but extends to cover northern Togo and central Benin. The dominant land cover class in this cluster is grassland, but it has the second highest proportion of land cover change (18.2 percent) in the Gulf of Guinea. This cluster is 115,200 km2 with a mean population of 86.1 people/km2. From 2000 to 2020, the population in this cluster grew at an average of 30.0 people/km2. The change in average maximum temperature between 2020 and 2100 is predicted to be 2.61°C, with an increase in annual precipitation of 429.43 mm. The average number of conflict fatalities per 1,000 inhabitants was 0.03.

Landscape restoration and resilient agriculture hold promise for addressing climate change and conflict vulnerabilities in Cluster 6.1.



3.4 A DIGITAL CATALOGUE TO IMPROVE ACCESS TO CLIMATE VULNERABILITY INFORMATION

Identifying the most promising adaptation strategies to address climate change and conflict requires information to be useful as well as usable. Useful information in this context refers to findings that promote understanding about, and address community needs related to, climate change and conflict. The research within this report thus advances useful information related to basic understanding of climate change and conflict dynamics and describing vulnerability trends across West Africa. For this information to become usable, however, requires uptake by those who design, implement, and participate in adaptation strategies.

The usability of climate information is not an inherent quality of any finding or fact. Rather, it exists in the relationship between users and information. Three factors determine the extent to which climate information is usable: users' perception of how well the information fits their context, complementarities between new information and preexisting knowledge upon which users draw; and the extent and quality of interaction between users and climate information (Lemos et al. 2012). Enhancing the usability of information in this report thus depends upon the extent to which users are able to access it, how it points to reasonable and effective adaptation strategies, and a set of processes for promoting ongoing engagement.

Usefulness and usability require two additional elements: access and awareness. To maximize the actionability of the climate models, a web-based tool is under development. This tool will allow policy makers and researchers to access the data directly, or use filtering and visualization mechanisms, for their own analysis. Users will be able to do simple querying and filtering of the data and tailor basic visualizations to their needs. Improved understanding of vulnerability profiles will help policy makers craft better climate responses at local, national, and regional levels. Additionally, government policy planners can look at local level data to find patterns and insights across geographic areas to begin formulating individual and collaborative responses. The dataset, visualization, and querying tools, and supporting content could, over time, be incorporated into regional or national Knowledge Management Platforms (KMP).

The climate data tool will also allow users to closely scrutinize specific regions and communities, conduct comparisons across locales and national borders, and explore the data overlaid on maps. The tool is web-based and relies on standard web page components, such as sliders and pull-downs, to ensure maximum ease of use. Further, the tool is able to expose as many variables to the user as deemed relevant, with the possibility of exposing more over time.

The tool will help cluster communities into profiles that reflect their climate vulnerability and adaptability. The clusters are descriptive in terms of geography, climate, and conflict risk. However, the app is not intended to be a final decision-making tool. Instead, it should be used as a starting point for prioritization or an input into the final decisions that communities and policy makers make. The underlying data and the profile can be useful to policy makers in multiple ways:

- Identify areas with common vulnerabilities to formulate adaptation responses.
- Compare communities with similar vulnerability profiles to find additional underlying commonalities that can further inform responses.
- Identify projects and areas at greater risk due to climate vulnerability and conflict.
- Explore and compare sensitivities, adaptive capacity, and particular needs of specific locations to build programs around them.
- Generate clusters of areas with similar climate vulnerability profiles and responses to create

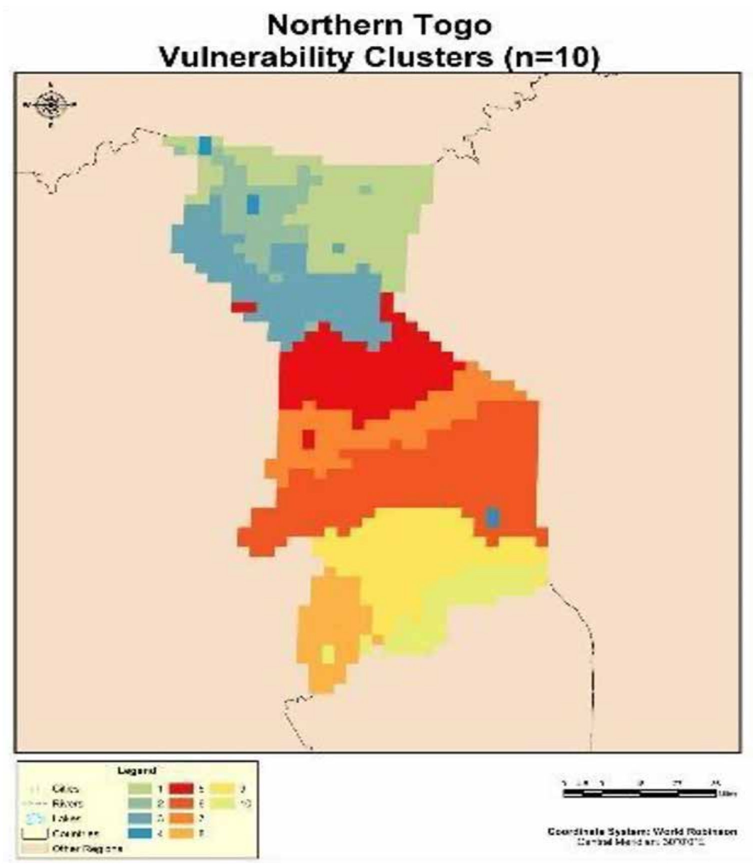
efficiencies in the use of resources.

- Identify communities and profiles to be prioritized for resources, and identify gaps in their ability to respond.
- Use these vulnerability profiles as input for creating templates for response and policy that communities can use to start their planning and adaptation responses.
- Use vulnerability profiles to inform CDD and Community Engagement (CE) planning and activities.

At a national level, vulnerability profiles of specific areas will help users to identify clusters or see differences in vulnerabilities among clusters, thus assisting local governments in the formulation of their local development plans.

This analysis focused on generating and analyzing clusters at the regional level, but the underlying methodology is flexible with respect to scale. Generating vulnerability clusters for northern Togo, for example, provides a more focused evaluation of variation across data for exposure, sensitivity, and the capacity to adapt to conflict or climate change (Figure 3.2). Combining regional, national, and subnational cluster analysis can assist with the coordination of development investments, and it can facilitate the communication of predicted vulnerabilities to communities interested in conscientious development planning. In addition, working with local groups to review the findings from the vulnerability clusters and the related data summaries can help to validate the findings presented here and tune future cluster analyses.

FIGURE 3.6 Northern Togo Vulnerability Clusters



4 CONCLUSION AND RECOMMENDATIONS

The research and analysis on which this report is based identifies extremely promising new opportunities to interconnect vulnerabilities related to conflict and climate change. The resulting data and information products yield operationally relevant lessons for addressing climate–conflict vulnerabilities by pursuing climate-resilient and community-driven development in West Africa.

To conduct our research, we first considered the state of the literature on climate change and conflict and its relationship to climate vulnerability. We identified three broad pathways through which climate change influences violent conflict: economic (often agricultural) production shocks, resource decline and competition, and migration. These broad pathways may at times be interrelated, but they can be divided into specific causal mechanisms that connect changes in temperature, precipitation, or climate-related disasters with violent conflict. The importance of local context, social and economic conditions, institutional deficits, and historical patterns of group relations are especially relevant to whether climate risks translate into conflict and violence. The analysis thus highlights the importance of combining region-level insights based on statistical analyses (see Part I) and local patterns based on situation-specific knowledge for a deeper understanding of climate change and conflict relationships (see Part II).

Combining a predictive model of conflict based on data often included in climate change and conflict research with case studies of climate-related drivers of conflict also emphasizes the value of linking regional and local insights. The best-performing models used in the analysis in this report were reasonably accurate in predicting the location of violent conflicts in West Africa. But for operationally relevant insights, the insights from statistical models need to be animated with local knowledge. This is worth highlighting for three reasons. One, the most important predictor variables in this model were not climate-related. Demographic and infrastructure data were of substantial importance in modeling the occurrence and location of conflict. Two, it is unclear to what extent the climate variables included in this model represent relationships between climate change and conflict or are the product of confounding. The classification models are agnostic to causality, and thus do not generate causal insights concerning climate change and conflict. For example, the standard deviation of average monthly maximum temperatures—an important variable in modeling conflict occurrence—may be a proxy not for climate change, but of regional differences that co-occur with temperature variation. Although the best-performing model we developed could accurately identify locations where conflict did and did not occur, it does not provide insight into why such conflict occurred. Three, the modeling we conducted is most useful to consider the limits of data often used in climate change and conflict research. Assessing the validity of classification models for conflict occurrence highlights where data often used in climate change and conflict studies are sufficient for modeling past conflict, and where they are not. It provides only limited substantive information about the relationship between these variables. It does identify where the data accurately predict conflict occurrence. Thereby, the identification of subregional trends related to the accuracy of our classification model is useful for pointing out where current information is reasonable to use versus where there are gaps in understanding or information. In combination with case study insights, the modeling has the potential to identify the additional specific data and variables that will advance knowledge about the relationship between climate change and conflict.

To assess the type of vulnerability different parts of West Africa experience, Part III developed vulnerability clusters in four regions: The Gulf of Guinea, Lake Chad, Sahel, and Westernmost Africa. Within these regions, we identified 12 vulnerability clusters in the Gulf of Guinea, 15 clusters in Lake Chad, 19 clusters in the Sahel, and nine in Westernmost Africa. Each cluster is defined by a specific form of vulnerability. Focusing on the concrete features of different vulnerability profiles that characterize different clusters helps disseminate relevant information about vulnerability to stakeholders and decision-makers. It is also useful to identify the climate-smart adaptation and development strategies that are best suited to the vulnerability profile that characterizes the cluster. In this manner, the approach to vulnerability analysis used in this report can be harnessed to inform operations that respond to the most pressing needs of vulnerable communities.

4.1 ENTRY POINTS & OPERATIONAL LINKAGES

4.1.1 DIGITIZING VULNERABILITY CLUSTERS

To make the vulnerability data presented in this report more comprehensible, accessible and operationally relevant, an online platform allowing diverse stakeholders to intuitively engage with the data generated by this research is currently under development. The platform will allow users to navigate a map of West Africa that is overlaid with climate-vulnerability data. Apart from providing cluster descriptions and enabling rapid access to summary statistics linked to grid cells within a chosen cluster, a filtering tools enables users to filter and query the climate change, conflict, and adaptive capacity variables for their own analysis. Using the tool to explore and compare adaptive capacity and exposure for specific locations could provide development practitioners, policy-makers and civil society with additional evidence on regions likely to benefit particularly from investments into adaptation or social safety nets. Data contained in climate–conflict vulnerability clusters, especially when augmented by an interactive platform, can be harnessed across the whole operational spectrum from high-level discussions with clients to field-level operations at the community-level.

4.1.2 OPERATIONAL LINKAGES

The climate conflict vulnerability clusters could be a valuable component in formulating regional, national, and local responses to climate and conflict challenges. Knowledge Management Platforms (KMPs) in and across these regions will host new data, new content, and ongoing dialogue. There are currently four WBG-financed regional projects that could leverage this digital tool as part of their planned KMPs: 1) Community-Based Recovery and Stabilization Project for the Sahel; 2) Lake Chad Region Recovery and Development Project (PROLAC); 3) Gulf of Guinea Northern Regions Social Cohesion Project; and 4) the West Africa Food System Resilience Program (FSRP). The FSRP aims at increasing the resilience of the West African food systems, whereas the former three are designed to support stabilization and prevention of climate and conflict-related risks. They use a regionally coordinated approach to inform locally adapted investment into community-driven development (CDD). More specifically, climate conflict vulnerability clusters could benefit operations and analytical work in four ways:

First, vulnerability cluster information can strengthen the evidence base underlying regional, national and subnational climate adaptation dialogues and knowledge management platforms. While vulnerability clusters featured in this work were generated at the regional level, the existing dataset can also be used to derive clusters at national and subnational levels depending on operational needs.[19] In addition, the vulnerability cluster approach is variable-agnostic, meaning that additional socioeconomic and biophysical variables for which spatial data is available can be used to generate vulnerability clusters. Given this flexibility, vulnerability cluster generation could be adapted and integrated into both regional and national knowledge management platforms (KMPs) which are planned under ongoing operations such as the PROLAC project (mentioned above). Relatedly, combining regional with national, or subnational cluster analysis can provide additional evidence to identify communities and areas that require interventions most urgently and thus contribute to increasing the effectiveness with which available resources are deployed. It is important to note that vulnerability clusters, alone, do not provide a metric for prioritizing regions for funding or interventions. The clusters can, however, be paired with a prioritization measurement to evaluate relative development needs.

Second, evidence provided by the clusters could enhance regional Country Climate and Development Reports (CCDR). Designed specifically to tackle disconnects between climate and development policies, CCDRs help inform country strategies by exploring synergies between climate action and measures that promote economic growth, shared prosperity and poverty reduction. Integrating multidimensional climate–conflict vulnerability data would strengthen the evidence base of the CCDRs by providing an

[19] Vulnerability clusters change according to the region in which they are specified and the data on which they are based.

opportunity to map hotspots and facilitate the identification of resilience-building strategies that more adequately reflect subnational variations of climate exposure and adaptive capacity.

Third, vulnerability profiles could be deployed to facilitate comparative research on the effectiveness of development interventions and knowledge exchanges. Connecting vulnerability profile data with program monitoring and evaluation systems can facilitate monitoring of the impact of different types of interventions both across and within vulnerability clusters. For example, vulnerability clusters might be useful for informing the selection and comparison of monitoring and evaluation and impact evaluation sites in the context of the West Africa Food System Resilience Program (FSRP). In addition, cluster data could be used for targeted knowledge exchanges and peer-to-peer learning by bringing together stakeholders (for example, at community, municipality, provincial or national level) from areas with similar vulnerability profiles. This might promote the diffusion of best practices and lessons learned linked to conflict-sensitive climate adaptation strategies across areas with shared vulnerability characteristics.

Fourth, both the targeting and design of field-level operations could benefit from vulnerability cluster information. The interactive platform provides an easily accessible tool for raising the awareness of clients, task teams, and community stakeholders about future climate risks and the existing adaptive capacity in different localities. By facilitating the identification of hotspot areas that score particularly low in terms of adaptive capacity but that are highly exposed to climate change impacts, the vulnerability data represents an important piece of evidence for discussions on program targeting. In addition, program facilitators could use the vulnerability information to verify the long-term viability of different options that are considered for local investments in the context of community-driven development (CDD) activities. For instance, if community stakeholders at a locale targeted by a CDD program propose investing in infrastructure needed for the cultivation and processing of climate-sensitive cash crops, the facilitator could combine the climate vulnerability data with local knowledge to explore whether growing the proposed crop would likely be viable in the medium-term considering site-specific climate projections.

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ANNEXES

Annexes

Annex A – Additional Information on Research Methods and Results

A1. Data sources, data treatment, and variables

Table A1.1: Data for describing conflict occurrence and generating vulnerability clusters. Values in "Input to Analysis" identify the use of a variable within the Conflict Occurrence Modeling analysis (COM), the Vulnerability Clustering (VC) analysis, or both analyses.

Variable Description	Inputs to Analysis	Vulnerability Category
VIIRS monthly average radiance in 2020	VC	Adaptive Capacity
Nighttime lights DMSP-like digital number (DN) (Li et al, 2020) in 2020	Both	Adaptive Capacity
Difference VIIRS monthly average radiance in 2020 between 2020 and 2000	VC	Adaptive Capacity
Multidimensional Poverty Index (MPI)	COM	Adaptive Capacity
ID for ethnic groups in grid cell	COM	Adaptive Capacity
Difference in nighttime lights DMSP-like digital number (DN) (Li et al, 2020) between 2020 and 2000	Both	Adaptive Capacity
Number of ethnic groups in grid cell	COM	Adaptive Capacity
Grid cell contains an international border	Both	Adaptive Capacity
Travel time to nearest populated place (minute)	Both	Adaptive Capacity
Road length (km/1000) circa 2020	Both	Adaptive Capacity
Country of majority 5km grid	Both	Adaptive Capacity
Difference in standard deviation of monthly maximum temperature from 2015-2020 average and the 2000-2005 average (C)	Both	Exposure
Difference in average monthly sum of precipitation from 2100 average and the 2015-2020 average (mm)	VC	Exposure
Difference in average monthly minimum temperature from 2015-2020 average and the 2000-2005 average (C)	Both	Exposure
Difference in standard deviation of monthly minimum temperature from 2015-2020 average and the 2000-2005 average (C)	Both	Exposure
Difference in average monthly maximum temperature from 2015-2020 average and the 2000-2005 average (C)	Both	Exposure

Difference in standard deviation of monthly maximum temperature from 2100 average and the 2015-2020 average (C)	VC	Exposure
Difference in average monthly sum of precipitation from 2015-2020 average and the 2000-2005 average (mm)	Both	Exposure
Measure of difference between general category of land cover between 2000 and 2020	Both	Exposure
Difference in average monthly Palmer Drought Severity Index (PDSI) from 2015-2020 average and the 2000-2005 average (mm)	Both	Exposure
Difference in average monthly Palmer Drought Severity Index (PDSI) from 2015-2020 average and the 2000-2005 average (C)	Both	Exposure
Difference in standard deviation of monthly minimum temperature from 2000-2005 average and the 1980-1985 average (C)	Both	Exposure
Difference in average monthly maximum temperature from 2000-2005 average and the 1980-1985 average (C)	Both	Exposure
Difference in standard deviation of monthly maximum temperature from 2000-2005 average and the 1980-1985 average (C)	Both	Exposure
Difference in average monthly sum of precipitation from 2000-2005 average and the 1980-1985 average (mm)	Both	Exposure
Difference in standard deviation of monthly maximum temperature from 2000-2005 average and the 1980-1985 average (mm)	Both	Exposure
Difference in average monthly Palmer Drought Severity Index (PDSI) from 2000-2005 average and the 1980-1985 average	Both	Exposure
Difference in standard deviation of monthly maximum temperature from 2015-2020 average and the 2000-2005 average (C)	Both	Exposure
Difference in average monthly minimum temperature from 2000-2005 average and the 1980-1985 average (C)	Both	Exposure
Occurrence of any conflict from 2000-2020	COM	Exposure
Difference in standard deviation of monthly maximum temperature from 2100 average and the 2015-2020 average (mm)	VC	Exposure

Any occurrence of ACLED event type Protests and Riots from 2000-2020	COM	Exposure
Any occurrence of ACLED event type Violence against civilians from 2000-2020	COM	Exposure
If a grid cell is adjacent to conflict (Queen's Continuity Matrix)	VC	Exposure
Sum of all fatalities for ACLED event types Battles and Explosions/Remote Violence, Violence against civilians, and Protests and Riots) from 2000-2020	VC	Exposure
Sum of all conflict events for ACLED event type Battles and Explosions/Remote Violence, 2000-2020	Both	Exposure
Sum of all conflict events for ACLED event type Violence against civilians, 2000-2020	Both	Exposure
Sum of all conflict events for ACLED event type Protests and Riots, 2000-2020	Both	Exposure
Travel time to nearest conflict event (minute)	VC	Exposure
Category of all ACLED conflict types that have occurred in this grid cell from 2000-2020 from 2000-2020	COM	Exposure
Any occurrence of ACLED event type Battles and Explosions/Remote Violence from 2000-2020	COM	Exposure
Standard deviation monthly minimum temperature (C)	VC	Exposure
Average monthly maximum temperature (C)	VC	Exposure
Standard deviation monthly maximum temperature (C)	VC	Exposure
Average monthly precipitation accumulation (mm)	VC	Exposure
Standard deviation of monthly precipitation accumulation (mm)	VC	Exposure
Average monthly PDSI from 2000-2020	VC	Exposure
Average standard deviation of monthly PDSI from 2000-2020	VC	Exposure
Difference in average monthly Palmer Drought Severity Index (PDSI) from 2000-2005 average and the 1980-1985 average	Both	Exposure
Average monthly minimum temperature from 2000-2020 (C)	VC	Exposure
Difference in average monthly maximum temperature from 2100 average and the 2015-2020 average (C)	VC	Exposure
Measure of NDVI from 2020	COM	Sensitivity
Population count in 2020	Both	Sensitivity
Land cover according to IGCP classification and then generalized to a set of 11 categories in 2000	VC	Sensitivity

Average annual population count from 2000-2020	VC	Sensitivity
Travel time to water body in 2020 (m)	Both	Sensitivity
Total forest loss within cell (2000-2020)	Both	Sensitivity
Difference in population count between 2020 and 2000	Both	Sensitivity
Land cover according to IGCP classification and then generalized to a set of 11 categories in 2020	Both	Sensitivity

Data Sources

Grid

The unit of analysis for both analyses are 5km X 5km grids which span the study area extent. There are a total of 273,411 5km X 5km grids therefore that were used to spatially summarize the various datasets. Given the inconsistencies in spatial resolution across the various datasets, each dataset is uniquely processed and summarized at the grid-level. Refer to the Treatment column in Annex A, Table A1.2 for a more detailed explanation of the processing applied to each dataset.

Conflict

The Armed Conflict Location and Event Data (ACLED) dataset was used to inform conflicts that occurred from 2000-2020. The ACLED dataset records individual events of conflict as reported in primarily news reports and for each event, characterizes the type of conflict event each event most identifies with, the location of the event (latitude and longitude), the timing of the event, information on the actors involved with the event and finally information on the total number of fatalities associated with each event. While there are numerous event types designated by ACLED, only three conflict event types were considered for this analysis include ACLED categorized "Violent Events" of "Battles", "Explosions/Remote violence" and "Violence against civilians", and the category of "Demonstrations" which entails "Protests" and "Riots". We have decided to lump Battles and Explosions/Remote Violence together as one event type (BExRem), leave Violence against civilians as its own event type (CivVio) and lump Protests and Riots together as a singular event type (RioDem). The conflict category we decided to omit was "Non-violent actions", which the ACLED taxonomy describes as Strategic Development event type (arrests, establishment of headquarters, etc). For each of the three event types, we summarize the total number of events and fatalities.

Climate

We draw upon both historical measures of climate and future modeled estimates of climate variables in order to create baselines of climate trends and assess differences between past and future climate projections. The climate variables we use from both the historical and future climate datasets are average monthly maximum temperature (C) and total annual precipitation (mm). For the historical climate estimates, we used the TerraClimate dataset which applies modeled climate anomalies to the high spatial resolution WorldClim product to create monthly climate estimates that span a large temporal swath at a relatively high spatial resolution. For the historical data, we averaged across months each year to get annual estimates from 1980-2020. For the future climate variables, we used the NASA Earth Exchange Global Daily Downscaled Climate Projections (NEX-GDDP) which includes XX models generated from the Global Circulation Model (GCM) under CMIP-5 with four different emissions scenarios. We took the mean across the model estimates from both the 4.5 and the 8.5 RCP emissions scenarios to get measures of average annual precipitation (mm) and average monthly maximum temperature (Celsius) in 2100.

Land Cover

Land cover classes from the International Geosphere-Biosphere Program (IGBP) classification scheme from the MODIS Land Cover Type Yearly Global 500m product were used as the input land cover dataset. The mode land cover within each grid cell was assigned as the grid cell's land cover value. The classification scheme includes a total of seventeen classes. A second land cover associated variable was collected is average annual Normalized Difference Vegetation Index (NDVI) from the MODIS Terra Vegetation Indices 16-day Global 1km product. NDVI is a commonly used remotely sensed spectral index which measures green vegetation. The 16-day NDVI composites were averaged across each year and the average value within each grid cell was calculated.

Forest Cover Loss

The Hansen Global Forest Change v1.8 (2000-2020) product was used to calculate the total area (ha) of forest cover loss each year from 2001-2020, cumulative area (ha) of forest loss across 2001-2020.

Nighttime Lights

Average annual radiance of nighttime lights was calculated from 2000-2020. Two separate products were used to create the annual time series. The Defense Meteorological Program Operational Line-Scan System (DMSP-OLS) was used to generate the 2000-2013 annual estimates and the Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB) to collect the 2014-2020 annual estimates.

Roads

Road lines from OpenStreetMap (OSM) were used to calculate the road length (km) within each grid cell. OSM is crowd-sourced data used in multiple open-source applications.

Population

Annual total population count from WorldPop was summarized within each grid cell from 2000-2020. In addition to grid-level population counts, the Natural Earth populated place points were used to estimate travel time for each grid cell to the nearest populated place. The populated place points include administrative 0 and 1 capitals, and major cities and towns.

Water Availability

The JRC Yearly Classification from 2019 was used to include classification of permanent and seasonal water.

Travel Time

The Global Friction Surface 2019 provides land-based travel speeds. The Global Friction Surface was used to generate travel times (minutes) to nearest ACLED conflict event, JRC permanent and seasonal water sources and Natural Earth nearest populated place point.

