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ASSESSMENT OF CLIMATE CHANGE IMPACTS ON INTERNAL MIGRATION IN BURKINA FASO

BY

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DECLARATION

I hereby declare that this submission is my work towards the Ph.D. in Climate Change and Land Use and that to the best of my knowledge and belief, it contains no material previously published or written by another person nor material that has been accepted for the award of any other degree or diploma at Kwame Nkrumah University of Science and Technology, Kumasi or any other educational institution except where due acknowledgment is made in the thesis.

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ABSTRACT

This study examines the impact of climate change on internal migration in Burkina Faso, focusing on Comoé, Ziro, Boulkiemdé and Oubritenga. Using a participatory approach (workshops) and econometric analysis, it identifies the socio-economic and environmental factors driving migration and its impact on welfare. Data collected from 493 households in Comoé Province and drought assessments in Comoé and Boulkiemdé provide insights into the relationship between climatic conditions and migration. The Standardized Precipitation Index (SPI) and Standardized Precipitation-Evapotranspiration Index (SPEI) over 3-, 6-, and 12-month time scales were used to assess drought conditions while Pearson correlation analysis examined their link to migration. Local stakeholders highlight poverty employment scarcity, inadequate vocational training, population growth, and land constraints as major push factors while water availability, land access and favourable rainfall attract migrants. Migrants, mainly farmers, migrate in search of better climatic conditions. In Oubritenga Province, future migration is expected to be driven by drought and lack of policy support, while in Boulkiemdé Province it is expected to be influenced by land scarcity and poor vocational training. The econometric analysis shows that rainfall deficits, droughts and land degradation have a significant impact on migration patterns. Comparing migrants with non-migrants, the former tends to have higher levels of assets, demonstrating that migration can be a strategy to strengthen economic resilience, although its impact on remittances varies. Migration facilitates asset accumulation, while those unable to migrate are often trapped in deteriorating circumstances. Drought assessments show that Comoé, located in the Sudan zone, faces less frequent but extreme droughts, while Boulkiemdé, located in the Sudano-Sahelian zone, faces prolonged and severe droughts. Migration patterns show a moderate to high correlation with drought indices; however, discrepancies in some cases suggest that environmental stressors alone do not determine migration dynamics. In 1985, slightly humid periods in Comoé correspond to higher inflows and positive net migration, with SPEI6 showing a strong positive correlation with inflows (r = 0.81) and net migration (r = 0.80). Conversely, in Boulkiemdé, drought conditions in 1985 coincide with significant outmigration, with strong negative correlations between SPI12 and outflows (r = 0.83) and net migration (r = -0.91). However, the migration trends for 2019 for the Comoé and 1996 for the Boulkemede do not follow this logic, showing the complexity of climate-induced migration, influenced by socio-economic and policy factors beyond environmental stress alone.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANAM	:	Agence Nationale de la Météorologie
AOF	:	Afrique Occidentale Française
ATE	:	Average Treatment Effect
ATT	:	Average Treatment on the Treated
ATU	:	Average Treatment on the Untreated
BMBF	:	German Federal Ministry of Education and Research
BNDT	:	Base Nationale de Données Topographiques
CC	:	Climate Change
CCFV	:	Commission de Conciliation Foncière Villageoise
CCLU	:	Climate Change Land Use
CDF	:	Cumulative Distribution Function
CFA	:	Communauté Financière Africaine
CSO	:	Civil Society Organisation
DAC	:	Development Assistance Committee
EVET	:	Extreme Value Theory
GCM	:	Global Compact for Safe, Orderly and Regular Migration
GCPH	:	General Census of Population and Housing
HDI	:	Human Development Index
INSD	:	Institut National de la Statistique et de la Démographie
IOM	:	International Organisation for Migration
IPCC	:	Intergovernmental Panel on Climate Change
IV	:	Instrumental Variables
MIDEQ	:	Migration for Development and Equality
MLE	:	Maximum Likelihood Estimation
MTE	:	Marginal Treatment Effect
NDVI	:	Normalized Difference Vegetation Index
NEM:	:	New Economics of Migration
NELM	:	New Economics of Labour Migration
NGO	:	Non-Governmental Organisation
NOAA	:	National Oceanic and Atmospheric Administration
ODA	:	Official Development Assistance
OECD	:	Organisation for Economic Co-operation and Development