Ethnicity

Spatial data on ethnic groups comes from the Geo-referencing Ethnic Power Relations (Geo-EPR) dataset. Per this dataset, spatial polygons represent “politically relevant” ethnic groups (Vogt et al 2015). This data was processed to provide information on

Table A1.2. Datasets used including information on dataset description, spatial and temporal resolution and treatment.

Data Category	Dataset Name	Dataset Description	Spatial Resolution	Temporal Resolution	Notes
Conflict	ACLED	Conflict events coded by event type, includes fatalities, spatial and temporal precision.	Latitude/ Longitude	daily (events reported at single dates of yyyymmdd) from 1997-present	
Historical Climate	TerraClimate	Monthly climate and climatic water balance for global terrestrial surfaces. It uses climatically aided interpolation, combining high-spatial resolution climatological normals from the WorldClim dataset, with coarser spatial resolution, but time-varying data from CRU Ts4.0 and the Japanese 55-year Reanalysis (JRA55). Conceptually, the procedure applies interpolated time-varying anomalies from CRU Ts4.0/JRA55 to the high-spatial resolution climatology of WorldClim to create a high-spatial resolution dataset that covers a broader temporal record.	~4.5 km	Monthly (1958-2020)	
Future Climate	NEX-GDDP: NASA Earth Exchange Global Daily Downscaled Climate Projections	The NASA NEX-GDDP dataset is comprised of downscaled climate scenarios for the globe that are derived from the General Circulation Model (GCM) runs conducted under the Coupled Model Intercomparison Project Phase 5 (CMIP5, see Taylor et al. 2012) and across two of the four	~27.75 km	Daily (1950-2099)	https://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-11-00094.1

		greenhouse gas emissions scenarios known as Representative Concentration Pathways (RCPs, see Meinshausen et al. 2011).			
Water Availability	JRC Yearly Water Classification History, v1.2	This dataset contains maps of the location and temporal distribution of surface water from 1984 to 2019 and provides statistics on the extent and change of those water surfaces.	30 m	Annual (1984-2019)	
Forest Loss	Hansen Global Forest Change v1.8 (2000-2020)	Results from time-series analysis of Landsat images in characterizing global forest extent and change.	30 m	Annual (2000-2020)	
Population	WorldPop	Dasymetric modeling of population estimates based on census and variety of geospatial datasets (settlement extents, nighttime lights).	100 m	Annual (2000-2020)	
	Natural Earth Populated Places	Point symbols with name attributes. Includes all admin-0 and many admin-1 capitals, major cities and towns, plus a sampling of smaller towns in sparsely inhabited regions.	Latitude/Longitude	time invariant	
Travel Time	Global Friction Surface 2019	This global friction surface enumerates land-based travel speed for all land pixels between 85 degrees north and 60 degrees south for a nominal year 2019.	1 km	nominally 2019	
Land Cover	Terra Vegetation Indices 16-Day Global 1km	Normalized Difference Vegetation Index (NDVI)	1 km	16 day	
	MODIS Land	Land cover classes from the	500 m	Annual (2001-	Mode land cover class within each

	Cover Type Yearly Global 500m	International Geosphere-Biosphere Programme (IGBP) classification scheme		2019)	grid cell taken for each year.
Administrative Units	GADM	Administrative Level 0, 1 and 2	na	Most recent available data on GADM site	
Spatial Extent of Ethnic Groups	Geo-EPR	A spatial dataset that contains polygons of predominant ethnic groups. In this report, we present the identification numbers of ethnicities, rather than common names.		Most recent data available at the Geo-EPR site.	https://icr.ethz.ch/data/epr/

A.2 Additional information on models and model tuning

To select the best fit model for each machine-learning algorithm, we instituted a number of tuning parameters. For random forest models, we used the gini split criteria, compared models that used from 10 to 25 variables to generate decision trees, and compared minimum node sizes of 10 and 20. Each random forest was run across a k-fold of five. For artificial neural network models, we compared models with the number of hidden layer neurons from one to 10 and compared across decay sequences ranging from 0.1 to 0.5 by an increment of 0.1.

Model accuracy and visualizations

Table A1.3: Model accuracy and Kappa statistic

Model	Accuracy	Kappa
Binary Regression	NA	NA
Random Forest	0.9202144	0.6398934
Weighted Random Forest	0.9209247	0.6388142
Artificial Neural Network	0.8658231	0.2421505
Weighted Artificial Neural Network	0.862572	0.2407415

Figure A1.2: Top 20th percentile of administrative units with model agreement greater than or equal to 3.

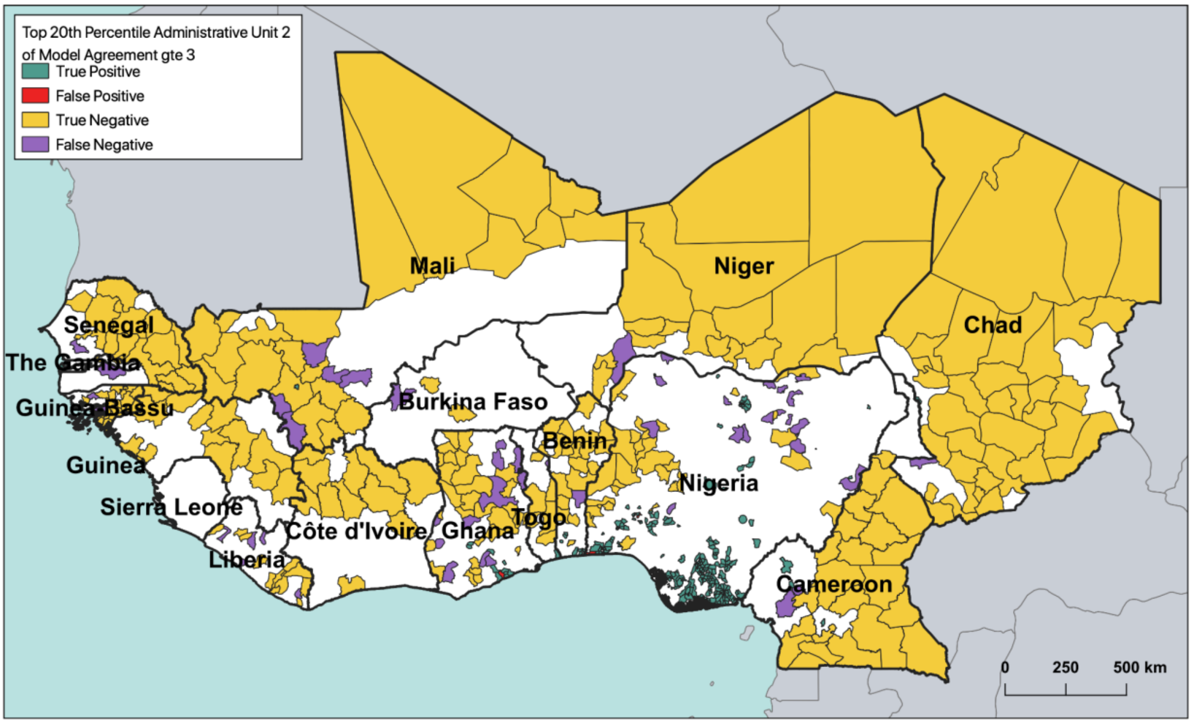


Table A1.4. Percent of true positive, false positive, true negative and false negative administrative 2 units that are in the top 20th percentile of units with model agreement greater than or equal to 3.

	Top 20th True Positive Units	Top 20th False Positive Units	Top 20th True Negative Units	Top 20th False Negative Units
True Positive	0.88	0.80	0.03	0.13
False Positive	0.01	0.06	0.00	0.00
True Negative	0.11	0.13	0.97	0.86
False Negative	0.00	0.00	0.00	0.02

Table A1.5. List of units illustrated in Figure A1.2 in the False Positive and False Negative validation categories. Country and Administrative Level-1 information pertain to the Administrative Level-2 units. As indicated in Figure A1.2, these units are in the top quantile for their proportion of grid cells within the False Positive or False Negative validation category.

Validation Category	Country	ADM1	ADM2
False Positive	Benin	Ouémé	Adjarra
False Positive	Ghana	Greater Accra	Ga West
False Positive	Nigeria	Abia	Ukwa West
False Positive	Nigeria	Imo	Mbaitoli
False Positive	Nigeria	Lagos	Badagary
False Positive	Nigeria	Ogun	Ifo
False Positive	Nigeria	Akwa Ibom	Eket
False Positive	Nigeria	Osun	Boripe
False Negative	Benin	Collines	Ouesse
False Negative	Burkina Faso	Boucle du Mouhoun	Banwa
False Negative	Côte d'Ivoire	Woroba	Worodougou
False Negative	Cameroon	Center	Mbam et Inoubou
False Negative	Cameroon	Center	Nyong-et-Kéllé
False Negative	Cameroon	Littoral	Nkam
False Negative	Cameroon	West	Ndé
False Negative	Ghana	Western	Wasa Amenfi West
False Negative	Ghana	Brong Ahafo	Nkoranza
False Negative	Ghana	Brong Ahafo	Sene
False Negative	Ghana	Brong Ahafo	Asunafo North
False Negative	Ghana	Brong Ahafo	Jaman South
False Negative	Ghana	Eastern	Kwabibirem
False Negative	Ghana	Eastern	Birim North
False Negative	Ghana	Northern	Saboba Chereponi
False Negative	Ghana	Northern	Sawa-Tuna-Kalba
False Negative	Ghana	Northern	Zabzugu Tatale

False Negative	Ghana	Northern	East Gonja
False Negative	Ghana	Northern	East Mamprusi
False Negative	Ghana	Northern	Karaga
False Negative	Ghana	Upper West	Wa West
False Negative	Guinea-Bissau	BafatÃ¡	Contuboel
False Negative	Guinea-Bissau	Oio	Bissora
False Negative	Guinea-Bissau	Quinara	Fulacunda
False Negative	Guinea-Bissau	Quinara	Tite
False Negative	Liberia	Maryland	Barrobo
False Negative	Liberia	Bong	Panta-Kpa
False Negative	Liberia	Bong	Suakoko
False Negative	Liberia	Gbapolu	Gbarma
False Negative	Liberia	GrandBassa	Stjohnriver
False Negative	Mali	Koulikoro	Banamba
False Negative	Mali	Koulikoro	Kangaba
False Negative	Mali	Koulikoro	Koulikoro
False Negative	Mali	Ségou	Barouéli
False Negative	Mali	Ségou	Barouéli
False Negative	Mali	Sikasso	Sikasso
False Negative	Mali	Sikasso	Yanfolila
False Negative	Niger	Dosso	Dogon-Doutchi
False Negative	Niger	Dosso	Loga
False Negative	Nigeria	Jigawa	Maigatari
False Negative	Nigeria	Jigawa	MalamMad
False Negative	Nigeria	Jigawa	BirninKu
False Negative	Nigeria	Kaduna	Kubau
False Negative	Nigeria	Adamawa	Fufore
False Negative	Nigeria	Kano	Doguwa
False Negative	Nigeria	Kano	Shanono
False Negative	Nigeria	Kogi	Mopa-Muro

False Negative	Nigeria	Niger	Magama
False Negative	Nigeria	Niger	Rijau
False Negative	Nigeria	Sokoto	Dange-Shuni
False Negative	Nigeria	Sokoto	Illela
False Negative	Nigeria	Yobe	Karasuwa
False Negative	Nigeria	Bauchi	Jama'are
False Negative	Nigeria	Bauchi	Kirfi
False Negative	Nigeria	Bauchi	Zaki
False Negative	Nigeria	Bauchi	Darazo
False Negative	Nigeria	Bauchi	Giade
False Negative	Senegal	Kaolack	Kaolack
False Negative	Senegal	Kolda	Medina Yoro Foula
False Negative	Chad	Mayo-Kebbi Est	Mont Illi
False Negative	Togo	Kara	Bimah

Table A1.6: Data summary of input variables for the weighted Random Forest model for each validation class for all grid cells.

Variable Description	False Negative	False Positive	True Negative	True Positive
Mode country of majority 5km grid	Mali	Nigeria	Chad	Nigeria
Mode category of all ACLED conflict types that have occurred in this grid cell from 2000-2020 from 2000-2020	None	None	None	None
Mode land cover according to IGCP classification and then generalized to a set of 11 categories in 2020	Grassland	Grassland	Barren	Grassland
Mode ID for ethnic groups in grid cell NOTE: These codes pertain the ID numbers within the Geo-EPR data. We do not report ethnicities by name in this report.	43201000	[47502000. 47506000.]	43606000	47501000
Average total forest loss within cell (2000-2020)	63.9700622	46.8622703	40.9166087	82.6636298
Average road length (km/1000) circa 2020	0.00769881	0.05136263	0.00635978	0.02563831
Average travel time to nearest populated place (minute)	208.674968	70.43402	792.671265	126.61551
Average percent of grid cell contains an international border	0.02814259	0.01639344	0.03032109	0.05284853
Average travel time to water body in 2020 (m)	125.738536	28.8564913	562.364832	65.6604225
Average number of ethnic groups in grid cell	1.72160356	2.57894737	1.60092918	2.1943257
Average Multidimensional Poverty Index (MPI)	0.41521951	0.26921311	0.45722798	0.36682756
Average sum of all conflict events for ACLED event type Battles and Explosions/Remote Violence, 2000-2020	0	0	0	0.33617465
Average sum of all conflict events for ACLED event type Violence against civilians, 2000-2020	0	0	0	0.30261317
Average sum of all conflict events for ACLED event type Protests and Riots, 2000-2020	0	0	0	0.36749701
Average population count in 2020	750.766883	15172.9324	702.27987	5815.86701
Average nighttime lights DMSP-like digital number (DN) (Li et al, 2020) in 2020	2.27676627	8.65632755	1.64637676	4.73099165
Average measure of NDVI from 2020	4107.74872	4028.23979	3060.72699	4022.8577

Average difference in population count between 2020 and 2000	315.798002	8919.02831	318.714037	2730.27571
Average difference in nighttime lights DMSP-like digital number (DN) (Li et al, 2020) between 2020 and 2000	2.26950601	3.68817549	1.58281382	3.29146906
Average difference in average monthly minimum temperature from 2015-2020 average and the 2000-2005 average (C)	0.42713154	0.36732696	0.46496498	0.33399263
Average difference in standard deviation of monthly minimum temperature from 2015-2020 average and the 2000-2005 average (C)	0.15230133	0.08912195	0.17282158	0.12191705
Average difference in average monthly maximum temperature from 2015-2020 average and the 2000-2005 average (C)	0.21924119	0.22556922	0.21156823	0.15588602
Average difference in standard deviation of monthly maximum temperature from 2015-2020 average and the 2000-2005 average (C)	0.05127331	0.0676881	0.16121254	0.06042734
Average difference in average monthly sum of precipitation from 2015-2020 average and the 2000-2005 average (mm)	-63.87242	140.726775	4.37152993	24.7633054
Average difference in standard deviation of monthly maximum temperature from 2015-2020 average and the 2000-2005 average (C)	1.96400642	16.1407796	7.0787497	9.15288179
Average difference in average monthly Palmer Drought Severity Index (PDSI) from 2015-2020 average and the 2000-2005 average (mm)	-68.464325	143.60769	126.69651	48.8436808
Average difference in average monthly Palmer Drought Severity Index (PDSI) from 2015-2020 average and the 2000-2005 average (C)	46.8992622	51.5462284	59.1540267	44.0498746
Average difference in average monthly minimum temperature from 2000-2005 average and the 1980-1985 average (C)	0.22257922	0.0984745	0.27698771	0.19426386
Average difference in standard deviation of monthly minimum temperature from 2000-2005 average and the 1980-1985 average (C)	-0.1817072	-0.1824187	-0.1808095	-0.1865125
Average difference in average monthly maximum temperature from 2000-2005 average and the 1980-1985 average (C)	0.54441057	0.36955828	0.67967485	0.4738693
Average difference in standard deviation of monthly maximum temperature from 2000-	0.05755366	0.03086739	-0.0988585	0.0506127

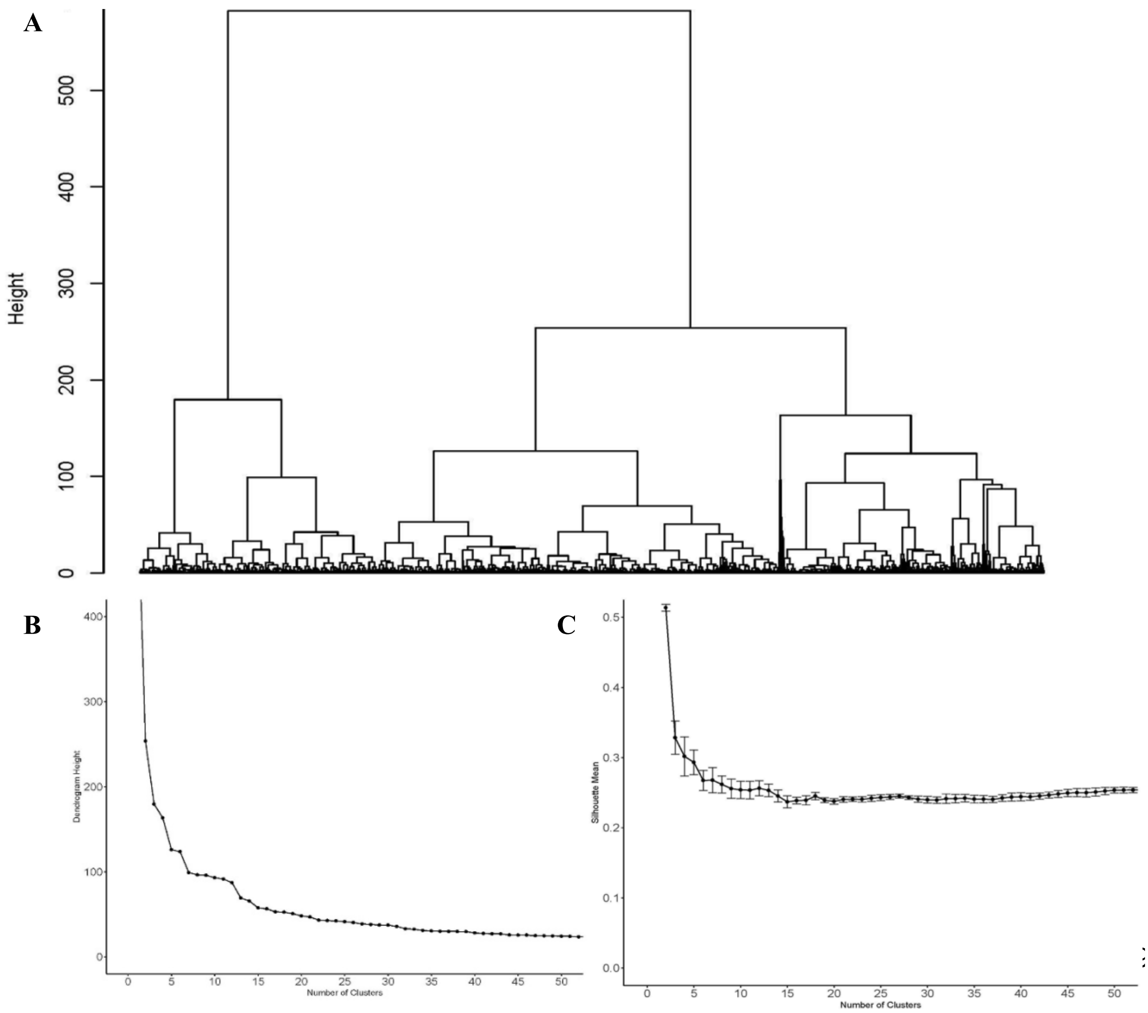
2005 average and the 1980-1985 average (C)				
Average difference in average monthly sum of precipitation from 2000-2005 average and the 1980-1985 average (mm)	66.7808015	119.710384	46.2571726	93.911177
Average difference in standard deviation of monthly maximum temperature from 2000-2005 average and the 1980-1985 average (mm)	7.43795276	14.6447774	5.79884951	10.5214549
Average difference in average monthly Palmer Drought Severity Index (PDSI) from 2000-2005 average and the 1980-1985 average	93.5781987	136.353369	65.2130936	129.430752
Average difference in average monthly Palmer Drought Severity Index (PDSI) from 2000-2005 average and the 1980-1985 average	34.9502052	46.263815	31.5127665	48.2558214
Average percent occurrence of any conflict from 2000-2020	0	0	0	0.17007201
Average percent occurrence of any ACLED event type Battles and Explosions/Remote Violence from 2000-2020	0	0	0	0.08786036
Average percent occurrence of any ACLED event type Violence against civilians from 2000-2020	0	0	0	0.1012188
Average percent occurrence of any ACLED event type Protests and Riots from 2000-2020	0	0	0	0.05582555
Average difference between general category of land cover between 2000 and 2020	0.0619137	0.21311475	0.05975896	0.10175314

A.3 Vulnerability clusters and data profiles

Selecting optimal numbers of clusters

We visualize the results from hierarchical agglomerative clustering on the principal components from exposure, sensitivity, and adaptive capacity variables as a dendrogram (Fig A1.3 Panel A). Cutting the dendrogram refers to the selection of an optimal number of clusters based on minimizing differences across a Euclidean space within the clusters and maximizing differences between clusters. To visualize potential cluster options represented in the dendrogram, we inspect elbow diagrams (Figure A1.3 A) as well as bootstrapped (k=10) silhouette models for 10% random sample in each subregion (Figure A1.3 C). Based on these metrics, we provide domain experts with a set of options for choosing the number of clusters they think best represents vulnerability in the region, as determined by maps and data summaries.

Figure A1.3: Dendogram and elbow plot. Panel A presents a dendrogram that represents the clustering of all grid cell units. "Height" represents the overall distance (Euclidean), calculated from all principal components, at which observations or groups are clustered together. Panel B provides an elbow plot that illustrates the number of clusters by the distance metric at which an additional cluster occurs. Panel C presents a silhouette plot that illustrates the number of clusters (x-axis) by the silhouette coefficient.



Data Profiles for Vulnerability Clusters

Table A1.7: Variable information for the vulnerability cluster analysis

Variable Name	Description
Cluster No.	Identification Number for Vulnerability Cluster
Majority Country	The country in which the majority of grid cells* within the cluster are located
Area	The total area of the vulnerability cluster (km^2)
Mean Forest Loss	The average loss of forest cover per grid cell
Mean Road Length	The average length of roads within grid cell (km/1000)
Mean H20 Travel Time	The average travel time, using road networks, to the nearest surface water (river/lake) in minutes
Mode Land Cover Type	The most common, general land cover type for grid cells within the cluster (ha)
Proportion LC Change	The percentage of grid cells in the cluster that experienced their majority land cover change from 2000 to 2020
Mean Conflict Deaths	The average number of fatalities from conflict, as measured by ACLED's battles/remote violence, violence against civilians, and riots/demonstrations categories
Mean Battles	The average number of battles and remote violence, as measured by ACLED, per grid cell within the vulnerability cluster
Mean Civ Violence	The average number of conflicts with violence against civilians, as measured by ACLED, per grid cell within the vulnerability cluster
Mean Riots/Demos	The average number of riots and demonstrations with violent conflict, as measured by ACLED, per grid cell within the vulnerability cluster
Mean Population	The average number of people per grid cell
Mean Population Change	The average change in the number of people from 2000 to 2020
Mean Max Temp Difference (2020 to 2100)	The estimated change in mean maximum temperature (measured monthly) between 2020 to 2100, using NASA DEX downscaled climate data (averaged RCP 4.5 and RCP 8.5) measured in C˚
Mean Precipitation Difference (2020 to 2100)	The estimated change in annual precipitation (measured monthly) between 2020 to 2100, using NASA DEX downscaled climate data (averaged RCP 4.5 and RCP 8.5) measured in mm.
Mean PDSI Difference (2000 to 2020)	Average change in Palmer's Drought Severity Index per grid cell within the vulnerability cluster.

Figure A1.4: Vulnerability clusters in the Sahel Region

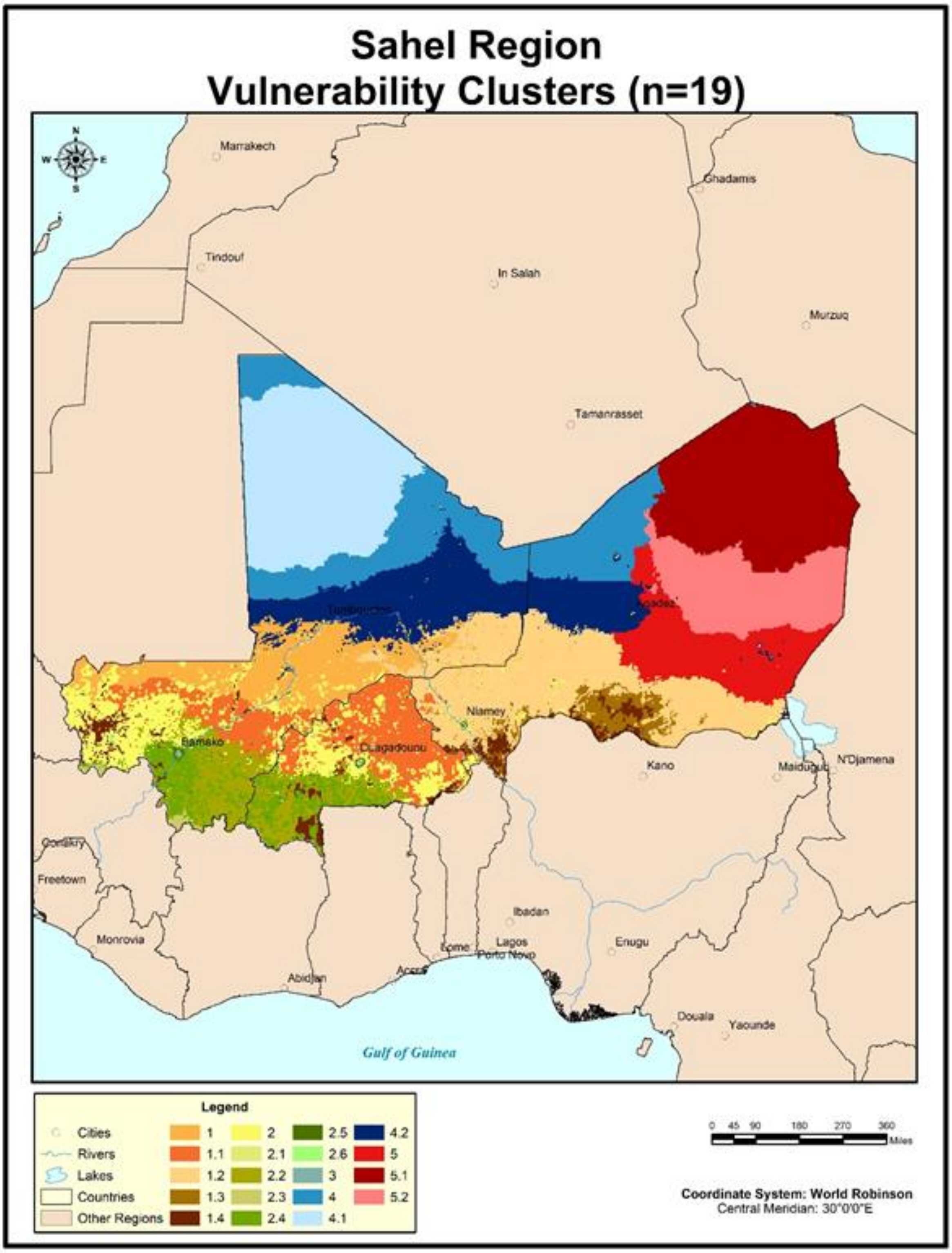


Table A1.8: Cluster summary statistics (measures of center) for the Sahel Region

	Majority Country	Area	Mean Forest Loss	Mean Road Length	Mean H20 Travel Time	Mode Land Cover Type	Proportion LC Change	Mean Conflict Deaths
1	Mali	201800	0.000858	0.00977	93.8037	Grassland	0.092542	0.514742
1.1	Burkina Faso	174250	0.002396	0.012403	66.20734	Grassland	0.001865	0.284505
1.2	Niger	323025	4.36E-05	0.005459	159.36	Grassland	0.073292	0.060754
1.3	Niger	44800	4.87E-05	0.00894	131.4409	Cropland Mosaic	0.378348	0.008371
1.4	Niger	53200	0.020213	0.010042	79.19474	Cropland	0.401786	0.085056
2	Mali	191375	0.06201	0.01894	73.67406	Grassland	0.002613	1.284128
2.1	Burkina Faso	850	0	0.379494	8.455612	Grassland	0.058824	0.5
2.2	Mali	108900	0.028756	0.013331	53.61365	Grassland	0.00023	0.01584
2.3	Mali	5700	12.37508	0.008753	66.59112	Savanna	0.008772	0
2.4	Mali	86025	0.145323	0.017621	55.01554	Grassland	0.024702	0.036617
2.5	Mali	5450	0.000404	0.142777	30.42358	Grassland	0.027523	14.94037
2.6	Mali	700	0	0.00118	1.522814	Water	0.25	0
3	Burkina Faso	550	0	0.433085	6.395713	Urban/Built-Up Land	0	16.54545
4	Mali	294350	0	0.001154	1029.204	Barren	0	0.008578
4.1	Mali	320675	0	0.0002	2362.982	Barren	0	0.001949
4.2	Mali	263525	4.93E-05	0.002791	348.5192	Barren	0.014135	0.059103
5	Niger	168625	0	0.001017	776.5776	Barren	0.000148	0.001631

5.1	Niger	321975	0	0.000388	1380.974	Barren	0	0.001631
5.2	Niger	178150	0	0.000212	2794.906	Barren	0	0.000702

Table A1.9: Cluster summary statistics (measures of center) for the Sahel Region (continued)

Cluster No.	Mean Battles	Mean Civ Violence	Mean Riots and Demos	Mean Population	Mean Population Change	Mean Max Temp Difference (2020 to 2100)	Mean Precipitation Difference (2020 to 2100)	Mean PDSI Difference (2000 to 2020)
1	0.074827	0.073464	0.001734	438.8092	211.5219	4.017048	-199.427	499.6807
1.1	0.036872	0.058537	0.003013	1124.091	468.885	3.662454	-114.826	386.1671
1.2	0.011609	0.016098	0.000542	693.7218	406.4505	4.012207	25.64165	251.3347
1.3	0.00279	0.006696	0.013393	2771.943	1500.352	4.06952	100.3851	81.95758
1.4	0.018797	0.021617	0.005169	1775.992	853.1375	3.451213	-23.3368	156.9852
2	0.190856	0.145526	0.040235	1163.062	520.2972	3.456581	-164.056	359.4172
2.1	0.117647	0.029412	1.382353	110062.1	77016.1	2.988782	12.77349	147.038
2.2	0.007346	0.001607	0.002755	1154.33	559.3239	2.888319	183.5506	-126.138
2.3	0.008772	0	0	307.0745	150.3085	2.497274	214.974	-267.531
2.4	0.015984	0.006393	0.015402	1203.713	581.0015	2.734448	182.8748	-168.144
2.5	2.917431	1.311927	2.307339	17271.91	10905.88	3.252608	0.011915	167.6012
2.6	0	0	0	224.7586	120.2523	3.842715	-177.189	372.8165
3	2.954545	3.136364	37.95455	217158.4	153350.1	2.747398	26.17768	115.4129
4	0.002208	0.00034	8.49E-05	13.16428	6.601479	3.271097	-80.9121	452.618
4.1	0.000468	0.000156	0	2.323934	1.945124	2.485472	-68.646	353.681

4.2	0.013471	0.005407	0.000569	87.95227	52.35715	3.84486	-75.9064	390.574
5	0.000741	0.001186	0	61.81733	38.56251	4.455215	75.81771	252.9308
5.1	0.000776	0	7.76E-05	1.757156	0.585421	3.704695	-60.7222	617.3945
5.2	0.000421	0	0.00014	6.355254	3.923204	4.360321	13.41499	321.7775

Figure A1.5: Vulnerability clusters in the Lake Chad Region

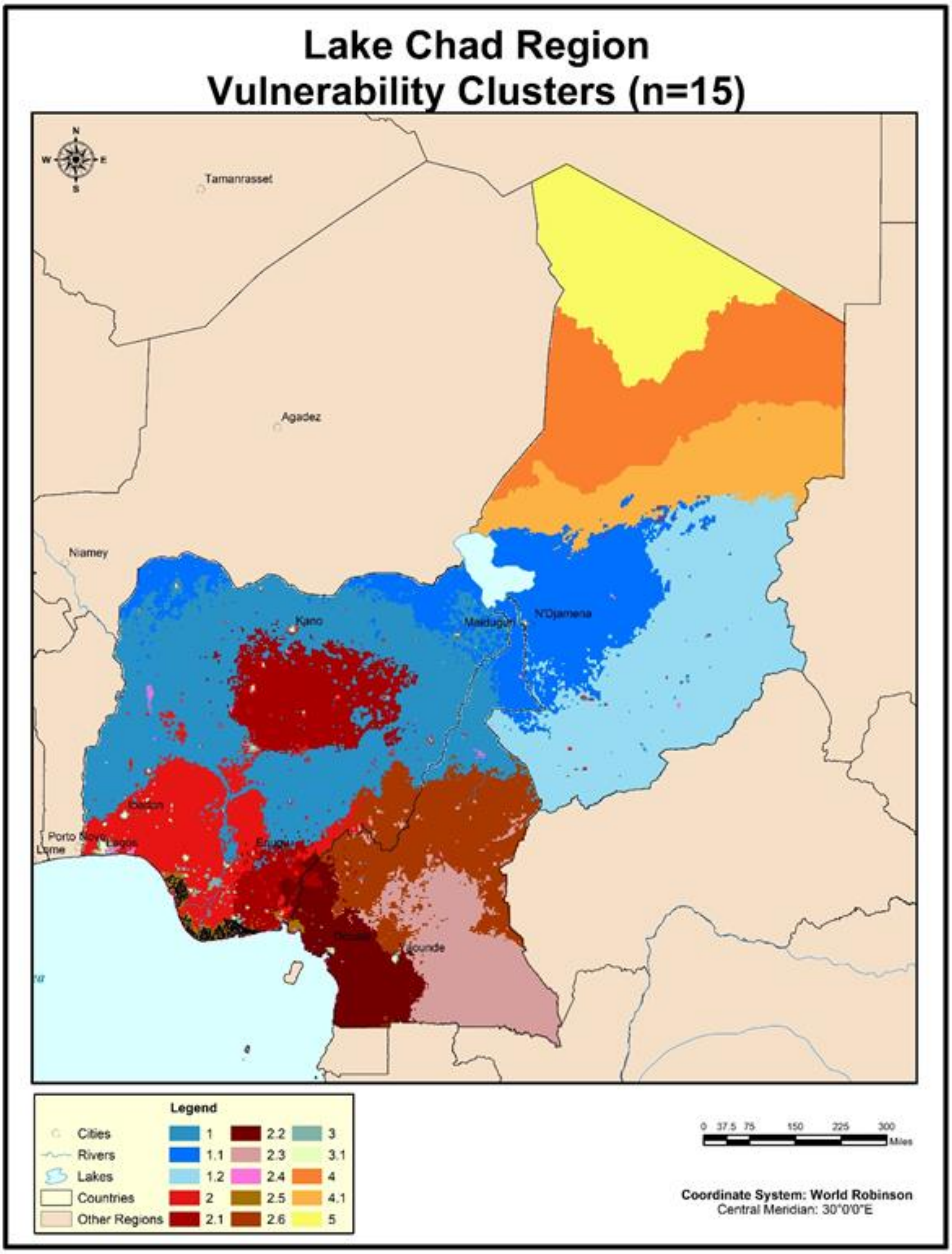


Table A1.10: Cluster summary statistics (measures of center) for the Lake Chad Region

Cluster No.	Majority Country	Area	Mean Forest Loss	Mean Road Length	Proportion Border Cells	Mean H20 Travel Time	Mode Land Cover Type	Proportion LC Change
1	Nigeria	500800	1.827323	0.016923	-0.99935	52.72604	Cropland	0.140425
1.1	Chad	279700	0.03124	0.009745	-0.99911	164.9083	Grassland	0.07803
1.2	Chad	405350	3.360705	0.003364	-0.94061	188.7343	Grassland	0.086222
2	Nigeria	153475	126.736	0.023134	-0.99691	52.49631	Savanna	0.221534
2.1	Nigeria	156875	15.53285	0.019953	-0.99809	42.31424	Cropland	0.176574
2.2	Cameroon	93575	189.494	0.006945	-0.96099	151.8976	Forest	0.14133
2.3	Cameroon	158375	80.32207	0.003993	-0.96417	221.5338	Forest	0.088398
2.4	Nigeria	8650	14.81909	0.005354	-0.45376	1.861893	Water	0
2.5	Nigeria	14775	8.395088	0.003145	-0.28596	44.48289	Wetland	0.084602
2.6	Cameroon	183875	52.95472	0.011348	-0.95908	99.80886	Savanna	0.063358
3	Nigeria	9075	127.2697	0.136743	-0.91185	22.05308	Urban/Built-Up Land	0.429752
3.1	Nigeria	3850	54.34167	0.278902	-0.96104	15.61322	Urban/Built-Up Land	0.051948
4	Chad	280100	0	0.000559	-0.99223	1305.432	Barren	0
4.1	Chad	195550	0	0.001105	-0.98811	571.4511	Barren	0.000256
5	Chad	228275	0	0.002961	-0.97262	762.3113	Barren	0

Table A1.11: Cluster summary statistics (measures of center) for the Lake Chad Region

Cluster No.	Mean Battles	Mean Civ Violence	Mean Riots and Demos	Mean Population	Mean Population Change	Mean Max Temp Difference (2020 to 2100)	Mean Precipitation Difference (2020 to 2100)	Mean PDSI Difference (2000 to 2020)
1	0.131639	0.127596	0.028055	3159.38	1466.795	3.423564	11.98792	-68.0816
1.1	0.039596	0.0202	0.002681	961.8454	442.5431	3.484148	110.9309	82.23541
1.2	0.013939	0.01067	0.001912	596.7848	293.4071	3.412232	207.3873	-151.348
2	0.077374	0.131292	0.129826	7306.397	3336.417	3.240385	-109.787	70.52794
2.1	0.10008	0.177849	0.054502	5517.763	2499.677	3.404163	-16.4304	-259.591
2.2	0.036334	0.045952	0.013358	1113.448	405.2735	3.036225	444.901	-417.641
2.3	0.000631	0.000789	0.000789	191.1595	57.72483	3.706959	493.074	-395.13
2.4	0.049133	0.115607	0.115607	2949.05	1494.305	3.743123	-386.56	-20.4558
2.5	0.199662	0.143824	0.120135	6425.546	2825.956	3.075382	-1104.68	142.8675
2.6	0.021618	0.027464	0.008838	922.5953	330.1952	3.72403	378.0577	-152.184
3	5.834711	3.760331	7.165289	41533.69	21235.84	3.053222	-261.046	36.21916
3.1	3.655844	4.201299	16.5974	181647.7	90422.09	2.919909	-84.4632	-33.2152
4	0.00116	0.000268	8.93E-05	15.82941	12.95074	4.494186	39.63864	355.8184
4.1	0.002813	0.000511	0	107.3574	79.41213	4.138891	126.6861	128.3639
5	0.008433	0.000876	0.000329	7.814504	6.533395	3.420913	-108.195	585.3285

Figure A 1.6: Vulnerability clusters in the Gulf of Guinea Region

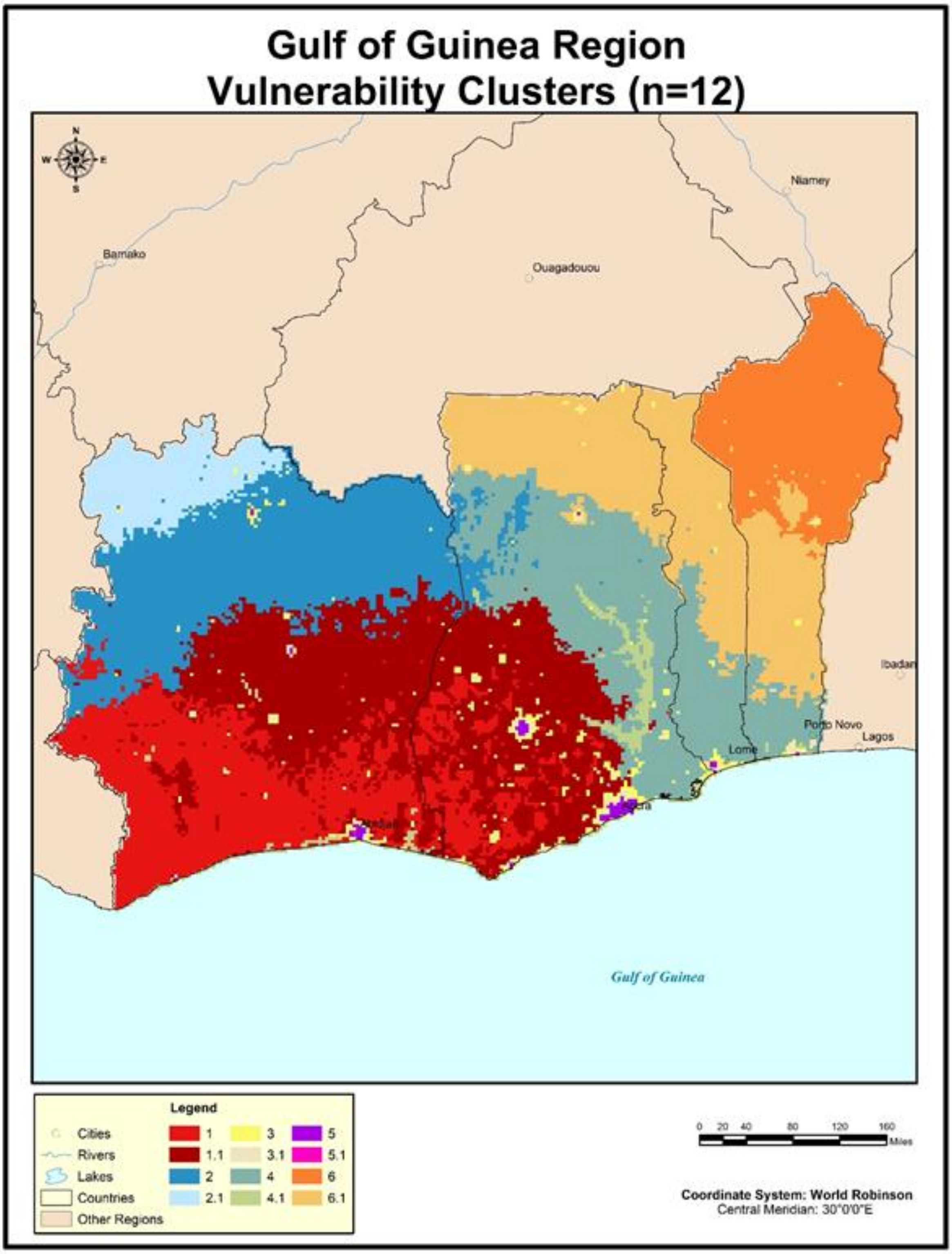


Table A1.12: Cluster summary statistics (measures of center) for the Gulf of Guinea Region

Cluster No.	Majority Country	Area	Mean Forest Loss	Mean Road Length	Mean H20 Travel Time	Mode Land Cover Type	Proportion LC Change	Mean Conflict Deaths
1	Côte d'Ivoire	107450	474.0896	0.0094	94.75427	Savanna	0.13704	0.043509
1.1	Côte d'Ivoire	156725	284.4359	0.012024	67.45062	Savanna	0.057744	0.295103
2	Côte d'Ivoire	118900	100.4324	0.005906	98.94901	Savanna	0.063919	0.033011
2.1	Côte d'Ivoire	29725	41.04918	0.005644	63.01343	Savanna	0.021026	0.018503
3	Ghana	10475	206.4401	0.080365	25.99651	Savanna	0.090692	0.813842
3.1	Ghana	3275	146.0948	0.195173	22.47748	Urban/Built-Up Land	0.282443	2.755725
4	Ghana	109000	26.31443	0.014066	63.24341	Grassland	0.118119	0.022706
4.1	Ghana	11950	39.5468	0.004474	2.422089	Water	0.056485	0.004184
5	Ghana	2150	44.37804	0.310189	10.06378	Urban/Built-Up Land	0.069767	7.72093
5.1	Côte d'Ivoire	25	14.88774	0.331077	2.625554	Urban/Built-Up Land	0	1163
6	Benin	71450	0.217568	0.00826	143.4843	Cropland	0.187894	0.014696
6.1	Ghana	115200	8.376056	0.012762	84.53637	Grassland	0.181858	0.032552

Table A1.13: Cluster summary statistics (measures of center) for the Gulf of Guinea Region (continued)

Cluster No.	Mean Battles	Mean Civ Violence	Mean Riots and Demos	Mean Population	Mean Population Change	Mean Max Temp Difference (2020 to 2100)	Mean Precipitation Difference (2020 to 2100)	Mean PDSI Difference (2000 to 2020)
1	0.008841	0.006282	0.016287	1573.834	544.3757	2.535802	538.4722	-432.281
1.1	0.030786	0.023608	0.051045	2151.511	750.2337	2.6123	429.43	-390.79
2	0.0082	0.002733	0.009462	693.1567	288.8409	2.805308	555.3667	-528.531
2.1	0.007569	0.002523	0.000841	619.1455	291.3268	2.727395	497.5239	-546.916
3	0.176611	0.126492	0.491647	12848.05	5264.592	2.562359	271.9216	-255.831
3.1	0.717557	0.610687	3.21374	47827.26	23276.56	2.532203	276.2936	-216.6
4	0.004587	0.009633	0.026376	2253.094	993.204	2.404525	183.8296	-222.368
4.1	0	0.006276	0.027197	1005.684	464.6975	2.018003	254.1333	-230.47
5	1.081395	1.383721	7.395349	149495.4	79242.93	2.314136	334.7013	-222.322
5.1	159	229	440	393772.6	169127.6	2.470893	329.0473	-362.847
6	0.003499	0.002449	0.006648	1136.321	625.2385	3.107867	-78.6405	89.05053
6.1	0.010851	0.009983	0.019314	1579.012	701.6518	2.842542	52.21522	-71.1865

Figure A1.7: Vulnerability clusters in the Westernmost Africa Region

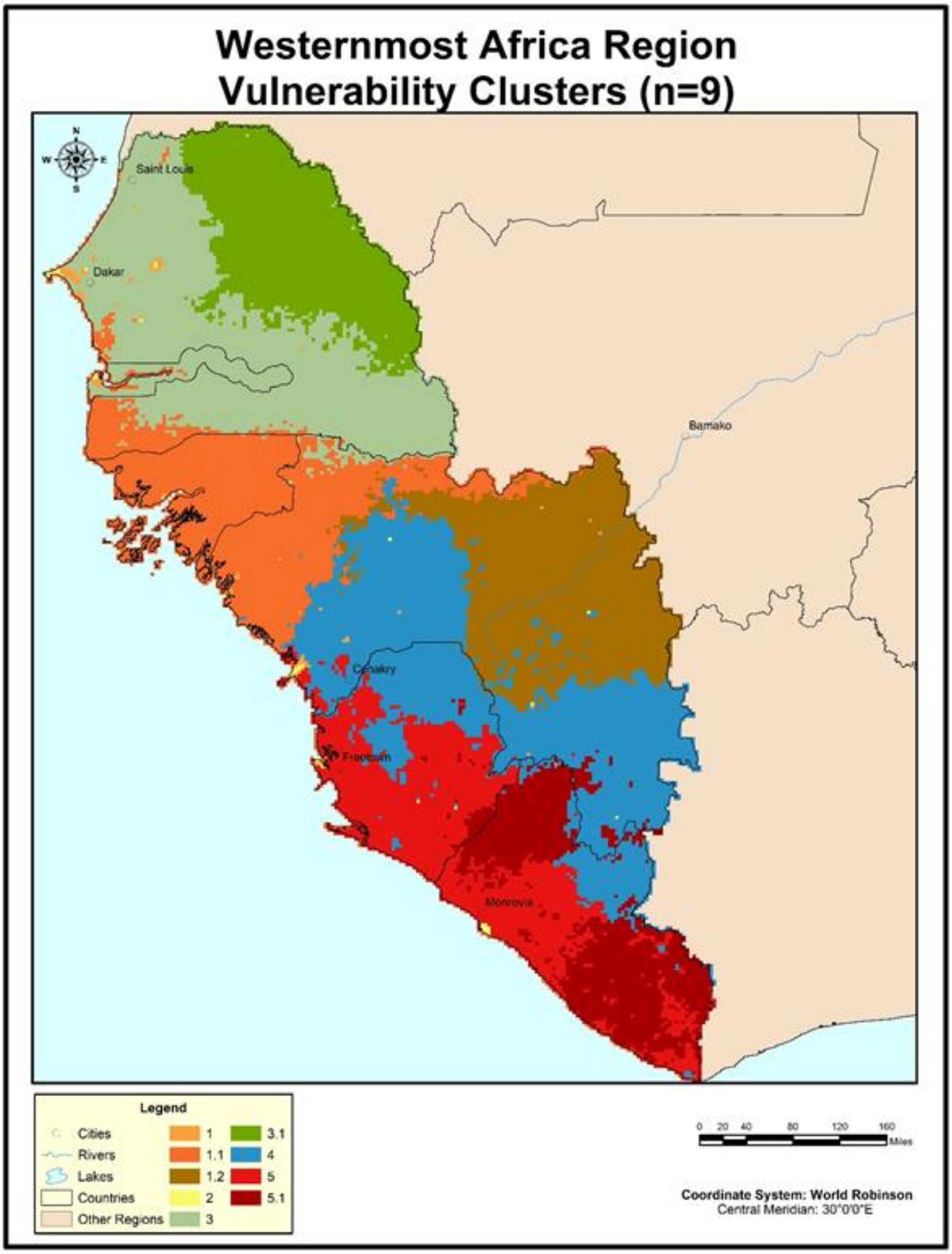


Table A1.14: Cluster summary statistics (measures of center) for the Westernmost Africa Region

Cluster No.	Majority Country	Mean Forest Loss	Mean Road Length	Mean H20 Travel Time	Mode Land Cover Type	Proportion LC Change	Mean Conflict Deaths
1	Senegal	33.10201	0.172803	17.25339	Grassland	0.10084	14.58824
1.1	Guinea	144.5462	0.013148	47.58644	Savanna	0.0478	0.092509
1.2	Guinea	51.13873	0.011604	63.07958	Savanna	0.050587	0.018253
2	Guinea	45.995	0.328051	12.17377	Urban/Built-Up Land	0.243902	7.170732
3	Senegal	0.188066	0.017068	66.60503	Grassland	0.103231	0.026005
3.1	Senegal	5.87E-05	0.008974	116.4475	Grassland	0.02262	0.00135
4	Guinea	337.6415	0.019648	77.61575	Savanna	0.027949	0.112523
5	Sierra Leone	722.1033	0.018083	47.44735	Savanna	0.010661	0.393847
5.1	Liberia	227.5875	0.003648	243.2343	Forest	0.295435	0.000878

Table A1.15: Cluster summary statistics (measures of center) for the Westernmost Africa Region (continued)

Cluster No.	Mean Battles	Mean Civ Violence	Mean Riots and Demos	Mean Population	Mean Population Change	Mean Max Temp Difference (2020 to 2100)	Mean Precipitation Difference (2020 to 2100)	Mean PDSI Difference (2000 to 2020)
1	1.521008	1.487395	6.394958	36433.55	18402.99	2.155806	-487.842	214.2842
1.1	0.036861	0.015458	0.037812	902.8799	330.9508	1.934271	-878.544	289.4842
1.2	0.00704	0.002608	0.022947	668.6009	337.51	1.784998	164.4395	-243.486
2	1.121951	2.243902	13.65854	155176	66885.4	2.361874	-442.424	39.60874
3	0.008274	0.009653	0.039007	1712.128	742.543	2.857973	-444.491	404.2402
3.1	0.000338	0	0.003714	495.968	212.7957	3.063399	-609.711	398.428
4	0.036298	0.022505	0.047368	1080.701	270.7835	2.244661	164.4655	-202.046
5	0.175145	0.105087	0.311301	1500.136	485.339	2.625392	194.0967	-168.626
5.1	0.032485	0.007902	0.010536	321.4664	94.24073	2.28501	443.2271	-339.467

Table A1.16. Percent of true positive, false positive, true negative and false negative grids among total grids within each regional cluster.

Region	ClusterID	True Positive	False Positive	True Negative	False Negative
Gulf of Guinea	1	0.14	0	0.85	0
	1.1	0.23	0	0.77	0
	2	0.08	0	0.92	0.01
	2.1	0.08	0	0.92	0
	3	0.81	0	0.19	0
	3.1	0.96	0.02	0.02	0
	4	0.17	0	0.83	0
	4.1	0.16	0	0.84	0.01
	5	0.96	0	0.04	0
	5.1	1	0	0	0
	6	0.08	0	0.91	0
	6.1	0.14	0	0.86	0.01
Lake Chad	1	0.34	0	0.66	0
	1.1	0.15	0	0.85	0
	1.2	0.07	0	0.93	0
	2	0.54	0	0.46	0
	2.1	0.45	0	0.54	0

	2.2	0.15	0	0.84	0
	2.3	0.02	0	0.98	0
	2.4	0.38	0	0.62	0
	2.5	0.59	0	0.4	0
	2.6	0.13	0	0.87	0
	3	0.87	0.01	0.12	0
	3.1	0.97	0	0.03	0
	4	0	0	1	0.00E+00
	4.1	0.01	0	0.99	0
	5	0.01	0	0.99	0
Sahel	1	0.28	0	0.72	0
	2	0.27	0	0.73	0
	1.1	0.35	0	0.65	0
	1.2	0.14	0	0.86	0
	1.3	0.06	0	0.93	0
	1.4	0.17	0	0.83	0
	2.1	0.85	0	0.15	0
	2.2	0.09	0	0.9	0.01
	2.3	0.08	0	0.92	0

	2.4	0.16	0	0.83	0.01
	2.5	0.69	0	0.31	0
	2.6	0.07	0	0.93	0
	3	0.95	0.05	0	0
	4	0.01	0	0.00	0
	4.1	0	0	1	0
	4.2	0.07	0.00E+00	0.93	0
	5	0.02	0	0.98	0
	5.1	0	0	1	0
	5.2	0	0	1	0
Westernmost	1	0.81	0	0.19	0
	1.1	0.15	0	0.85	0
	1.2	0.08	0	0.91	0
	2	1	0	0	0
	3	0.16	0	0.83	0
	3.1	0.03	0	0.97	0
	4	0.24	0	0.76	0
	5	0.35	0	0.64	0
	5.1	0.14	0	0.86	0

Annex B – Additional Case Studies

B.1 Case Study 6 – Climate–fragility risk: Lake Chad Region

Johanna Dieffenbacher, Janna Greve

Introduction

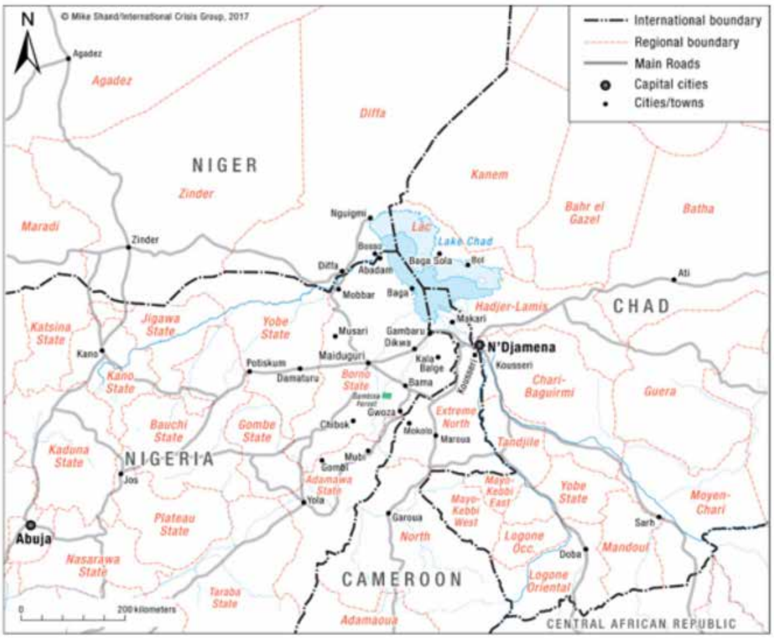
The ongoing crisis in parts of Cameroon, Chad, Niger and Nigeria, which collectively make up the Lake Chad region, has numerous root causes. Ranging from weak governance, an absence of basic infrastructure and services, a lack of trust in the state and severe poverty, to the increased influence of armed extremist groups, environmental stress factors and their impact on mobility and livelihoods.

While a significant amount research has been carried out regarding either the conflict dynamics and stakeholders or the impacts of global warming on the Lake Chad ecosystem, little attention has been paid by both the research and practitioner community to the interplay of fragility, climate and violence (FCV) in the region. By analyzing the regional security and climate context, the present study thus aims to assess the degree to which climatic stressors provoke fragility and violence, and the extent to which climate fragility is exacerbated by conflict.

First, it will analyze key socioeconomic, political, national security and climatic conditions in the Lake Chad region, and the (human security) situation of the communities living therein. Based on state-of-the art climate and hydrological information in the form of quantitative climate data and impact projections for the Lake Chad region, it will depict the growing climate variability which is further challenging resilience of communities in the lake area.
Drawing on qualitative analysis in the form of desk research, consultations and conflict- as well as gender-sensitive analysis, the profile then goes on to assess the interactions of climatic and conflict dynamics to provide a comprehensive assessment of climate-fragility risk dimensions and resilience across a range of societal actors. The study focuses on increased competition over vital natural resources due to conflict-and/or climate-related displacement and changes in livelihoods, as well as on risks posed by growing tensions between pastoralist, farmers and fishers related to access to the lake and to fertile land. On the other hand, the study will analyze the impact of hard security responses, extremism, and livelihood insecurity provoked by marginalization, which, when compounded by climate fragility, might continue to feed the vicious circle of violence.

This analysis uses a climate-related fragility risk analysis framework developed under the project Shoring up Stability and further refined under the multilateral initiative Weathering Risk. The analysis draws on the extensive primary research conducted under Weathering Risk alongside additional desk research to provide locally informed, up-to-date, concrete entry points and policy recommendations for better addressing these risks in peacebuilding and development efforts. Given the nexus between climate, development and security, these reflect the need for integrated climate-security assessments, locally informed risk prevention, inclusive governance, reduced social inequalities, and resilience building for climate security.

Figure B.1.1: Map Lake Chad Region



Source: ICG 2017a

Background

Political context

The Lake Chad region consists of four countries: Cameroon, Chad, Niger and Nigeria. There are strong socioeconomic ties across borders and the region has a rich cultural history, with human settlements from ancient empires as early as the 5th century (UNESCO 2018). However, the arbitrariness of the borders set by former colonial powers still poses obstacles for the social ties and economic activities of the local population, especially when temporary border closures are imposed by governments in times of crisis, such as for security or pandemic-related reasons (Taub 2017; World Food Programme 2016).

The political context as well as the state of rule of law in the Lake Chad region continue to be volatile. While administrative systems differ significantly (Cameroon for example continues to be highly centralized, whereas in Nigeria regional Governors have significant autonomy and decision-making power), the areas composing part of the Lake Chad region all face notable governance issues – and have been marked by years of political marginalization. The latter manifests in weak or absent presence of the state, lack of basic infrastructure and, on a societal level, in the stigmatization of specific (ethnic) population groups. All four countries are facing political tensions, although to different degrees. Niger is on the most promising track to consolidating democracy. Recent elections in the country led to a change in government according to the Nigerian constitution. Chad has not undergone democratic changes in its governmental power structure since decades and is currently facing an uncertain future after the late president Deby was killed in obscure circumstances (African Union 2021). Cameroon underwent constitutional changes, which consolidated the centralized power of President Biya who has been ruling the country for almost 40 years. Nigeria is confronted with governance failures or severe flaws in many aspects and on several levels (Okoi and Iwara 2021). Additionally, civil and political rights are yet to be fully consolidated; particularly Chad and Cameroon continue with highly limited political rights and civilian liberties (Freedom House 2021). Apart from complex administrative structures, regional power dynamics are also marked by the significant influence on decision-making processes and social relations of traditional leaders.

Although all four countries also face specific and distinct conflicts within their national borders, the crisis in the Lake Chad region is a shared one, revealing that common issues of this multifaceted and protracted crisis and insecurity demand collaborative and transnational efforts to overcome instability:

In early 2018, the Lake Chad Basin Governors' Forum was inaugurated (CBLT 2019) with the objective of enhancing cross-border cooperation in the realm of stabilization efforts. Toward the end of the same year, the Lake Chad Basin Commission (LCBC/CBLT), supported by the African Union, launched the "Regional Stabilization Strategy for the Stabilization, Recovery and Resilience of the Boko Haram effected Areas of the Lake Chad Basin Region" (RSS). The strategy aims to contribute to addressing key challenges such as good governance and the impacts of climate change and is based on nine thematic pillars. The implementation and coordination efforts of both the RSS and the LCB Governors' Forum (CBLT 2021) are supported by a Secretariat within the LCBC structure.

Two economic regional frameworks cover each part of the Basin: ECOWAS with Nigeria and Niger as member states, and ECCAS with Cameroon and Chad as members. The same applies for the UN with UNOWAS and UNOCA. However, ECCAS continues institutionally very weak, and recently these regional frameworks recognized the need to closely cooperate to address the cross-border crisis and realize join efforts, partially also with the LCBC, on topics related to peace and security – which increasingly also implies climate-related security risks. (United Nations 2019(a); United Nations 2019(b)). As for regional actors, ECOWAS is supported by UNOWAS via a joint work plan for the ongoing year which, inter alia, entails, climate security aspects and mitigating conflicts between pastoralists and farmers (United Nations 2021a)[20]. Despite the evident imbalance regarding institutional capacity, ECOWAS and ECCAS undertook important attempts related to the common Peace and Security challenges in the region and to address e.g. the increasing conflicts between pastoralists and farmers (see point 16 in the Lomé Declaration, ECCAS and ECOWAS, 2018).

However, the Lake Chad Basin Commission (LCBC) is the only regional framework covering all four countries in the Lake Chad region (Galeazzi et al. 2017) and also has a peace and security mandate. The LCBC was founded in 1964 predominantly for hydropolitical reasons. Later, due to contextual dynamics and increased demands for a common security approach, it was given the role to lead regional military coordination and funding for the Multinational Joint Task Force (MNJTF), composed of troops from all four countries with the aim to fight violent extremism. Despite the engagement of the forces and significant losses on their side, it needs to be said that the mostly militarized efforts over many years were not sufficiently accompanied by other measures and therefore did not address the root causes of the crisis. Additionally, individual national troops and members of the MNJTF have been accused of human rights violations.

[20] See also ECOWAS and ECCAS "Lomé Declaration" point 16, https://www.eip.org/wp-content/uploads/2020/07/Lom%C3%A9-Declaration-on-Peace-Security-Stability-and-the-Fight-Against-Terrorism-and-Violent-Extremism.pdf)

As for efforts to protect the fragile environment in the region, it is worth noting that the Lake Chad states have recognized areas as protected under the 'Ramsar Convention', a UN treaty that was adopted in 1971 and has as objective the conservation and sustainable use of important wetland, such as those in the Lake Chad region (GIZ, LCBC 2016).

UNDP and other UN organizations are key international support actors in the region also due to the implementation of the Regional Stabilization Facility (RSF) since 2019. The RSF is supported by Germany, Sweden, the United Kingdom (UK), the Netherlands, the African Development Bank (AfDB) and the European Union (EU). The Facility focuses on seven key Impact Areas – Education, Health, Security, Justice, Environment, Communal Support and Livelihood – and aims at taking positive change and building local peoples' resilience. Amongst others, there are national and Regional Territorial Action Plans and other measures tailored with and for governments and affected local authorities to building trust and strengthen social contracts and law and order as well as improving infrastructure (UNDP 2021). Additionally, the UNESCO has supported the improvement of the regional ecosystem management (Sustainable Development Goals Partnership Platform; UNESCO).

Another international key actor in the region is the World Bank, amongst other via its contributions to the RSS, but also, with a specific environmental focus via its PROLAC program (World Bank 2020).
The variety of efforts is important if complementarity of the different actors is improved, and ownership of national and regional actors enhanced. This is especially relevant in light of the complex risks posed by the interplay of climate and fragility – which require sustainable and locally-informed responses across borders, knowledge management and sharing within the region and across different levels. (AFD 2021; United Nations 2020b). So far however, critical stumbling blocks consist in severe governance deficits and corruption, also within state institutions.

Socioeconomic context

The Lake Chad region is ethnically diverse, with different languages and different faith groups, including Christian, Muslim or Animist. Each group has its own specific economic activity, culture and language (GIZ, LCBC 2016).

Due to the conflict and the instrumentalization of religion by extremists and politicians, relations between Christians and Muslims have become strained in some areas. In other areas, people have united across religious lines against what has been seen as a common enemy, with Christians and Muslims jointly fighting armed opposition groups through joining vigilante groups.

While the geographic areas composing the Lake Chad Basin used to form a prosperous economic hub with significant trade activity, in past decades, governance gaps – which can also be classified as political marginalization – as well as extreme weather conditions have provoked development deficits, widespread severe poverty, high school-dropouts or lack of access to education and lack of employment opportunities. The main, often informal, livelihoods outside the regional capitals and in the lake, area are agriculture, fishery as well as pastoralism. These make up 90 percent of the regional population, which equates to approximately 49 million people, all of which are vulnerable to changing climate conditions such as irregular rainfall and drought (see Soumahoro et al. 2021). Additionally, for a decade the ongoing violent conflict and impact of extremist groups, as well as militarized responses, have posed obstacles to people's ability to maintain their livelihoods. The many years of conflict have led to a destruction of market infrastructure and impacted transportation and storage of goods.

The related vulnerability leaves civilians exposed to violence, while the latter led to ruptures of community ties, social cohesion and trust vis-à-vis the respective state agents. There is thus even less ability for coping and adaptation to new challenges such as climate change and COVID-19 (Bank 2020).

At the same time, population growth in the region is amongst the highest worldwide, with growth rates of up to 4 percent. The population structure predominantly comprises youth below 24 years old who, though not a homogenous group, are especially impacted by the lack of educational and employment opportunities, causing frustration and a vicious circle of poverty and insecurity (UNFPA 2017). At the same time, this segment of society began to organize themselves, though to varying degrees, including on the grassroots level, and voice their potential to be part of the stabilization and development responses aiming to overcome the multifaceted challenges in the region and build resilience. This is being recognized at the highest levels, such as at the AU, the LCBC and the UN (Kujeke and Odinukwe 2021).

In a recent UNSC briefing on the Lake Chad region, SRSG Annadif emphasized the continuous need for engaging women and youth – while also emphasizing the impact of climate change on the Lake Chad region (United Nations 2021(b)).

Levels of frustration and mistrust toward the governments of the region amongst the local populations are high– also due to a perceived lack of policies to support adaptation regarding the impact of climate change – ranging from drought to floods – in the

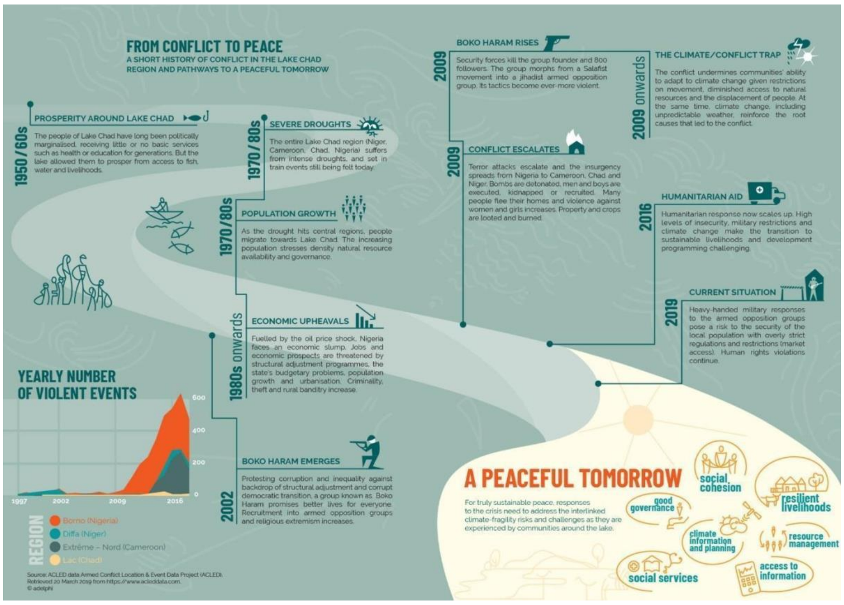
Levels of frustration and mistrust toward the governments of the region amongst the local populations are high– also due to a perceived lack of policies to support adaptation regarding the impact of climate change – ranging from drought to floods – in the volatile security context[21]. Many people opted to migrate to access other farmlands, water, pastures and fishing resources – provoking even more stress on already scarce resources, including land.

Given the constant threat of, or already occurring loss of, livelihoods and life of family and community members, there are considerable impacts on mental health; poor access to vital resources provokes additional health problems (Vivekananda et al., 2019).

Recently, in response to the movements of extremist groups and the COVID-19 pandemic, governments in the region imposed severe restrictions regarding mobility and social contact. This has led to severe economic impacts in the region, especially for those engaged in informal trade in the border areas and in trade activities that depend on cross-border exchanges. Apart from affecting family ties that span across borders, border closures thus cause significant financial losses and hardship for many segments of society (Handy, 2020).

National Security Overview

Figure B.1.2: A Short History of Conflict in the Lake Chad Region



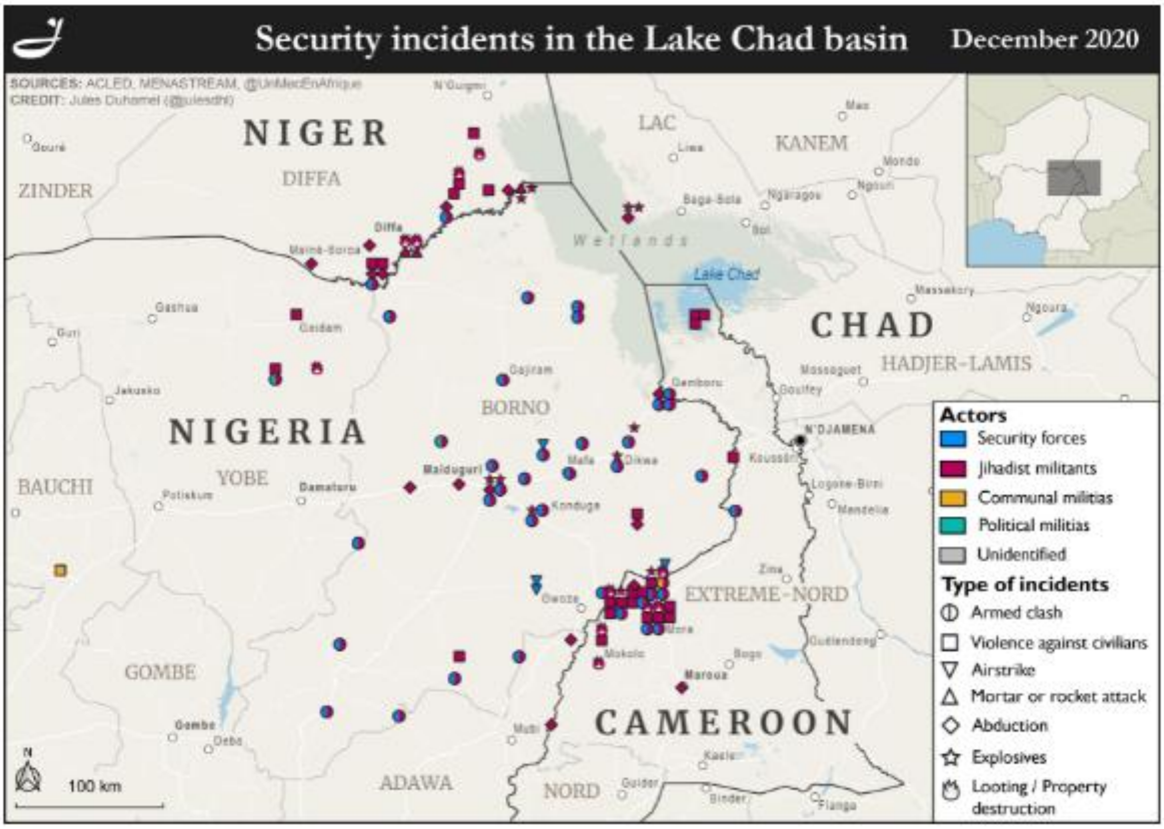
Source: adelphi, Shoring up Stability Report.

While there are numerous conflicts playing out within the four countries in focus, the conflict in the Lake Chad region continues to be the most severe crisis. For over a decade, violent extremist groups have made use of local grievances and the partial absence of state actors in order to gain a foothold in communities, especially in border areas. In the already fragilized context permeated by longstanding widespread inequality, corruption, nepotism and political marginalization, the rise of armed extremist steadily fuel humanitarian disasters and insecurity.

The violence triggered by violent extremist groups began in 2009 in Northeastern Nigeria, but gradually spread across borders from 2013 onwards, to Cameroon, Niger and Chad. The two dominant extremist groups are Jama'atu Ahl al -Sunna li -l- Da 'wa wa-l-Jihad (JAS), known as Boko Haram, and Wilayat al Islamiyya Gharb Afriqiyyah (Islamic State West Africa, ISWAP). However, there are indications that the Islamic State is similarly gaining influence and ground, building on a tactic that allows civilians to continue livelihood activities and then taxing them. This is achieved by 'winning the hearts and minds' of communities, for example by providing services which the state fails to deliver, or which international humanitarian and development actors are impeded to carry out due to constant threats (Fru and Tayo, 2021).

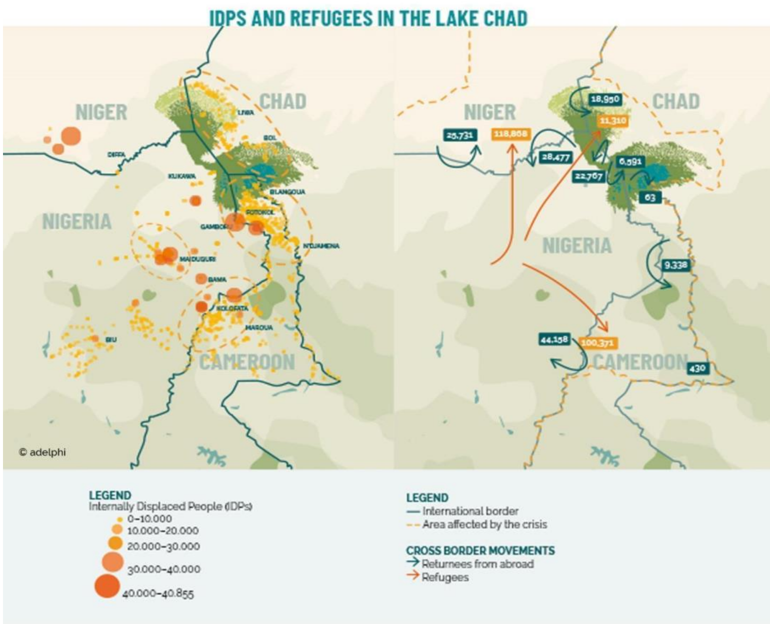
[21] This analysis builds on the research of Shoring Up Stability by Vivekananda et al. (2019). This research was conducted by an adelphi research team and is based on more than 200 interviews with community members, including past and present members of armed opposition groups, experts and officials, and an extensive review of the literature on Lake Chad.

Figure B.1.3: Security Incidents in the Lake Chad Basin



Source: Jules Duhamel: Image (wordpress.com)

Their conduct and influence have led to forced recruitment especially of young people in conditions of vulnerability, the destruction of social ties, displacements, the loss of lives, livelihoods and homes, sexual gender-based violence (SGBV), and a culture of intimidation and social control. It is also causing mass displacements within and across national borders, with an estimate of over 10 million people in need of humanitarian assistance. According to 2020 figures from the International Organization for Migration (IOM) over half of the population of Chad's Lac Province are displaced due to structural instability caused by the protracted insurgency and rapidly degrading climate and environmental conditions – as well as, since 2020, the COVID-19 pandemic. Of the 363,807 persons displaced in the Lake Chad region in 2020, the majority found refuge in communities which are already facing challenges related to scarce resources and overstretched infrastructure (United Nations, 2020a; IOM, 2020).



IDP sites in late 2018 (left) and cross-border refugee movements as of early 2019 (right). Source: IOM 2019: Displacement Tracking Matrix (DTM). IDP data. Retrieved 05 February 2019 from https://displacement.iom.int/; IOM 2019: Displacement Tracking Matrix (DTM). Lake Chad Basin Crisis Monthly Dashboard #8. Retrieved 05 March 2019 from https://displacement.iom.int/.

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by adelphi or any of the funding parties.

The presence of violent extremist and criminal groups has furthermore led to the formation of so-called self-defense groups whic themselves have at times committed human rights violations, inter alia due to the unregulated conduct and use of arms, social contr and recruitment of youth. (International Crisis Group, 2017b). At the same time, the militarized response by the national security force or the Multinational Joint Task Force also led to civilian casualties and was not free from violating human rights (ACLED, 2021; Afric Center for Strategic Studies, 2020).

The conflict has not only led to increased intra- and intercommunal tensions, but also changed perceptions and gender roles: youn men are vulnerable to (forced) recruitment by armed extremist groups and stigmatized or even arbitrarily detained as potenti extremists by state agents. As for the men and women in extremist groups, the offer of disarmament, demobilization, rehabilitatio and reintegration processes does not yet meet the needs on the ground, causing severe challenges for reintegration and soci cohesion. As a result, women, who make up the majority of the population in many areas, have taken up new types of econom activities and decision-making roles. At the same time, community leaders are increasingly frustrated due to a perceived decrease authority and ability to address tensions in their communities.

Apart from the 'shared crisis' in the shared geographic space of the Lake Chad region, all four concerned countries have several other insecurity hot spots in different regions: Niger for example faces regular outbreaks of violence by extremist groups in the Tillabery region; in Cameroon, a partially armed secession movement in the Anglophone region and militarized responses by the State continue to cause severe harm to the local population; in the Northern State of Kaduna in Nigeria criminal groups spread fear and violence, and instability in Southern Libya is strongly linked to the dynamics in the border region with Chad.

Climate Context

Lake Chad is located in the Sahel at the southernmost edge of the Sahara, creating an oasis in an otherwise largely arid region. The lake's basin covers a huge area, constituting more than 8 percent of the African continent, and features strong diversity in climate, from desert in the north to humid tropics in the South. Fed by precipitation in the south, the region is characterized by a tropical climate in the South and hyper-arid climate in the north and is split into four different climate zones (the Saharan climate, the Sahelo climate, the Sahelo-Sudanian climate, and the Sudanian-Guinean climate) with differing rainfall levels (LCBC, 2021).

There are significant temperature differences in the basin: the average annual temperature in the basin varies from 35°C and 40°C, is hot and dry from March to June, and dry and cooler from November to February (GIZ, 2016). In general, temperatures are low during the rainy season and at night throughout the dry season.

The myth of a disappearing lake

In the 1960s Lake Chad was ranked the world's sixth largest inland water body with an open water area of 25,000 km2, but at the beginning of the 1970s it shrank dramatically and reached less than 2,000 km2 during the 1980s, decreasing by more 90 per cent in area.

The 1970s and 1980s droughts split the lake into a southern and a northern pool, and the regular drying of the northern pool of the lake alerted the international community to the possible disappearance of the lake.[22] Since the 1990s, people have observed that the surface water of the lake has increased due to more favorable rainfall in the western Sahel (Nicholson, 2001). However, the regular dryness of the northern pool and the consequent spread of vegetation cover have perpetuated a perception of a shrinking lake, which is frequently repeated amongst policy makers (Vivekananda et al., 2019).

The perception that the lake is shrinking is influenced by its topography, as it is incredibly shallow. With an average depth of only three meters, the average intra-annual variation of 1 meter translates into huge variations in surface area between summer and winter months, which can create the illusion that the lake is shrinking. But new findings, based on the multisatellite data and analysis of data from the past 20 years, indicate that Lake Chad is not shrinking and recovers its surface water extent and volume seasonally (Pham-Duc, 2020).Since the 1990s Lake Chad's overall size has, on average, been stable over the past 20 years. In some parts, it has even been growing. Further, when the total water storage of Lake Chad - including the lake surface area, soil moisture and groundwater – is considered, it can be seen that the lake's total water storage is increasing. Overall, the lake is thus not decreasing in size or disappearing, its size is rather fluctuating more unpredictably than it has historically done so, between seasons, years and decades (Vivekananda et al., 2019).

Climate projections

Although global models show some uncertainty regarding future climate projections, heavier precipitation and drier conditions are expected to intensify in the Lake Chad region (Tomalka et al, 2021a). This will lead to an increased frequency of severe droughts, resulting in a lack of pastures and water which has and will lead to increasing competition over these valuable resources (Tomalka et al, 2021a).

Temperature:

Global models predict warming in the Sahel, above global warming averages. This will have direct effects on agriculture and human health in the Lake Chad region and will increase evaporation from the Lake. Global models show some uncertainty regarding future climate projections, however the majority - approximately 75 percent - of the models forecast that temperature will increase across most of the Sahel, including the areas around Lake Chad, with varied estimations on the scale of the change (Roehrig et al. 2013). In Chad, it is predicted that by 2080, 300 days per year will experience very hot days (days with a daily temperature above 35 degrees Celsius) (Tomalka et al, 2021a). while the annual number of very hot days is also projected to rise substantially over southwestern Niger (Tomalka et al, 2021b).

Precipitation:

Rainfall influences the water level of Lake Chad, which is mainly fed by water and runoff from the Chari River (which flows from the Central African Republic through Chad) and the Logone River (which rises in Cameroon and joins the Chari River around N'Djamena before joining Lake Chad). This river system drains more than 610,000 km2 of a huge catchment located in the Sudanese areas. (Vivekananda et al., 2019)

Overall, the region experiences a single rainy season from June to October and a long dry season throughout the rest of the year. More specifically, the north of the basin – northern Chad, Libya and Algeria – is characterized by low monsoon precipitations, while the south – southern Chad and the Central African Republic – experiences high monsoon precipitations (LCBC, 2021).

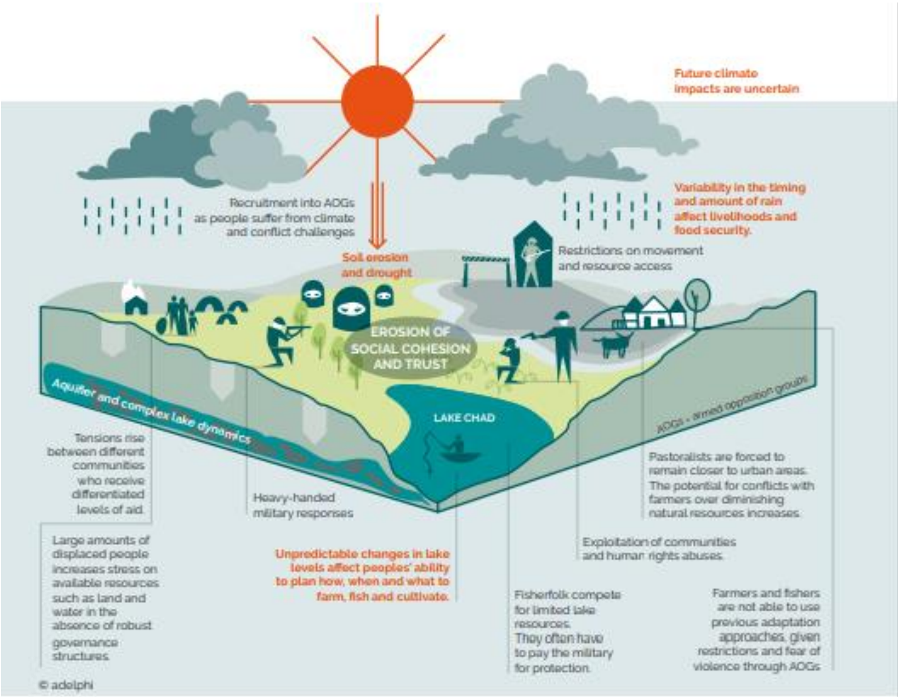
[22] The following article contributed to the common perception that Lake Chad would be shrinking. Chandler, Lynn 2001: Africa's Lake Chad shrinks by 20 times due to irrigation demands, climate change. Note 01-17. Goddard Space Flight Center. Greenbelt, MD: NASA. Retrieved 04.04.2019 from http://geoalliance.asu.edu/sites/default/files/LessonFiles/Martin/Chad/GSFC_Press_Release_01_17.pdf

However, the region is facing increasingly uncertain rainfall patterns. From 1990 to 2007, the Central Sahel has become increasingly wetter (Nicholson, 2005), increasing flooding risks and making it more difficult to keep and use water (Taylor et al., 2017). While some models forecast that this trend will continue and that precipitation will increase across most of the Sahel and Lake Chad area (e.g. AGRICA, 2021), leading to increased variability and frequency of extreme weather events, various studies underscore the difficulty of current models to make reliable predictions about future rainfall (Roehrig et al, 2013). For example, countervailing mechanisms such as a cooling of the Atlantic due to accelerated Greenland ice sheet melting, might induce a large decrease of Sahel rainfall. (Defrance et al., 2017). Such uncertainty and the variability of the timing and amount of rainfall poses a significant risk to livelihood security and prospects for sustainable peace and stability in the region.

Climate-Fragility Risks

The four countries in the Lake Chad Basin region find themselves in vulnerable conditions due to continuous violence, the insurgence of armed extremist groups such as Boko Haram and militarized responses to them, political instability, cross-border conflicts and population displacement (FAO, 2021). The impacts of man-made climate change – such as prolonged droughts, changing rainfall patterns and heavier rains – are compounding these challenges and increasing the pressure on livelihoods, particularly in rural areas, and thereby communities (Vivekananda et al., 2019). Further stressors include increasing competition for natural resources, such as grazing land for livestock and water, increase cross-border and intercommunal conflicts (Tomalka, 2021b).

Figure B1.5: The Climate Conflict Trap



Source: adelphi. Shoring Up Stability Report.

In other words, the Lake Chad Basin is caught in a conflict trap. Figure B1.5 outlines various linked pathways through which climate change is compounding the many political, environmental, economic, and security challenges that face the region, exacerbating the already complex security challenges facing the region and affecting people's adaptation capacities (see also ICRC, 2020; Mach et al., 2019). This creates a self-enforcing feedback loop whereby conflict between armed opposition groups and state security forces is increasing peoples' vulnerability to climate change risks while simultaneously undermining traditional coping mechanisms and exacerbating conflicts over natural resources (Vivekananda, 2020).

The four main climate-fragility risks facing the Lake Chad Basin are:

1. The impacts of climate change increase social tensions and livelihood insecurity

Communities in the Lake Chad Basin mostly have mixed livelihoods, consisting in a combination of fishing, agriculture, livestock farming and trade (Raimond and Rangé, 2015) which switch at different times of the year. The majority of these livelihoods are climate-sensitive, and people switched occupations as a result of lake and climate variation for generations. For example, when the risks of early flooding are high, people would traditionally shift from flood recession agriculture to livestock farming and fishing. Similarly, during flood recessions people would also migrate to areas where farming opportunities are higher.

However, as the impacts of climate change put increasing pressure on livelihoods dependent on fishing and farming, social tensions are aggravated due to conflicts over resources such as land and water. Such pressures are decreasing social cohesion and aggravating tensions and conflicts at all levels of society. As shown by field data for the Shoring Up Stability assessment, inter-generational tensions and higher levels of domestic violence are increasing at a household level due to the fact that strained livelihoods challenge traditional perceptions of masculinity and 'manhood'. Within and between disparate identity groups such as host communities and IDPs, existing grievances are more prone to worsen as climate risks exacerbate existing tensions and conflict resolution mechanisms become less viable. Between the state and people, strains on social cohesion also grow as climate-fragility risks accentuate weak governance and a limited state presence, further depriving the region's population of access to basic services (World Bank, 2020).

In the Lake Chad Basin, the greatest challenge is thus not the change in lake levels, but the uncertainty regarding the future climate and how it will impact livelihoods. While greater annual fluctuation of Lake Chad can offer benefits in terms of the fertility of land for recession agriculture (Ngaressem et al., 2014), it poses risks for the fishing and irrigated agriculture sectors, and thus significant livelihood risks. It also remains to be seen how this ecosystem can maintain a rapidly increasing population.

Figure B1.6: Multifunctional spaces of Lake Chad

Source : Christine Raimond and Charline Rangé, ‘Les systèmes d’activités’, in : Gèraud Magrin, Jacques Lemoalle and Roland Pourtier (eds.), Atlas du lac Tchad. (Paris: IRD Éditions/ Passages, 2015).

2. Conflict dynamics are increasing people’s vulnerability to climate and conflict risks and undermining their capacity to cope

Due to the on-going humanitarian crisis and widespread violence in the region, the resilience of the population and their capacity to adapt to climate change has been notably reduced. This makes communities more vulnerable to climate shocks, inhibiting their chances of sustainable livelihoods and development, which are integral to achieve and sustain peace and stability. For people living around Lake Chad, such vulnerabilities manifest in four main ways:

Firstly, state security forces and armed opposition groups are increasingly restricting access to agricultural land, fishing areas and natural resources, which are integral for the livelihoods of big parts of the regional population. As a result, traditional coping strategies such as shifting to alternative livelihoods as a strategy to cope with climate and weather variability are becoming less viable. Similarly, traditional livelihood practices are becoming less viable due to limited access to land and water, increased military control over crops and forest ground, and more uncertain and variable rainfall patterns.

Secondly, mass displacement has left many people, and especially women and elderly, in extremely vulnerable states. The affected population lacks access to natural resources, such as land for subsistence agriculture which forms the basis of their livelihoods, as well as protection. This leaves them unable to work and more dependent on humanitarian aid for survival. Often, the affected people have been displaced multiple times and thus have scarce financial resources which lowers their ability to cope with future pressures. Further, in areas of destination, pressure on natural resources is leading to increased competition between displaced communities and host populations. This in turn reduces the resilience of both displaced populations and host communities.

Populations that have not been able to flee and have no access to humanitarian aid are highly vulnerable. This is particularly the case for small islands in the Lake Chad that are utilised as retreating areas by armed opposition groups.

Third, the crisis in the Basin has eroded social cohesion, increased mistrust and between communities and population groups. For example, suspicion has grown between Muslims and Christians as well as groups or individuals that are seen to be part or in support of armed opposition groups. This creates challenges for cooperation within and across communities and can reduce their resilience to tensions and pressures. Similarly, traditional governance structures have been fractured due to the conflict, leaving a power vacuum and weakened community leadership.

Fourth, the crisis has deteriorated the often already volatile relations between the population and the state; heavily militarized interventions by national or regional security forces have sown further distrust when they caused casualties also on the civilian side and impacted the ability of people to carry out activities vital for their livelihoods. This undermines efforts to address climate-security and conflict risks, for example in the realm of stabilization.

3. Increased competition over natural resources

Natural resource competition between different occupational groups such as farmers, pastoralists, fisherfolk and hunters has been exacerbated by reduced land availability, the planting of crops on grazing routes, varying rainfall patterns that affect crop yield, military interventions and water scarcity. (Griffin, 2020). As Figure B1.6 shows, communities use the land around Lake Chad in disparate ways. While this enables people to make a living through various means, it can also lead to quarrels over who can access and use land at different times in face of changing weather patterns.

Climate change adds to these tensions. The impacts of global warming will not only put increased pressure on natural resources such as land and water, but also shift the availability of and access to natural resources, thereby polarizing he population by creating ‘winners and losers’ of the new climatic circumstances. This means that conflicts around land and water are likely to worsen, particularly between different occupational groups such as pastoralists and farmers. Therefore, even if the violent impact of armed extremist groups decreases, allowing people to go about their livelihoods, there remains the risk of increased tensions around natural resources. The corresponding competition can turn into conflict, particularly in the context of weak governance and peaceful conflict resolution mechanisms and unstable community relationships.

4.Livelihood insecurity leads to increased recruitment into armed extremist groups.

In the Lake Chad region, violence undermines communities’ ability to adapt to climate change, while climate change compounds the roots and drivers of conflict and deepened the humanitarian crisis. This has simultaneously impacted livelihoods and availability of vital resources and worsened core drivers of the conflict and worsened the humanitarian crisis (Vivekananda et al., 2019). Not only does this leave young people exposed to economic insecurity and a lack of perspectives, and thus at risk to be exploited by extremist groups

(Mécanisme de sécurité climatique, 2020), but it has also meant that the root causes of conflict in the Lake Chad region remain largely unaddressed and are worsening as a consequence.

The rise of armed opposition groups can be loosely linked to religion, poverty and inequality, political and electoral competition post democratic transition in 1999, the geographical context and the personal motivations of those involved (Mustapha, 2015). While survey sample sizes used in the research as part of Shoring Up Stability are too small to make general statements, existing evidence demonstrates that recruitment is occurring in the context of socioeconomic inequality, changing livelihoods and financial incentives offered by armed groups. Particularly young men, who see traditional routes to adulthood and livelihood security impeded, are targeted. However, motivations for joining armed opposition groups do vary by country and region. In Niger, economic advancement is a key motivator, whereas in Nigeria persuasive religious preaching played a strong role in recruitment. By comparison, minority ethnic groups are socially ostracized in Chad, likely fueling their interest in joining armed opposition groups.

Membership in armed groups provides recruits with a wage, larger purpose, a sense of belonging and the opportunity to gain respect in societies usually dominated by deep ethnic, gender and age hierarchies (Nagarajan, 2018a). In Nigeria, a desire for revenge for real or perceived human rights violations committed by the security forces also became key in the recruitment process.

Gender norms, which operate in disparate ways for girls, women and boys, also play a role in the recruitment for armed groups. Women and girls have joined opposition groups to search for (relative) empowerment and to be part of a movement (Mercy Corps, 2016), or with the hope of acquiring access to education or better social mobility. Instead, the groups' strict rules have limited their opportunities and freedoms, with many women experiencing violence and domestic abuse (Vivekananda et al., 2019). Simultaneously, young men are faced with societal pressures to marry, get a job and provide for a household - ideals of masculinity that typically stand for status and respect – which are made more difficult due to livelihoods being affected by corruption, nepotism and inequality. This plays a role in mobilizing boys and men to join armed forces (Nagarajan, 2018a).

Further, armed opposition groups in all four countries have taken advantage of the lack of health and education services in the Lake Chad region by providing services that governments do not. This further facilitates recruitment into armed opposition groups, as new members value the health care, food, religious education and access to funding that these groups offer (Nagarajan, 2018b). In turn, provided that such material conditions are better and more appealing than living with no employment prospects, re-joining armed groups has become more common amongst both young women and young men. Young women have been compelled to affiliate themselves with extremist groups despite the limitations and rules posed within them, as these offer them respite from insecurity or dependence on aid organizations for food (Moaveni, 2019). Similarly, many men who have tasted the respect, status and power of engaging with such groups struggle to return to unemployment, lack of food or shelter they previously encountered in mainstream society.

Entry Points and recommendations

In order to effectively and sustainably respond to climate-fragility risks, this analysis was based on the Weathering Risk Methodology (see Figure B1.7).

Figure B1.7: The Weathering Risk Methodology

Based on the above analysis, the following action-oriented points can contribute to the design and implementation of more sustainable stabilization and peacebuilding efforts in the Lake Chad region:

Better Integration of Climate Security into Stabilization and Resilience programming

Given the objective of long-term stabilization as displayed in the RSS and prevention of future disruption and conflict, crisis response and stabilization-focused programs and strategies should be developed in a conflict-sensitive manner and take the underlying root causes of instability into consideration, including climate-related aspects (United Nations 2020). Accordingly, the success of stabilization efforts to enhance human security in the region strongly depends on the ability of humanitarian, development and peacebuilding actors and their regional counterparts to build partnerships around and take account of climate-fragility risks and integrate these in their programming and monitoring. The respective long-term planning needs to be based on credible and accurate scientific data. For example:

- ⇒ Support and realize integrated recovery, peacebuilding, resilience, and development programming and complementary implementation of interventions in view of the climate, conflict and social context.
- ⇒ Complement military strategies, such as the one of the MNJTF, with regional climate-sensitive development, humanitarian and peacebuilding efforts, as envisaged by the RSS and RSF.
- ⇒ Coordinate the climate, peace and security agendas and efforts of key actors, such as the AU, ECOWAS, ECCAS, LCBC, EU, World Bank.

Address transboundary risks through transboundary institutions, partnerships and processes

The institutional set-up of the LCBC provides for an environmental/hydrological as well as security component. Enhanced complementarity and coordination of these components as well as of instruments like the LCBC's Lake Chad Development and Climate Resilience Action Plan (2015) and the RSS and of the programs of support partners would ensure improvements regarding natural resource management, land rehabilitation and improved agronomic practices as part of development efforts. This requires continuous commitment and buy-in from all key stakeholders. Given the cross-border dimension of climate security risks, the inter- and intra-state, as well as cross-sectoral cooperation should be enhanced by initiatives such as the Lake Chad Basin Governors' Forum – which therefore also need to factor in climate security aspects in their agendas. For example:

- ⇒ Ensure the regional ownership and sustainable implementation of multipartner programs, cross-border policy implementation to mitigate or prevent climate-fragility risks.
- ⇒ Support efforts to improve women's access to land and education as well as those to regulate the land use of different ethnic groups engaged in different livelihoods, such as reflected in the ECOWAS and ECCAS Lomé Declaration.

Focus on social cohesion

Strengthening resilience to cope with climate security risks by enhancing social cohesion should be at the core of any regional efforts. This implies, inter alia, building trust between the state and the population, and supporting institutional climate security risk assessment tools and capacities, early warning and foresight mechanisms, and response capacities, such as mediation, of local authorities, national governments and regional mechanisms, such as the LCBC. At the same time, monitoring must be strengthened and linked to the engagement of key stakeholders, including women and youth. Land rights and access to natural resource consider the needs and interests of all occupational groups and parts of society as well as the likely impacts of climate change. In the light of increasing tensions between farmers and pastoralists as well as intra-communal tensions, improved local governance, the demarcation of grazing routes and capacities to mediate between conflict parties can contribute to preventing further tensions. For example:

- ⇒ Invest in programs that strengthen coping capacities and address marginalization and persisting inequalities as key drivers of conflict and recruitment of youth by extremist or criminal groups.
- ⇒ Build capacities in mediation for the peaceful resolution of resource-related conflicts, also in cooperation with traditional leaders.

Gender sensitive and climate sensitive livelihoods

Gender-sensitive economic empowerment, by providing skills and training, improving transport infrastructure, opportunities regarding context-adapted livelihoods, and access to markets, increase resilience. This also implies an enhanced focus on, especially rural, youth and educational as well as vocational training opportunities, especially in the realm of innovative climate-sensitive sectors and a diversification of crops. For example:

- ⇒ Ensure the meaningful and coherent engagement of traditional leaders, civil society and local organizations with a focus on ensuring meaningful participation, especially of women, youth, and people with disabilities.
- ⇒ Build gender-, community- and environmental-sensitive reintegration programs for those who disarm and want to return to civil life.

Engage local scientists and experts for informed and sustainable knowledge building

Regional climate security risks should be identified via locally informed analysis. As for water, regional scientists should be engaged in quality assessments, studying the run-off from the southern to the northern pool of the Lake, and thus support knowledge dissemination and management on the extraction of ground water across the region. For example:

⇒ Engage and support experts in and from the region and research institutes to advance the necessary knowledge / data generation and dissemination.

Tackle root causes of deforestation

Given the evident risks caused by deforestation, local governments and international organizations can also be effective in promoting reforestation and engaging local communities as well as people in IDP and refugee camps in the transition for alternative energy sources for cooking and other immediate needs. For example:

⇒ Support and invest in new innovative, context-adaptable energy generation and in the vocational training of young people to gain jobs in the new economic sectors.

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B.2 Case Study 7 – Does climate change influence conflict? Evidence for West African countries

Ateba Boyomo Henri Aurélien [23]

Abstract

In this paper, we use the two-way fixed effect method to analyze the existence of climate conflict in West Africa, using data from 2000 to 2020. The direct analysis of the effect of climate change on conflict shows that climate change influences conflict in West Africa, through periods of conflict during relatively warm periods or with less rainfall. Similarly, indirect analysis of this relationship identifies climate conflict risk multipliers such as agricultural production, food price volatility, deforestation and livelihoods.To reduce the risk of future conflicts in West Africa, we recommend that policy makers implement measures to control food prices, increase agricultural production, limit deforestation, and improve the living conditions of the population.

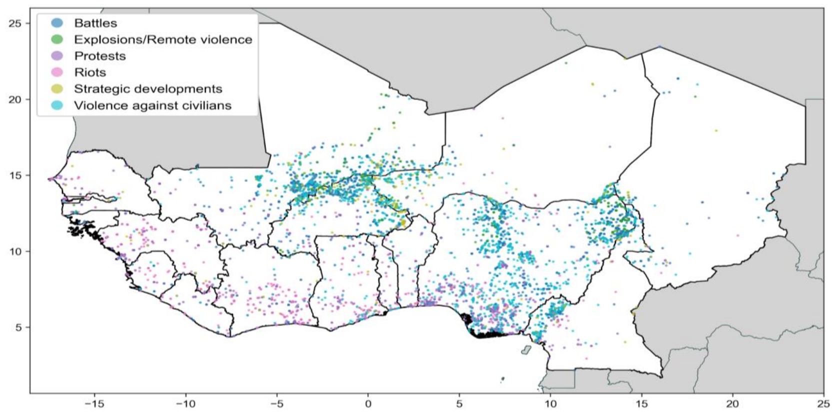
1 Introduction

Three main factors are considered as determining the advent of conflicts in the world. These are political factors related to the conquest of power, socioeconomic factors emanating from the inequality of income and wealth between individuals within society, and religious factors characterized by the superiority of one religion over another (Hugon, 2006).

However, in the African context, the literature identifies two main sources of conflict, such as poor living conditions captured by the level of income of populations (Alesina and Perotti, 1996; Alesina et al. 1996; Rodriguez and Rodrik, 2000; Collier and Hoeffler, 2004), and the deprivation of freedoms, captured by the level of democratization (Collier and Hoeffler, 1998; Blanco and Grier 2009). West Africa seems to be no exception to this rule, as it is an area in which the security environment is considered highly unstable, and characterized by intra-state conflicts (Annan, 2014).

The figure below presents the security situation in West Africa.

Figure B2.1: Security situation in West Africa.



Source: Armed Conflict Location and Event data project (ACLED, 2020).

This graph highlights the security situation in the countries of the West African region, where the nature of the riots varies from one country to another. Indeed, we can identify, for example, the dominance of riots in the Gambia, Senegal, Guinea Bissau and Conakry, the Ivory Coast, Ghana and Benin, while battles and violence against civilians are more common in Burkina Faso, Mali and Niger. Finally, we can identify on our map the dominance of battles, riots, explosions, and violence against civilians in the northwest and southwest regions of Cameroon, and in almost all regions of Nigeria.

Nevertheless, whatever the nature and forms of conflict identified in this region, most of them have been characterized by extreme violence (Afis, 2009). Multiple factors such as poverty, human rights violations, poor governance and corruption, tribalism, and the

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proliferation of weapons are considered to be determinants of conflict in this region (Fithen, 1999; Voz di Paz and Interpeace, 2010; Vinck et al., 2011; Keili, 2008).

However, long considered an environmental and energy issue, climate change plays a primary role in fuelling conflict (Oli et al., 2019). It is part of enormous threats to national security, global stability, and human well-being (IPCC, 2014; Department of Defense, 2014; USAID, 2014). In addition, experts fear that the change in rainfall will increase civil conflicts, still considered internal conflicts or intra-country conflicts between the government and separatists (Department of Defense, 2014; USAID, 2014). Africa is one of the most vulnerable continents to climate change and climate variability, a situation that is exacerbated by the interaction of multiple stresses at various levels and low adaptive capacity" (IPCC, 2007). According to the Intergovernmental Panel on Climate Change (IPCC), climate change is understood as any variation in climate over time caused either by natural variability or by human activities (Parry et al., 2007; P.21). Indeed, high average temperatures, low precipitation levels, sea level rise, and increased variability and unpredictability of weather events such as droughts, floods, and cyclones act as a multiplier of risk and instability (CGIAR, 2009).

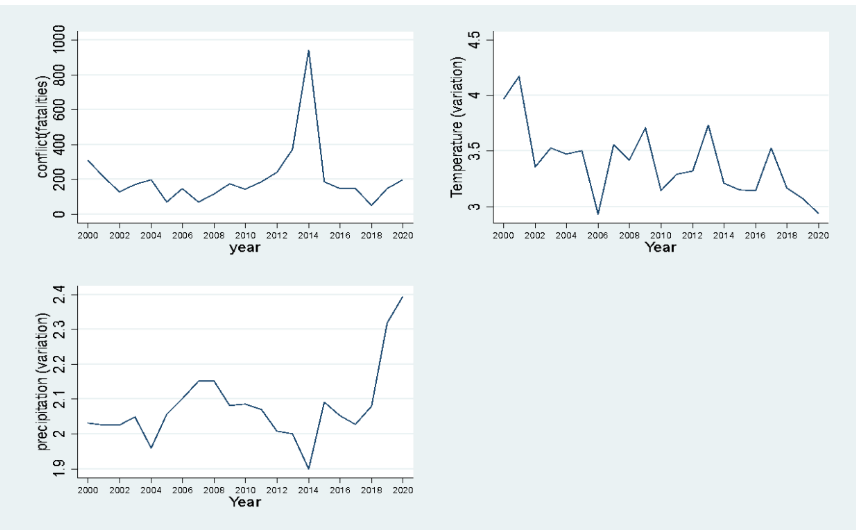
West Africa experienced a severe drought in the 1970s (Nicholson, 1980; Held et al., 2005), which had a largely disastrous impact on agriculture, the main activity of the people in this region.

In the Africa Report on Population, Health, Environment and Conflict, Nyong (2006) shows that the West African Sahel, located between the Sahara in the north and the savannahs in the south, is the scene of recurrent droughts that lead to vulnerability and conflict. According to this report, average rainfall in the region has declined sharply from 1,000 mm/year in the northern bangs. It is also recognized that this region has experienced severe drought due to rising temperatures and a drastic decrease in rainfall (Adger & Brooks, 2003; Lebel et al., 1997; L'Hôte et al., 2002). In its June 2007 report, the United Nations Environment Programme (UNEP) argued that the conflict in Darfur was partly fuelled by climate change and environmental degradation.

A graphical analysis (Fig. B2.2) shows the evolution of climate change and conflict in West Africa from 2000 to 2020. It shows that average temperatures and rainfall in West Africa are evolving in a sawtooth pattern, through irregular movements. Indeed, the evolution of these phenomena in upward and downward phases clearly reflects the climate variability or change recorded in recent years. However, these irregularities are more in favor of an increase in temperature, and a relative decrease in the level of precipitation. Indeed, there are more peaks in temperature levels (increasing temperatures), and troughs in precipitation (decreasing precipitation). These analyses are in line with the IPCC results which had anticipated an increase in temperatures and less humid periods in West Africa, and more specifically in the Sahel. Moreover, it should be noted that the decrease in rainfall and the increase in temperature in Africa is not new. Indeed, a decrease in annual rainfall has been observed since the late 1960s, with a decrease of 20 to 40 percent between the periods 1931-1960 and 1968-1990 (Nicholson et al., 2000; Chappell and Agnew, 2004; Dai et al., 2004), while one third of the populations in West Africa live in drought-prone areas and are vulnerable to the impacts of droughts (World Water Forum, 2000).

With respect to the evolution of conflicts (Figure B2.2), a sharp increase in the level of conflict-related deaths can be observed starting in the 2010s. Indeed, the early 2010s were marked by an unstable security environment in West Africa that led to a considerable number of deaths. These include the post-election crisis in Côte d'Ivoire, jihadist attacks by Al-Qaeda in the Islamic Maghreb (AQIM) in Mali, and the terrorist actions of Boko Haram in Nigeria and Cameroon.

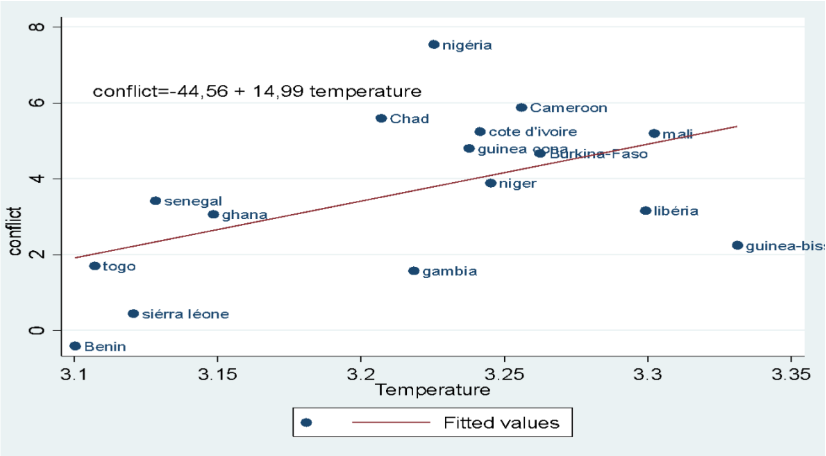
Figure B2.2: Evolution of climate change and conflict in West Africa from 2000 to 2020.



Source: author

However, there is no empirical evidence that identifies climate change as a trigger for different conflicts in West Africa. However, a correlation analysis can identify the link between these variables. It shows that the variation in average temperatures and conflicts (Figure B2.3) in West Africa are positively correlated. Variations in temperature levels seem to move in the same direction as conflicts.

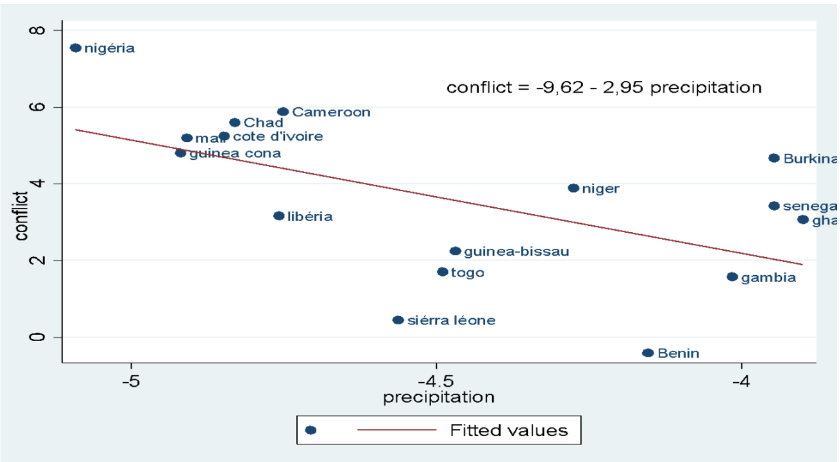
Figure B2.3: Correlation between temperature variation and conflicts in West Africa from 2000 to 2020.



Source: author

On the other hand, we find a negative correlation between average rainfall and conflicts (Figure B2.4) in the same region. Indeed, the decrease in the level of rainfall would be at the origin of an increase in the number of conflicts. Indirectly, the channel that validates the idea of climate conflict in Africa would be the level of agricultural production and the volatility of food prices. Indeed, climate change in Africa has contributed to water stress, land deterioration and decreased agricultural yields (Ehrart, 2020). This decrease in production is a consequence of higher food prices and protest and conflict movements. As an example, the food crisis of 2007-2008, which was caused by the increase in food prices, resulted in protest movements that constitute a risk of conflict for developing countries and their various households.

Figure B2.4: Correlation between average rainfall and conflicts.



Source: author

The existing literature on climate conflict is very extensive. However, the results and conclusions reached by these empirical studies appear to be inconsistent. While some studies find a systematic link between higher levels of climate stress and conflict (Burke et al. 2009), other analyses conclude that higher temperatures, excessive rainfall variability do not influence the risk of armed conflict and political instability (Buhaug 2010; Dell et al. 2012; Theisen et al. 2012). On the other hand, another fringe of analysis states that the existence of evidence between these variables is mixed (O'Loughlin et al. 2012; Couttenier and Soubeyran 2013).

However, the seemingly contradictory empirical results should not lead to a radical rejection of the climate conflict hypothesis, but rather should lead to further quantitative analyses that clarify the nature of the relationship between these variables. Indeed, a closer look at the literature reveals that seemingly inconsistent results can often be explained by important differences across regions and study periods (Salehyan, 2014; Buhaug, 2015).

For example, several studies have empirically analyzed the effect of climate change in the occurrence of conflict in Africa (Raleigh et al.,2015; Harari and La Ferrara, 2014; Theisen et al., 2011; Nords's and Gleditsch, 2007; Raleigh and Urdal, 2007; Barnett, 2000), in sub-Saharan Africa (Miguel et al., 2004; Hendrix et al., 2007; Miguel and Satyanath, 2011; Burke et al., 2009; Buhaug (2010); Hsiang et al., 2013), and in East Africa (Raleigh and Kniveton ,2012; O'Loughlin et al., 2012).
Furthermore, empirical evidence on the effect of climate change in the onset of conflict in West Africa is almost nonexistent.

The contribution of this article can thus be made on three points: (i) globally, it sheds light on the existence of a climate conflict whose analyses in the literature are ambiguous. Specifically in space, (ii) it empirically verifies the hypothesis of a causal relationship between climate change and conflicts in West Africa, in time (iii) it proposes a study on a relatively recent time horizon, as opposed to those observed in the literature.

It is in light of the above that one may ask the question: is there climate conflict in West Africa? Specifically: (i) what is the effect of temperature variations on the occurrence of conflicts in West Africa? (ii) what is the effect of rainfall variations on the resurgence of conflicts in West Africa? The rest of the article is organized as follows: a review of the literature, a methodological analysis, a presentation of the results of the econometric estimates followed by a discussion and some recommendations.

2 Literature review: nexus between climate and conflict

The literature on climate conflict is very diverse, and the main results and conclusions are mostly ambiguous. Indeed, analyses identify an influence of climate change on conflicts, whose effect can be either direct or indirect, while others highlight an absence of relationship between these variables. Therefore, we present at this level a literature on the issue, focusing on the main studies identified in Africa.

Direct effect of climate change on conflict: ambiguous results

According to the Intergovernmental Panel on Climate Change (IPCC, 2014), there is an inextricable link between climate and conflict. Indeed, a high level of scarcity due to a decrease in precipitation in a region increases the risk of conflict (Raleigh and Urdal, 2007). This conclusion is shared by Lecoutre, d'Excelle and Van Campenhout (2010). Moreover, Homer-Dixon (1994) demonstrates that the scarcity of natural resources due to climate change generates national and international conflicts. This result is confirmed by the work of Hendrix and Salehyan (2012) and Theisen (2012). Witsenburg and Adano (2007) argue that the rate of conflict in rural areas corresponds to seasonal climate periods.

Ciccone (2011) and Jensen and Gleditsch (2009) in turn show that lower levels of precipitation decrease the outbreak of civil wars. Other studies show that low or declining rainfall increases the risk of communal conflicts, such as Hindu-Muslim riots in India (Bohlken & Sergenti 2010, Sarsons 2011) or land invasions in Brazil (Hidalgo et al. 2010). Livestock theft as a source of conflict between populations is common during rainy periods in pastoral areas, as the operating environment is favorable, and the animals are healthy (Adano et al, 2012). Meier et al (2007) shows that rainy months are conducive to increased conflict, as rain increases the cover needed to launch attacks and raids.

High temperatures increase the risk of many forms of intergroup conflict, both political and other forms of mob violence (Burke et al. 2009; Hsiang et al. 2011, 2013b; Dell et al. 2012; O'Loughlin et al. 2012; Baysan et al. 2014; Caruso et al. 2014; Maystadt&Ecker 2014; Maystadt et al. 2015).

However, while some studies find a systematic link between higher levels of climate stress and insecurity (Burke et al. 2009), other analyses conclude that higher temperatures, excessive rainfall variability, and similar variables do not influence the risk of armed conflict (e.g., Buhaug 2010; Dell et al. 2012; Theisen et al. 2012). Thus, the lack of conclusive quantitative evidence of a causal link between climate and conflict should not be taken as evidence of the absence of any link between the two phenomena (Kallis and Zografos 2014, P.77). The seemingly contradictory results of the statistical analyses should lead us to identify the main sources and determinants that may influence this relationship

Indirect effect of climate change on conflict: the role of intervening variables.

A popular notion on climate shocks shows that there are certain intermediate factors called "risk multipliers" that can fuel and aggravate already fragile political situations (Rüttinger et al., 2015). Thus intermediate variables are considered to amplify the effect that climate can have on conflict.
Agricultural production.

Some researchers have argued that rainfall is linked to civil conflict through agricultural production (Miguel et al., 2004; Miguel and Satyanath, 2011; Maystadt and Ecker, 2014; Couttenier and Soubeyran, 2014). As a result, a lack of rainfall could lead to a decrease in subsistence agricultural production, which could increase famine, and then conflicts between riparians due to resource scarcity. Climate change also influences agricultural production through its impacts on productivity and availability of land and water (Huang et al, 2011). This interacts with food security and creates conflict (Maxwell et al, 2010).

Previous studies document that in the Philippines, above average rainfall during the wet season had a negative effect on agricultural production, while above average rainfall during the dry season has a positive effect (Lansigan et al.., 2000; Gerpacio et al., 2004; Roberts et al., 2009).

Supporting the argument that rainfall is linked to civil conflict through agricultural production, Crost et al. (2014) show that increased rainfall in the wet season is associated with more conflict in the year, while increased dry season rainfall is associated with less conflict. Using data from India, Fetzer (2014) found a negative relationship between monsoon rainfall and civil conflict. Using data from 26 Asian countries for the period 1951-2008, Wischnath and Buhaug (2014) found little evidence that civil conflict is triggered by lack of rainfall, perhaps because Asian economies and/or farmers are less dependent on traditional agricultural practices compared to African countries.

Food price volatility

The food crisis of 2007-2008 spurred the advent of several research studies highlighting the effect of global food price variation on increasing conflict in the form of food riots or food riots (Demarest, 2014). Various studies have shown the indirect influence of climate change on conflict through price volatility. Indeed, climate change influences conflict through food yields and prices. Demarest (2014) believes that increases in agricultural food prices due to climate disruption, create shortages and competition for natural resources, which generates conflict. This suggests that food prices are intermediate variables observed, but rarely used to present the link between climate security and conflict (see Berazneva and Lee, 2013; Zhang et al. 2010; Koubi et al. 2012). Climate change as a source of conflict in Africa through soaring food prices has raised the issue of food riots (Bellemare, 2014; Hendrix, 2009; Lagi et al, 2011), and several aid agencies and multilateral organizations argue that the increase in riots is due to soaring international commodity prices (Pomeroy, 2008; Lacey, 2008).

For Azereki and Brückner (2011), there is a positive correlation between international food prices and anti-government protests, and this relationship appears to be stronger in the case of low-income countries due to the vulnerability of households to price volatility. In this context, rising agricultural prices lead to conflict as poorer populations will take offense at the way governments expose them to high and unpredictable prices (Barnett and Bellemare, 2011).

For Besley and Persson (2008), the difference in commodity prices can affect the propensity of a group of people to engage in different forms of conflict. They argue that the risk of civil conflict increases as domestic import prices increase and real household income decreases.

Confirmation of this correlation came through a Colombian study showing that two primary products could differently modify conflict risks (Dube and Vargas, 2013). Indeed for these authors, in rural coffee-growing areas, the decrease in violence is due to the increase in the export price of coffee, while the increase in the export price of oil increases violence in areas where oil is the main resource for rebels (Hendrix and Salehyan, 2012).

Deforestation

Most studies on the link between environmental change and internal conflict focus on the relationship between conflict and environmental degradation, specifically forest degradation. The first work to identify environmental degradation as a source of conflict was that of Choucri and North (1975). Subsequently, two groups have particularly distinguished themselves in this field: the Toronto Group with Thomas Homer-Dixon as a key figure, and the Swiss 'Environment and Conflicts Project (ENCOP) led by Günther Bächler and Kurt Spillmann. These two groups have produced a series of case studies on the relationship between renewable resource degradation and national armed conflict; both conclude that deforestation, along with water and fish stock degradation, are major contributors to national armed conflict (Bächler, 1994, 1996; Homer-Dixon, 1994).

Bächler (1994) and Homer-Dixon (1996) use very different theoretical frameworks. On the one hand, in one of the three volumes discussed by ENCOP, Bächler (1996) discusses the links between deforestation and national armed conflict in relation to theories of land underdevelopment and consumption. These theoretical approaches are generally supported by a large number of case studies. On the other hand, Homer-Dixon (1994) has developed his own model of how environmental destruction leads to national armed conflict and applies it consistently (with minor variations) to case studies. Case studies by other researchers have reached similar conclusions (Gleick, 1993; Swain, 1996).

Finally, Hauge and Ellingsen (1998) concluded that countries subject to environmental damage, including deforestation and land degradation, were more prone to conflict.

Other factors: income, population and democracy.

Linking conflict to climate change and food insecurity through income levels, Miguel et al (2004) argue that changes in national rainfall led to lower growth and income, which in turn leads to more civil wars. Similarly, Bohlken and Sergenti (2010), analyzing Hindu-Muslim riots in India, find that lower rainfall decreases economic growth, which in turn increases riots.

Thus, regardless of the combination of these factors, the emergence of conflict also depends on the economic characteristics of countries (Barnet, 2000; Raleigh and Urdal, 2007; Theisen, 2008). Moreover, these effects are observed primarily in low- and middle-income settings in which populations are exposed to warm or hot temperatures on average. Collier and Hoeffler (2004) use the growth rate of GDP and show that an increase in the level of the economic growth rate, decreases the probability of having conflicts and riots. In addition, Cuzan et al (1988), Booth (1991), Annett (2000) and Blomberg and Hess (2002) show that a decrease in citizen satisfaction due to a decrease in income leads to a change in government.

Other studies conclude that the level of democracy positively influences the stability/instability of a country through the reduction of conflicts. Indeed, by promoting civil liberties and political rights, democracy generates conditions conducive to sustainable development that ensures political stability (Wittmann, 1989). For Elligsen (2000) and Parsa (2003), the democratic regime influences the stability of states, unlike authoritarian regimes which increase conflicts. They simply explain that democratic regimes allow citizens to be involved in the political process and to set economic policies through votes in either an election or a referendum. They add that through dialogue and voting, politically motivated violence and conflict can easily be controlled. Furthermore, democracy directs resources from investment to consumption, allowing countries to satisfy the primary needs of their populations (Rummel, 1995; Auvinen, 1997; Przeworski and Limongi, 1997).

2.3 Climate change and conflict: a synthesis of work on the issue in Africa.

While there is strong and consistent evidence that warmer temperatures lead to increased civil conflict (Hsiang et al., 2013), the evidence on rainfall is mixed. For example, using data on sub-Saharan African countries, Miguel et al. (2004) and Miguel and Satyanath (2011) found that rainfall stimulates economic growth, which in turn reduces the risk of civil conflict. In contrast, Hendrix and Salehyan (2012) found that abnormally wet years are associated with more civil conflict, while Burke et al. (2009) and Buhaug (2010) found no evidence of a relationship between rainfall and civil conflict in sub-Saharan Africa. Of the 60 studies reviewed by Hsiang et al. (2013), 11 examined the effect of rainfall on civil conflict. Four of these studies found that below average rainfall was associated with increased civil conflict, 6 found a statistically insignificant relationship (at the 5 percent level), and one found evidence that above average rainfall was associated with increased civil conflict.

Harari and La Ferrara (2014) found that weather shocks (such as above-average temperatures or below-average rainfall) had a greater impact on conflict-related incidents in Africa. Von Uexkull (2014) finds that regions in sub-Saharan Africa that are particularly dependent on rainfall for agricultural production are also more likely to experience civil conflict. This finding is supported by more recent evidence showing that social groups in Africa that rely heavily on rain-fed agriculture are also more likely than other groups to rebel after experiencing a devastating drought (von Uexkull et al. 2016). In the case of East Africa, Raleigh and Kniveton (2012) argue that climate change influences conflict. They show that higher rainfall leads to less conflict, while drier conditions increase conflict. In North Africa, Chaney (2013) shows that drought episodes, periods of low rainfall, also triggered political instability in historic Egypt. In a similar vein, Aribigbola et al. (2013) argue that climate change has triggered indicators of political instability such as terrorism and conflict in many African countries due to natural disasters that have broken the food chain. In the case of 16 countries in the Middle East and North Africa, Sofuoğlu et al (2020) shows that there is a causal relationship from climate change to conflict.

3 Empirical strategies: model and data

In this study case, we use the panel fixed effect model. Indeed, the inclusion / exclusion of control variables is one of the most contested questions among those who model the link between climate and conflict. Thereby, the choice of the use of fixed effects in the analysis of the relationship between climate change and conflict is recommended insofar as it makes it possible to take into account the problem of endogeneity bias that certain control variables can generate (Burke et al., 2009; Hsiang et al., 2013). Indeed, they argue that socioeconomic and political variables such as the GDP growth rate are poor control variables, as they can also be explained by climate. Another advantage of this model is that it takes into account not only the temporal dimension, but also the individual one.

So, the econometric specification is given by:

$$\ln conf_{it} = \beta + \gamma \ln vat + \delta \ln vap + \theta \ln at + \varphi \ln ap + X_{it-r}\lambda + \psi_i + \rho_t + \varepsilon_{it} \qquad (1)$$

In order to analyze the effect of climate change on conflict, we used many variables, and several databases over the period 2000 to 2020[24], for a panel of 16 West African countries[25].

i and t are respectively the individual and temporal dimension, β is the constant, ρt take in account the time specific effect, Ψi corresponds to the fixed individual effect, and εit the error term.

lnconfit is the dependent variable of natural logarithm of conflict and provides from Location and Event dataset (ACLED) by Raleigh et al. (2010). ACLED is a geo-referenced dataset, which collects conflict event data from multiple accounts commonly published by regional and national media, NGOs and humanitarian organizations, and records the date, location, actors and types of activities conflict.

The Conflict variable incorporates instances of violence against civilians (VAC) by state actors, but we prefer to restrict conflict events by type rather than by a fatality threshold, so, we aggregate the number of registered deaths for each year during conflicts. Such as robustness, we use the internal conflicts from the International Country Risk Guide (ICRG, 2020) (Sofuoğlu et al., 2020). This database gives scores to the different countries, ranging from 0 for countries where the risk of internal conflict is high, and 12 for countries that are relatively conflict-free (ICRG, 2020). For the sake of simplification, we note Xit the vector of independent variable composed of the interest variables and control variables.

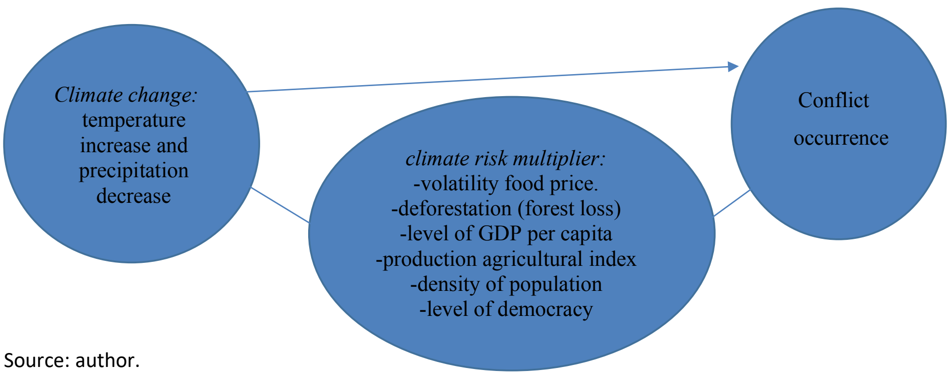
Our interest variables correspond to the climate variable, composed by lnvat, the natural logarithm of the variation of average temperature, lnvap natural logarithm of average precipitation variation, lnat, natural logarithm of average temperature, lnap, natural logarithm of average precipitation provide from geo-referenced dataset Terra climate, which is a global gridded dataset of meteorological (Raleigh et Urdal, 2007; Raleigh et Kniveton, 2012). By the calculating of standard deviations for each month, we obtained a variation of average temperature and precipitation in one hand, and other hand we calculate average on these data to obtain average annual precipitation and temperature variable.
For the sake of simplification, we note Xit the vector of independent variable composed by control variables.

Control variables take in account lnvofp, corresponding to the volatility of food prices. This dataset is taken from monthly FAO data (Faostat, 2020). Hugon and Mayeyenda (2003) use the coefficient of variation to measure price volatility. But for our study, as in Cariolle (2012), and based on Minot (2014), we calculated the standard deviations[26] annual data from the monthly food consumer price index.

lnfl, is natural logarithm quantity of forest loss from Hansen global forest change, which are georeferenced dataset (Hauge et Ellingsen (1998). lndenspop, is the natural logarithm of density of population per grilled given by the georeferenced dataset Worldpop population (Manarik, 1984). Lngdp and lnpai, are respectively natural logarithm of GDP per capita (Salyehan et al., 2013), and natural logarithm of production agricultural index (Miguel et al., 2004; Miguel et Satyanath, 2011; Maystadt et Ecker, 2014; Couttenier et Soubeyran, 2014) from World Bank (WDI, 2020). Demo is democracy dataset which provides form the Freedom House index (FH) proposed since 1972. In order to facilitate the econometric interpretation of this index, we reduce it to the interval 0 (autocracy) or 1 (democracy) as in Barro (1996), Helliwell (1994) or Rodrik (1998, 1999 and 2000).

We highlight the relationship between our variables (Figure B2.5) from the causality diagram below.

Figure B2.5: Causal diagram



Source: author.

[24]All these databases are geo-referenced databases.
[25]Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo.

In practice, we will apply the two-way fixed effect méthod (2FE) to estimate our model, because Fisher[27] test rejects the null hypothesis of homogeneity of the individual dimension.

3 Results and discussion

From the model 1 defined above, we estimate 3 sub-models (Table B.C7.1). The first specification (1) analyzes the link between climate change and conflict, while the other specifications not only analyze the link between these variables, but also allow us to highlight the influence of the different control variables (2-7).

Table B.1 below presents the results of the estimates of the link between climate change and conflict in West Africa. Specifically, our estimates present the link between temperature variation and conflict on the one hand, and between rainfall variation and conflict on the other. To do so, we proposed several specifications. In the first specification, we analyze the effect of temperature and precipitation variation, as well as their average level on conflicts (1). Thereafter, we add in turn the different control variables (2-7) in order to see the stability of our main results. In terms of our main results, all specifications (1-7) made in our analyses validate the existence of climate conflict in West Africa. As in Burke et al (2009), we show that climate change is one of the main causes of conflict in West Africa.

Specifically, our results are in line with the work of Hsiang et al. (2013). Indeed, we show that increasing temperatures positively influence conflicts in this region. Moreover, precipitation and conflict move in opposite directions as in Hendrix and Salehyan (2012). In line with their work, we show in our study that rainfall has a negative influence on the evolution of conflicts such that an abnormal decrease in rainfall would be the cause of multiple internal conflicts in the different countries of this region. These main results make sense in the context of West Africa. Indeed, in most African countries, more than 60 percent of the active population devotes its activities to agriculture (Beintema and Stads, 2004), and the majority is dependent on rain-fed agriculture as the basis of their subsistence (Rockström, 2003). Thus, a decline in agricultural production leads to a shortage of food on the market, which in turn leads to a rise in food prices. Since price volatility tends to be higher in Africa than in other regions (Minot, 2011), and since these households spend 60 percent of their budget on food most of the time (FAO et al., 2011a, b, 14), any increase in prices leads to increased protests and internal conflicts.

This analysis highlights the indirect influence of climate change on conflicts through the intermediate variables that constitute our control variables in our case.Thus, for specifications 6-7, we show that agricultural production, described as rain-fed, negatively influences conflicts in West Africa. Thus, concomitant with the analyses of Miguel et al. (2004), Miguel and Satyanath, (2011), Maystadt and Ecker (2014), any decline in agricultural production is the cause of internal conflicts in Africa. Similarly, our results (2-7) are similar to those of Raleigh et al. (2015) who show in the case of several African markets, climate change influences conflicts in Africa through food price volatility.

We also show in our results (3-7) that deforestation increases climate conflict in West Africa. Any loss of forest area is the cause of a new conflict, results similar to those of Hauge and Ellingsen (1998). As in Miguel et al (2004) and Bohlken and Sergenti (2010), we validate the results (4-7) that the level of per capita income is a determinant of conflict. Thus, the effect of climate change on the occurrence of conflict in West Africa is a function of the economic characteristics of individual countries and their ability to respond to climate shocks (Barnet, 2000; Raleigh and Urdal, 2007).

In most results (6-7), population density does not affect the occurrence of conflict in West Africa. Furthermore, and in relation to the work of Elligsen (2000) and Parsa (2003), we show (7) that a democratic regime is the framework for the occurrence of conflicts and demonstrations of all kinds in this region.

[26] As in Minot (2014), this involves the calculation of the standard deviation of the yield noted σ (r) with r = log (Pt/Pt-1), and Pt and Pt-1, the prices at period t and t-1.

[27] F=1.95 with p-value=0.059

Table B.1: Variables

	Dependant variable: natural log of conflict (lnconf).						
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
lnvat	0,428*	0,514**	0,610***	0,278***	0,154***	0,170***	0,08**
	(0,09)	(0,04)	(0,01)	(0,00)	(0,00)	(0,01)	(0.01)
lnvap	-0,529*	-0,280**	-0,849***	-1,265***	-1,761***	-1,759***	-1,713***
	(0,08)	(0,003)	(0,01)	(0,00)	(0,00)	(0,00)	(0,00)
lnat	6,686***	5,66***	5,909***	5,019***	5,878***	5,55***	4,914***
	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)	(0,01)
lnap	-0,048	-0,029	0,014	0,064	0,05	0,03	0,076
	(0,515)	(0,695)	(0,895)	(0,405)	(0,492)	(0,698)	(0,33)
lnvofp		0,365**	0,367**	0,287*	0,249*	0,297*	0,191*
		(0,04)	(0,02)	(0,06)	0,100	(0,05)	(0,1)
lnfl			0,280***	0,344**	0,567***	0,361***	0,371***
			(0,00)	(0,00)	(0,00)	(0,00)	(0,00)
lngdp				-0,621**	-0,567***	-0,580***	-0,718***
				(0,00)	(0,00)	(0,00)	(0,00)
lnpopdens					0,311*	0,284	0,304
					(0,1)	(0,142)	(0,112)
lnpai						-0,874**	0,718*
						(0,02)	(0,06)
Demo							-0,647**
							(0,00)
Constant	-18,65***	-14,63***	-18,69***	-20,30	-24,14***	-26,68	-25,49***
	(0,000)	(0,003)	(0,000)	(0,000)	(0,000)	(0,00)	(0,00)
R-squared	0,13	0,14	0,26	0,29	0,30	0,3	0,33
Fisher	2,28***	2,52***	4,59***	5,18***	5,40***	5,14***	5,55***
Observations	332	332	332	332	332	332	332
Number of countries	16	16	16	16	16	16	16

(***, ** and * represent the significance of the correlation coefficients at the threshold of 1 percent, 5 percent and 10 respectively).

Source: author.

For Salehyan (2014) and Buhaug (2015), the discrepancy observed in the empirical analyses highlighting the influence of climate change in the onset of conflict depends not only on the methods used, but especially on the differences between regions. We therefore propose a two-way fixed effect estimation of our initial model (Table B. 2) by dividing our sample into three sub-samples.

The analysis of the estimates by subregions does not literally change the nature of our main results. Indeed, for the three subregions that comprise West Africa, climate change is a relevant variable that helps explain the occurrence of conflicts. Thus, for all of the countries in the Gulf of Guinea, a relatively humid area, the decrease in rainfall leads to an increase in conflicts. These results make sense insofar as almost all of the populations in this zone carry out subsistence farming activities and would be sensitive to any rainfall variation. On the other hand, in the Sahel, a relatively hot area, the increase in average temperatures and the decrease in rainfall explain the risk of conflict in Africa. Thus, as in Hsiang et al. (2013), we show that as a hot zone, the Sahel is more exposed to the advent of climate conflicts. Finally, the results observed in the case of the Lake Chad Basin subregion are not far from those of the Sahel. These results validate and reinforce the idea of the existence of climate conflict for the three West African subregions, and call into question the work of Salehyan (2014) and Buhaug (2015), who showed that the ambiguous relationship between conflict and climate is a function of the differences between the regions.

Furthermore for these three subregions, the volatility of food prices is very significant in validating the climate conflict hypothesis. In the Sahel and Lake Chad, low agricultural production due to drought negatively influences conflict as Fetzer (2014). We also show for the three subregions that per capita GDP negatively influences conflict. As such, a decline in income level accompanied by poor living conditions, and stressful weather conditions is the cause of demonstrations and protests leading to civil conflict (Miguel et al., 2004). Moreover, in the case of our three subregions, we validate the conclusions of Elligsen (2000) and Parsa (2003) who see democracy as a means of reducing social tensions and conflicts, since the populations themselves can make decisions about their future. Finally, deforestation is also identified as a major cause of conflict in the Gulf of Guinea and the Sahel, while population growth generates conflict in the Gulf of Guinea and Lake Chad.

We test the quality of our results by conducting a robustness test that focuses on using an alternative measure of conflict. We use internal conflicts from the International Country Risk Guide (ICRG, 2020) as in Sofuoğlu et al. (2020), to confirm the hypothesis of the existence of climate conflict in West Africa.

The robustness analysis (Table B.3) confirms the quality of our previous results, and once again validates the hypothesis of climate conflict in West Africa. We show once again that increasing temperatures influence conflicts in West Africa (Hsiang et al., 2013), and as in Hendrix and Salehyan (2012), we validate the fact that decreasing rainfall leads to conflicts in the region. Similarly the expected effect of control variables on conflict is expected. Our results corroborate with those of Raleigh et al. (2015) who validate the effect of food price volatility on conflict. Accelerated deforestation leads to conflict (Hauge and Ellingsen, 1998), while declining democracy and household income levels created conflict in this region. However, our work does not validate the influence of population level in the onset of climate conflict.

Table B.2: Nexus between climate change and conflict in Gulf of Guinea region, Sahel and Lake Chad

	Dependant variable: alternative measure of conflict (lnconf).		
Independent variables	Gulf of Guinea	Sahel	Lake Chad
lnvat	0,018	0,032	0,087
	(0,54)	(0,587)	(0,470)
lnvap	-0,160***	0,091	-0,178*
	(0,00)	(0,489)	(0,07)
lnat	-0,151	0,647**	1,198***
	(0,262)	(0,02)	(0,00)
lnap	-0,325***	-0,002**	0,034
	(0,00)	(0,03)	(0,422)
lnvofp	0,025**	0,001***	0,034**
	(0,02)	(0,01)	(0,02)
lnfl	0,021***	0,025***	0,056
	(0,00)	(0,00)	(0,418)
lngdp	-0,078***	-0,111***	-0,440***
	(0,00)	(0,00)	(0,00)
lnpopdens	0,096***	-0,022	0,225***
	(0,00)	(0,642)	(0,00)
lnpai	0,011	-0,094*	-0,488***
	(0,811)	(0,072)	(0,00)
Demo	-0,077***	-0,098	0,100**
	(0,00)	(0,10) *	(0,06)
Constant	2,253***	5,42***	-1,97
	(0,00)	(0,00)	(0,10)
R-squared	0,62	0,67	0,76
Fisher	20,48***	7,74***	12,15
observations	189	103	63

(***, ** and * represent the significance of the correlation coefficients at the threshold of 1 percent, 5 percent and 10 percent respectively).
Source: author.

Table B.3: Robustness Analysis

	Dependant variable: internal conflict as another measure of conflict (lnconf).						
Indépendant variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
lnvat	0,055***	0,0514**	0,040***	0,021***	0,020***	0,017***	0,012***
	(0,00)	(0,00)	(0,01)	(0,01)	(0,01)	(0,01)	(0.01)
lnvap	-0,082**	-0,071***	-0,133***	-0,106***	-0,102***	-0,102***	-0,09***
	(0,02)	(0,01)	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)
lnat	-0,146	0,099	-0,125	0,183*	0,177*	0,171*	0,09
	(0,125)	(0,309)	(0,19)	(0,06)	(0,09)	(0,1)	(0,11)
lnap	-0,020***	-0,021***	-0,025***	-0,022***	-0,02***	-0,021***	-0,025***
	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)
lnvofp		0,016	0,016*	0,026*	0,026**	0,025**	0,016**
		(0,237)	(0,1)	(0,07)	(0,05)	(0,03)	(0,02)
lnfl			0,030***	0,026***	0,027***	0,026***	0,027***
			(0,00)	(0,00)	(0,00)	(0,00)	(0,00)
lngdp				-0,04***	-0,04***	-0,041***	-0,029**
				(0,00)	(0,00)	(0,00)	(0,04)
lnpopdens					0,002	0,004	0,002
					(0,9)	(0,8)	(0,88)
lnpai						-0,062**	-0,049*
						(0,06)	(0,06)
Demo							-0,055***
							(0,00)
Constant	2,60***	2,41***	2,861***	2,75***	2,73***	2,91	2,81***
	(0,000)	(0,00)	(0,00)	(0,000)	(0,000)	(0,00)	(0,00)
R-squared	0,17	0,17	0,37	0,36	0,36	0,37	0,39
Fisher	3,78***	3,88***	6,59***	6,72***	6,48***	6,51***	7,61***
Observations	335	335	335	335	335	335	335
Number of countries	16	16	16	16	16	16	16

(***, ** and * represent the significance of the correlation coefficients at the threshold of 1%, 5% and 10% respectively).
Source: author.

4 Conclusion

The empirical literature remains highly controversial and ambiguous regarding the existence of a significant relationship between climate change and conflict. The contribution of this paper is therefore globally to shed light on the existence of climate conflict in West Africa. Specifically in space, it empirically verifies the hypothesis of a causal relationship between climate change and conflict, and in time, it proposes a study on a relatively recent time horizon, as opposed to those observed in the literature. In order to achieve this objective, we estimated our model using the two-way fixed effect method, on a sample of 16 countries with data from 2000 to 2020.

The results of the estimations show firstly that climate change directly influences conflicts in West Africa, as periods of high temperatures increase conflicts, while seasons with less rainfall increase instability and conflict. Second, through climate risk multipliers such as food price volatility, agricultural production, deforestation, income level, population density and democracy, we show that climate variability indirectly influences conflict. Therefore, methods must be put in place to prevent the risks of these types of conflicts in West Africa.

To reduce the risk of conflict in West Africa, it is recommended that: measures be put in place to control food prices before, during and after periods of conflict. In concrete terms, the control of food price volatility involves, for example, increasing the level of national and regional stocks of various foodstuffs in order to limit or delay the influence of a climatic shock such as drought, and limiting the production of agrofuels, which makes it possible to prevent part of the production from being consumed directly for energy production. Secondly, the authorities must promote an increase in agricultural production by investing more in food security. In addition, the protection of the forest, the fight against deforestation in humid regions, and the promotion of reforestation in arid areas are measures that must be implemented. In addition, the improvement of the living conditions of the populations through an increase in per capita income and freedom of expression must be implemented. Overall, however, these measures are conducive to controlling or reducing climate-related conflicts in West Africa.

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B.3 Case Study 8 – Climate change and conflict between farmers and herders in Southwestern Nigeria

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Introduction

In 2011, the United States Institute of Peace (USIP)predicted the potential of climate change to raise risks of violent conflict (Sayne 2011), especially in least prepared countries with the most vulnerable citizens (Sayne 2011, 1). Nigeria today is undergoing shifts in temperature, rainfall, storms, and sea level rise co-existing with poor adaptive responses to these shifts thereby brewing conflicts over the shrinking environmental resources. Desertification in Nigeria's Sahel region lays bare the federal and state governments' deficit in managing climate change's salient factors such as Fulani herders' migration to the southwest exacerbating clashes with host communities. Also, to note is the intensive competition over the shrinking resources such as the vegetation, water, and arable land.

This paper demonstrates the interconnectedness of climate change and shrinking environmental resources alongside the existing ineffective governance structures, or lack thereof, for managing its effects. Added to this is the looming conflicts resulting from incompatible interests of the herders and farmers in the southwest due to the identity crisis buttressed by the existing differences between the Fulani herders and their host farming communities. This paper advances an argument of no simple causal linkage between climate change and conflict. It rather illustrates a complexity of interconnected factors such as climate change, the governance deficit, migration and displacement, and population growth operating in tandem to ferment fragility in Nigeria co-existing with the shrinking vegetation and water resources. This paper thus postulates that a shift in climatic conditions tagged to poor response mechanisms facilitates resource shortages, which heightens one or more structural conflict risks.

This paper accounts for a historical and current relationship between Fulani herders and farming communities in the southwest, and the ever-changing weather patterns as a push factor for Fulani herder migration to the southwest. It uses Eco-Violence and Social Identity theories to account for the existing complex relationship between climate change and conflicts in Nigeria's southwest. It applies a qualitative approach to collecting and analyzing data, which is thereafter discussed to account for this complex relationship. The paper then suggests approaches, based on the findings of the study, of addressing the existing climate change-related fragility, conflict, and violence in a comprehensive approach. It recommends that while most challenges are at the macro-level, a bottom-up approach is well suited especially in the Southern part of Nigeria given the region's highly organized governance structures compared to the rest of Nigeria. The paper thus suggests that engaging at the micro-level has potential to generate community suggestions for immediate outcomes that will also aid governance at the macro-level.

Background

Since attaining independence in 1960, Nigeria has been marred with pockets of violence in ethnic and religious dimensions. Whereas control over oil resources in the South is the common denominator in these conflicts, the dynamics in northern Nigeria are fueled by desertification, pushing nomadic communities' southwards in search of pasture and water. This migration intensifies fragility related to lack of proper incorruptible institutions to manage this migration leading to violence between "indigenous" farmers and "settler" herders.

Farmers and herders have intermarried for decades thereby developing symbiotic relationships (Shettima and Tar2008), through reciprocity and support. However, population growth and competition for the ever-shrinking vegetation and water resources, in recent times, invokes ethnic and religious identity differences used to compete for resources to facilitate their in-group versus out-group interests (cultivation versus grazing). For instance, grazing-associated conflicts accounted for 35 percent of all reported crises between 1991 and 2005 in Nigeria (Fasona and Omojola 2005).In 2004, farmer–herder clashes resulted in 'near genocide of Christians and Muslims in Plateau State, with over 20,000 refugees escaping to neighboring Cameroun (Moritz2010).Whereas climate change has no direct correlation with conflict, the absence of proper conflict early warning and climate change management strategies breeds violent conflicts, a social reaction to the induced consequences such as inadequate natural resources (Detges2017).Nigeria rests on a governance structure marred by endemic corruption, a major factor straining governance of climate change and its effects as public resources get diverted to private interests (Fadairo et al. 2018).Nepotism in recruiting public servants undermines expertise and strategic thinking in countering the effects of climate change.

Furthermore, in 2018, International Crisis Group noted religious and ethnic dimensions to the crisis between farmers and herdsmen with lives lost. Therefore, climate change-related environmental challenges and demographic variations(Adigun 2019; Intergovernmental Panel on Climate Change 2014; and Homer-Dixon1999),orchestrate violent conflicts due to drought and desertification especially in the Sahel, forcing herders to move southwards in search of pasture and water(International Crisis Group 2017).However, limited resilience strategies co-existing with corruption and nepotism undermine the effective management of existing climate change-induced frequent migration (Nte2016).This increases fragility and escalates the already existing tense relationship based on differences in identity and interests. This provokes conflict based on competition over the shrinking cultivable land, pasture, and water (Idakwoji et al. 2018).

Theoretical framework

This study adopts Eco-Violence and Social Identity theories to explain the climate change induced migration of Fulani herders to the southwest and the tense relationship that exists between migrants and their hosts due to a difference in identity added to their incompatible goals.

For Eco-Violence, a decline in the quality and quantity of renewable resources, population expansion, access to resources act singly or in diverse combinations to reduce arable land, water and vegetation for certain population groups (Homer-Dixon2010). This facilitates increasing livelihood challenges for the affected groups who migrate to least affected areas and compete for the shrinking environmental resources thereby triggering conflicts with their hosts.

For Social Identity, people's identities are shaped by group membership(s) as important sources of pride and self-esteem (Tajfel et al. 1979). Groups, through a process of social categorization, stereotype each other and exaggerate their differences, similarities of things within groups thereby forming in-group (us) and out-group (them) binaries of relationships. Group members of an in-group identify negative aspects of an out-group to enhance their self-image. This process begins with Categorization where objects or people are positioned based on certain markers like religion, color, and areas of origin. Social Identification follows with adopting a group's identity to affirm membership. Last is Social Comparison where people compare their identity group with other groups and the in-group needs to compare favorably with the out-group (Tajfel et al. 1979). Once two groups identify as adversaries, they compete for members to maintain their self-esteem (McLeod2019), which exacerbates competition for resources and identities (McLeod 2019).

The Eco-violence theory projects a decline in environmental resources such as pasture and water and arable land in northern Nigeria due to climate change. This facilitates movement of Fulani herders to Nigeria's southwest leading to competition over the shrinking arable land, vegetation, and water with the arable communities (Onuoha 2007; Blench 2004; Moritz(ed.) 2004; Blench and Dendo 2003), due to a population increase in this region of Nigeria. The Social Identity theory also demonstrates the identity crisis that exists between Fulani herders and communities in southwest who see one another as out-groups due to the incompatible cultural approaches and interests in utilizing the limited available land resources. Whereas the Fulani herders' interests are in land conducive for pastoralism, the interests of farmers in the southwest is in preserving land suitable for food production. Therefore, different identities and incompatible interests also breed tense relations between the migrant herders and their hosts who are farmers.

Climate change: A change in weather patterns is evident in a reduction in the volume of annual rainfall especially in the north, co-existing with the ever-increasing temperatures, drying up of water resources like Lake Chad, and a reduction in vegetation cover making it difficult for the Fulani herders to feed their animals, and the shrinking of cultivable land. A combination of these factors facilitates scarcity of environmental resources available for use by the herders and cultivators.

Population increase: An exponential growth in the number of live births co-existing with reduction in infant mortality and an increase in life expectancy collectively contribute to an ever-growing population in the north and south yet the land available is not enough to support human activities like pastoralism and cultivation, thereby breeding livelihood challenges. The shrinking environmental resources such as the green vegetation and water also forces people, especially Fulani herders to migrate to the South in search for pasture and water. This further exacerbates scarcity of land resources in the host communities since the migrating population of people and animals further strains these scarce resources. The increase in population co-existing with a youth bulge with no employment opportunities exacerbates poverty making youths prone to recruitment into programs of violence for a livelihood, by adversarial forces.

Identity crisis: The difference in cultures and social activities between the Fulani herders and their hosts in the south breeds tensions due to incompatible interests in the land, land use practices and livelihood goals. Fulani identify themselves as Muslim herders with a primary goal of finding pasture and water for their animals. On the other hand, their hosts in the South are mainly Christians who are majorly cultivators with an interest in producing food for subsistence consumption and earning a living by selling the surplus. This breeds competition over land as Fulani herders feed their animals on cultivators' crops, while cultivators respond with an interest in protecting their land and crops.

Governance Deficit: Climate change, population increase, and the identity crisis exist in an environment with huge governance gaps. There does not exist adequate climate change frameworks like policies and laws or their enforcement. Structures for managing internal migration are also nonexistent. The governance crisis is equally marred with identity politics where the current leadership is dominated by people from the north with limited interest in the migration-related crises in the South. Corruption continues to undermine institutional capacity to respond to the tensions that exist between Fulani herders and their hosts. The local governance structures remain less empowered to respond and mediate the crisis. Nepotism characterized by recruitment for government jobs based on family and ethnic lineage equally undermines strategic thinking around managing the aftermath of this migration crisis due to lack of expert knowledge and experience.

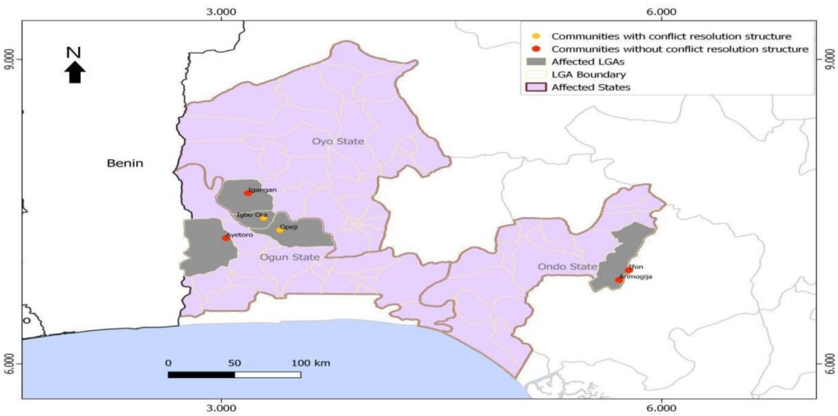
Note: Climate change and population growth are inevitable. The cultural connotations of different ethnicities in Nigeria implies identities which is ever evolving and constantly used to widen the gap between in-groups and out-groups. The most important factor to engage is Governance because these variables can be managed with the right structures in place, right human resource to use those structures to manage the independent variables (climate change, population increase and identity). The absence of a committed and effective governance structure exacerbates fragility leading to armed confrontation.

Methods and data

This study also benefits on the review of secondary literature on accounts of herder-famer relationships in the south from, as well as data on rainfall patterns and migration trends in Nigeria, using Government, NGOs reports and scholarly journal articles.

A qualitative approach was used to collect detailed accounts of respondents' perceptions, beliefs and opinions about climate change, fragility, conflict, and violence (Matthews and Ross2010). A 5-days preliminary study preceded selection of the sample population to understand the dynamics of the study population. Two communities namely, Opeji, Ayetoro (Ogun), Igbo Ora, Igangan (Oyo), Ifon and Arimogija (Ondo) were selected from each of the three sampled States (Ogun, Oyo and Ondo) from southwest Nigeria based on the high and re-occurring incidence of farmer–herders conflicts based on state and local government records as well as published newspaper reports and the study area map is presented in Figure B3.1.

Figure B3.1: Study Area Map (Southwest Nigeria)



The sample was also purposively selected based on their accessibility at the time of conducting the fieldwork. 12 Focus Group Discussions (FGD) were conducted (2 for farmers and 2 for herders in each State) to ensure full participation of respondents without exposing them to security threats from adversarial forces. In-depth interviews were also conducted on 6 community leaders, 12 heads of farmer and herder groups, as well as 2 experts (2) in the field of climate change and security making a total of 20 participants.

Data was transcribed and content analysis to bring out themes, concepts, and quotes from the transcribed data. This was in account of the relationship between climate change induced migration, ineffective governance and management structures, population growth, and identity differences to increase fragility and violence in southwest Nigeria.

Findings

Risk profile

- Climate risks: Changing rainfall patterns, desertification: Nigeria, especially the arid north, are facing the one-two punch of more heat and less rain (Boko et al. 2007). Parts of Nigeria's northern Sahel area get less than 10 inches of rain a year already, a full 25 percent less than thirty years ago. Temperatures can top 1050F and are likely rising (Sayne 2011). Over the past forty years, recorded volumes of torrential rains increased 20 percent across various southern states, some of which already see up to 160 inches of rainfall a year, with wet seasons lasting eight to 10 months (Odjugo, 2005). Reducing volumes of pasture and water are also noticed.
- Migration risks: North to South migration trends: More human displacement is a second possible impact. Pasture and water shortages accelerate migration in some parts of the country, especially the north (Sayne 2011), added to the search for arable land.
- Conflict risks: communal violence, most of it involving contested resources, killed at least 10,000 Nigerians in less than a decade (Human Rights Watch2007). Nigeria's frequent farmer–herder conflicts in search for pasture, water, and arable land. Weather-related factors are pushing farmers to cultivate more land each year, leaving wanderers fewer places to water and graze their stock with marked deaths due to competition over these meagre resources (Sayne 2011, 5).
- Principal drivers of conflicts between farmers and herders: both natural and anthropogenic: Man-made environmental degradation in tandem with inefficient and ineffective resource management strategies. Widespread desertification, especially in northern Nigeria exists. Government geological data shows a 400 percent increase in sand dunes over twenty years (Federal Ministry of Environment 2008). Potential land losses overlap with vulnerable assets, populations, and sectors of high strategic importance needs better mapping. Usable water is already at a premium for much of Nigeria. Poor management and government supply failures, not limited availability, are likely the biggest causes today. Some 85 percent of all Nigerian agriculture is rain-fed, and many crops are sensitive to even tiny shifts in rainfall and temperature. Some experts already link mounting crop failures and declining yields in the northeast to higher temperatures and drought (Sayne 2011, 5). Less rainfall and higher temperatures have helped shrink Lake Chad, once the world's sixth largest lake and the north's biggest irrigation resource, to one-tenth its size a half century ago (Coe and Foley 2001). Unfortunately, these challenges have been mainly treated as political which is blinding the potential for governing this crisis through a clear examination of underlying factors such as desertification, migration existing with incompatible interests in the use of the shrinking land resources, coupled with an identity crisis between the herders and farmers.
- Corruption and Nepotism: In Nigeria, embezzlement of funds and appointment of public servants based on ethnicity and family lineage/ties remain a fundamental obstacle in governance efforts to manage climate change. Government programs like the Great Green Wall Project, National Strategic Action Plan for Desertification and Drought, added to the recent National Livestock Transformation Plan have all fell shot on addressing the impact of climate change and managing competition over the shrinking environmental resources (Fadairo et al 2018). This is partly attributable to lopsidedness in the appointment of personnel to implement such projects. Favoritism in appointments based on ethno-religious inclinations opposed to experience and expertise, added to the unchecked looting of funds meant for environment management and sustainability projects has undermined strategic thinking in addressing climate change and its related effects. This is added to the marked laxity by the political class to manage or govern the frequent movement of herders to the South. The political class has successfully undermined institutional capacity to manage fragility because of frequent migration to the south leading to marginalization. This has escalated in-group and out-group tensions between Fulani herders and farming communities in the south in the absence of strong and capable institutions to protect and promote national security, good governance, and sustainable development (Alemika 2018).

This study engaged members of the Fulani herding community, their hosts (farmers), government officials, members of the civil society, and the community leadership including religious, cultural, and political in the southern states of Ogun, Oyo, and Ondo. Pseudo names were assigned to the respondents for purposes of protecting their identity given the sensitivity of the topic of this study.

The field interviews established the following.

Climate Change

Participants supported Elisha et al. (2017), and Ebele and Emodi (2016) who observed Nigeria's changing climate. They noted a change in weather and climate in terms of low rainfall patterns coinciding with an increase in the intensity of sunshine and temperatures in recent time, thereby affecting their farm productivity and the availability of pasture and water for their livestock. Added to these is the rise in sea level, drought, land degradation, and desertification. Amanchukwu et al. (2015) observed about 25 percent decrease in precipitation on average in the past 30 years, in Nigeria's Sahel as one of the participants also remarked:

> "Climate change is really affecting our farm productivity. In recent time, rain does not usually fall like it used to and temperature is really increasing. Take for example, we are in July now and we have not had any rainfall for the past 3 weeks. This is strange from what we used to experience years before. Most of our farm crops are having stunted growth and this is really worrisome because most of us collected loan to farm" (interview with Pastor Solomon in Ifon, 26/07/2021).

Respondents also revealed that migration down south from the northern part of the country has increased in the past few years due to drought and desertification, shrinking the available pasture and water for herders. This migration down south is bringing about competition over the available land and water resources between farmers and herders down south, thereby promoting violent conflict. Therefore, Aluko and Sayuti (2016) see migration of the Fulani herders to the southern and middle belt regions of Nigeria as a phenomenon that remains a by-product of climatic variation on their erstwhile established grazing routes. This is ascribed to the unfavorable atmospheric condition of the region. This factor is also advanced by Dembele (2015) who postulates that the Fulani herders, alongside issues of contestation over environmental resources in the purview of environmental degradation, had to swap locations and move to other parts of the country where the weather condition is 'favorable'. One of the respondents uses his experience in support of Dembele:

> "I migrated to this community over 50years ago with my cattle and I have been living here peacefully with farmers in this community until recent time when we started experiencing massive influx of herders here because of lack of pastures for herders in the northern region due to irregularity in rainfall. This had increased the rate of violent conflict in the community" (interview with Hassan, Ayetoro, 31/07/2021)

The International Crisis Group Report of 2017 also tied conflicts between farmers and herders to climate change induced migration of herders from the north adding to numbers in the south. The report notes that drought, desert encroachment, and desertification have immense adverse effects on people's livelihood in the northern zone, thus forcing nomadic pastoralists to move southward of the country. In line with this new reality, herders' migration to the southern part has become frequent; thereby provoking conflict on land-related resources exploitation between the two groups as Idakwoji, Ojomah, Usman, and Orokpo (2018) emphasize.

Population increase

Respondents also note that this migration is co-existing with a high fertility rate among migrant herders and their hosts. This increases numbers concentrated on the ever-shrinking arable land. The population of herders has increased in tandem with the number of people involved in cultivating land, thereby exacerbating competition over the available and shrinking environmental resources. Odoh and Chilaka (2012) noted frequent movement of herders down south that heightens the struggle over available land and water resources between farmers and migrating herders. With this rivalry over the limited and degrading land and water, the collaborative relationship that existed before has turned tense, thereby promoting conflict between migrating herders and local farmers with unrestricted access to land and water resources (Hagberg, 1998; and Bukari, 2017). A respondent remarked:

> "I will agree that the rate of migration by herders down south had increased in recent time but at the same time, the number of farmers is also increasing. Quite several people in the city are now acquiring land for farming in villages making the previously available land for grazing inaccessible to herders thereby heightening the competition between farmers and herders in the community" (interview with Mohammed, Igbo Ora, 30/07/2021)

Whereas herders' migration to the south was seasonal, that is only during dry season, as elaborated by respondents, they would move back to the north at the beginning of the rainy season because the weather down south is not suitable for their animals during the rainy season. However, more changes in the rainfall patterns in tandem with increases in temperature facilitates their permanent stay in the south, thereby increasing pressure on the available resources. The indigenous communities have found herders' new trend of permanent stay a potential threat to their source of livelihood. A respondent shared insight on herders' permanent stay and remarked that:

> "Fulani herders before recently when I was growing up used to migrate to our community during the dry season and once the raining season commenced, they move back northward because the weather during the raining season is not conducive for their cattle. But because of climate change, they are migrating permanently to the south in recent time. Majority of them now live permanently in the forest reserve and this has burdened the natural resources. (Interview with Jimoh, Arimogija, 27/07/2021).

Governance deficit

It was found that climate change, population increase, and the identity crisis do not independently breed conflicts. They are interconnected factors that operate in the absence of proper governance to exacerbate tense relations leading to violence. The Federal and State governments' governance deficit is evident in respondents recount of limited or no protection offered to the vulnerable communities or groups in the herder-farmer conflicts, even though farmers highlight herders' enjoyment of support from the Federal government headed by the president who is of the same ethnicity. In the focus group discussions with farmers' groups, they indicated that President Muhammadu Buhari used to be the patron of herders. They equally noted that police and the recently constituted 'Amotekun' security outfit lack the capacity, in form of training, facilities and willingness, to successfully resolve the conflict between farmers and herders without bias as one of the respondents commented:

> "We have been totally neglected by the government both at the state and federal level. The local government that is supposed to be the closest to the people is under the mercy of the state government even with the autonomy accorded by the constitution. Sometimes we even wonder if we are part of this state as we have never felt or enjoyed government presence in our community. Take for example, with the reported cases of killings that we are experiencing in our community, none of our community member was employed in the southwest security outfit (Amotekun) that was recently created." (Interview with Hassan, Arimogija, 27/07/2021)

This shortfall in governance also manifests through docile and dormant political structures that do not support structures for governing the adverse effects of climate change, population increase, and managing the identity crisis between groups that view themselves as adversaries. The limited response from the political class, or lack thereof, creates vulnerability of certain groups against others leading to confrontations to protect group interests. The main challenge therefore lies in the absence of a proper conflict early warning mechanism, together with political and economic governance structures to effectively respond to the possible effects of tense relations between migrant Fulani herders and their hosts in the south (Detges, 2017), as a respondent recounts:

> This competition coupled with unproductive social and political institutions as well as recent political marginalization of farmers has brought about conflicts in the entire southern region." (Interview with Jimoh, Arimogija, 27/07/2021)

Most communities have no existing structures and strategies for managing conflicts between farmers and herders and lack strategies of fostering collaborative relationships between them. However, some respondents revealed that they use traditional/informal conflict resolution mechanisms to resolve any conflict that spring up between farmers and herders in their community, a strategy they have found to be effective in their conflict contexts. Amankwaa (2019) identifies informal dispute resolution strategies as indigenous, out of court dispute resolution systems, where those offended presents a case and lodge grievances to the elders / community leaders. Offenders, once found guilty, are fined and asked to compensate their victims. A respondent elaborates the indigenous dispute resolution mechanism as below:

> "What our Baale did when we started experiencing a surge in conflict between farmers and herders was to call a meeting with all the tribes in our community and he asks them to go and choose a leader that will represent each tribe. The leaders presented were saddled with the responsibility to manage the affairs of their subject. Also, we usually have a meeting of all farmers and herders in the community twice every month to discuss and resolve any rising issue." (Interview with Nuru, Opeji, 31/07/2021)

Whereas the community finds these structures legitimate and effective, both the Federal and State governments have not prioritized them in the community level leadership and governance structures. These community level structures have not been empowered to resolve existing disputes between the Fulani herders and their hosts. Respondents retort that the Federal and State governments are also not involved in finding lasting solutions to the clashes between the Fulani herders and cultivating communities in the south. While the responses by community governance structures are not supported to increase their effectiveness, Community Based Organizations (CBOs) such as Ifon Community Development Association (ICDA) and Igangan Community Development Association (ICDA) were found to have invested in strategies to protect the interests of their community members as remarked by one of the respondents:

> "It was the members of the Igangan community development association that foiled the reprisal attack by the Fulani herders men that recent took place by mobilizing our youth and local vigilantes with funds and moral support. They also continuously brought the attention of the government and world into what is happening in our community." (Interview with Akiola, Igangan, 10/08/2021)

However, the opinion of one of the government representatives interviewed was contrary as he highlighted strategies in place to ensure the security of lives and property, which he emphasized as a constitutional mandate. The government representative equally identified open grazing as an illegal activity and stressed government policies such as the recent National Livestock Transformation Plan as one of government's efforts to end conflicts by creating grazing reserves for herders.

Over the years, government has taken policy steps to address the impact of climate change. In 2005, the African Union Heads of State set off and implemented the Great Green Wall Initiative to deal with the challenge of drought, land degradation, loss of biodiversity, desertification, and advance food security in Africa's Sahel region. This project had failed woefully in Nigeria despite the 10billion naira federal government investment into the project just in 2013 alone (Premium Times, 2013). The failure can be majorly attributed to poor management and lack of involvement of the local community members for ownership of the program. Added to this is the National Livestock Transformation Plan, which is the most recent government initiative to put an end to the conflict between farmers and herders. It is meant to bring about better affluence through transformations which will enable better productivity and sustainability of the livestock sector and at the same time, foster nonviolent coexistence between farmers and herders (NLTP, 2019-2028). This project is likely to fail just like many of the other government policies and initiatives due to the project's failure include the impact of the ever-changing climate on the environmental resources that the project will depend on.

Identity crisis

With competing interests for land-use, farmers and herders have always co-existed as participants across the study area (both from the farmers and herders) revealed a cordial relationship that existed until recent times. Migration is not a new phenomenon. However, a recent drastic increase in the number of herders moving to the south does not translate into readiness by the cultivating communities to receive them. The number of people is increasing at the expense of land that is shrinking due to the increasing number of users. The different land-use patterns on an ever-shrinking land exacerbates competition which strains the existing cordial relationship. The strain in relationship being experienced now can be attributed to constant conflicts between farmers and herders because of herders destroying their farm produce with their cows and farmers insincerity. Whereas herders' motivation for accessing the land is to feed their livestock, farmers are interested in producing food. A clash emanates when herders feed their livestock on farmers' crops. Farmers interviewed identified herders as visitors that are enjoying federal support at the expense of their hosts. They emphasized that herders have used federal government support to invade them and encroach on their farmland, thereby destroying their crops leading to low food production. Herders equally retorted that the tense relationship with farmers exists due to farmers attempts to poison pastures and water with the intention of killing their livestock. Whereas Aderinto et al. (2020) also agree that farming and pastoralism have cohabited alongside one another for decades as many pastoral and farming settlements in the same locality have developed symbiotic relationships through reciprocity, other exchange, and support, this pacific co-existence has not been devoid of conflicts. This is consistent with Idrissuo et al. (2017) observation that the destruction of crops is the fundamental root of conflicts between farmers and herders as this destruction results to reduction or total lack of harvest for farmers. A participant gives more context to this as he remarked:

> "We used to live together and conduct our businesses without any hostility between us before recently. But then we were not this many and there used to be plenty of land to farm and rear your animals. The cordial relationship that we used to enjoy then is no more because of competition over available land and water." (Interview with Mohammed in Igbo Ora, 09/08/2021)

Conclusion

There is no simple causal link between climate change and conflicts in Nigeria, but rather a complexity of factors relating together, in the absence of effective governance, to further breed fragility. These factors range from a change in rainfall patterns co-existing with an increase in temperature levels that strain the available environmental resources thereby pushing Fulani herders to the south. Ineffective management strategies for these factors facilitates conflicts. This study has found climate change interacting with population growth and the identity crisis to breed fragility. It equally identifies the governance deficit as a central precursor in breeding fragility. The study views the governance deficit in form of politicization of herders' migration to the south, support of migrant herders by the federal government against their hosts, the ineffective conflict early-warning mechanism or lack thereof, lack of expertise in laying strategies around managing the aftermath of climate change and migration. Another factor added to the governance deficit is the lack of support for the existing local and community governance structures for managing climate change and migration.

Suggested recommendations

Both the federal and state governments must invest in identifying and gazetting grazing/ranching reserves in all state of the federation. This would prevent cattle from destroying crops of farmers, thereby reducing the tension and conflict between these demographics.

An effective conflict early-warning system is important for both the federal and state governments to identify these conflicts and manage them before they escalate.

More intervention initiatives should be focused on the micro level. Findings from the field indicate interventions at the state and federal levels that have not yielded the desired outcomes of resolving conflict between farmers and herders. Whereas the target stakeholders/communities are never involved at the planning and designing phases of these initiatives, these government efforts also do not trickle down to the intended stakeholders. Hence, these demographics resort to their village heads, traditional rulers, pastors, and imams for mediating conflicts. This necessitates capacity building and empowering governance structures at the micro level would mean facilitating building of trust, establishing, and strengthening their legitimacy, and promoting participation of stakeholders to collectively find lasting solutions to the impasse. Meaningful and effective participation will promote ownership of these solutions and achieve accountability by all parties.

Banning of unlicensed gun usage by the herders must be the interest of the federal and state governments if they are to effectively fulfill their constitutional mandate of protecting, preserving and promoting the lives and property of all people irrespective of their ethnicity. Once this continues to fail, communities will continue to devise means of protecting themselves and this may involve the use of vigilante groups that will lead to uncontrolled use of illegitimate violence.

Religious and cultural institutions and other legitimate stakeholders must be empowered to organize periodic engagements with these demographics. These engagements should focus on collaborative efforts that promote peaceful co-existence. These are discussions that should not be imposed on the antagonistic communities by outsiders, but rather availing a conducive environment for candid conversations around sensitive topics of identity should be supported, not influenced, by outside forces.

Finally, the government must support and embrace the green wall initiative by the African Union which cuts across more than 20 African countries, done in a bid to push back the Sahara, to create fertile land in the Northern region. This initiative seeks to create a revitalized eco-system that would serve as a haven for herders and farmers alike in the Northern region of Nigeria. This initiative is not an immediate but a long-lasting and sustainable solution to the conflict between farmers and herders in Nigeria. Community involvement must be emphasized to achieve ownership and sustainability.

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