OLS	:	Ordinary Least Squares
PDF	:	Probability Density Function
RT	:	Return level
SPI	:	Standardized Precipitation Index
SPEI	:	Standardized Precipitation Evapotranspiration Index
SSA	:	Sub-Saharan Africa
UNCCD	:	United Nations Convention to Combat Desertification
UN	:	United Nations
UNEP	:	United Nations Environment Programme
UNFCCC	:	United Nations Framework Convention on Climate Change
US	:	United States
USD	:	United States Dollars
WFP	:	World Food Programme
WASCAL	:	West African Science Service Center on Climate Change and Adapted Land Use
WGI	:	Working Group I
WMO	:	World Meteorological Organisation

DEDICATION

To my beloved parents, **Bamaga and Fatimata**, who laid the foundation of my education with their unwavering love, sacrifices, and encouragement, and have been my guiding light every step of the way.

To my wonderful wife, **Bilama Mariétou**, whose endless patience, support, and belief in me made this journey possible. You are my rock, my inspiration, and my greatest source of strength.

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CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

Chapter 1 introduces the study by presenting its background and contextual framework. It defines the research problem, outlines the study's objectives, and formulates the key research questions. Additionally, this chapter highlights the significance of the study.

1.2 Background

One of the key findings of the Sixth Assessment Report (AR6) by the Intergovernmental Panel on Climate Change (IPCC) is that climate change is becoming increasingly widespread, rapid, and intense. Human activities have unequivocally driven global warming. The *Summary for Policymakers* by Working Group I (WGI) of AR6 emphasizes: "Each of the past four decades has been successively warmer than any decade since 1850" (IPCC, 2021). This persistent warming has disrupted the climate system with severe consequences, including more frequent and intense heatwaves, prolonged droughts, rising sea levels, and catastrophic cyclones. These changes place significant pressure on food production and access, particularly in regions already vulnerable to climate stressors, posing a serious threat to food security and nutrition.

In regions with moderate to high vulnerability, global warming of 1.5 °C to 2 °C, combined with low or insufficient levels of adaptation, is expected to increase the frequency, intensity, and severity of droughts, floods, and heatwaves. These climatic events will exacerbate risks to food security (Linong et al., 2022). Furthermore, if global warming exceeds 2 °C in the medium term, the risks to food systems will intensify, leading to heightened malnutrition and micronutrient deficiencies. Among these vulnerable regions, sub-Saharan Africa stands out due to its heightened vulnerability to climate stressors and limited capacity to adapt (Shackleton et al., 2015). In particular, the Sahel region is highly vulnerable to climate variability, characterised by unpredictable rainfall patterns, desertification and an over-reliance on rainfed agriculture, all of which contribute to a precarious socio-economic landscape(Zougmoré et al., 2023). Burkina Faso, a landlocked country in the Sahel, exemplifies these challenges. Approximately 80% of its population depends on subsistence agriculture, a sector that is increasingly challenged by declining rainfall and prolonged dry spells(Sorgho et al., 2020). This has led to widespread food insecurity, with rural livelihoods stretched to the breaking point.

The impact of climate change goes beyond the immediate economic disadvantages, triggering a cascade of socio-economic challenges, including migration. Migration has historically served as a coping mechanism in the Sahel, with both seasonal and permanent movements reflecting traditional responses to environmental pressures(Rain, 2024; Hoffmann et al., 2022). The scale and nuances of migration are evolving in line with the accelerating impacts of climate change (Selod & Shilpi, 2021). In particular, internal migration has become more prominent as rural populations increasingly move to other rural areas and urban centres in search of economic opportunities and protection from climate-related risks (Thorn et al., 2022).

The causal relationship between climate change and migration has gained significant attention among researchers and policymakers over the past two decades. It has become a prominent topic in public discourse and has been elevated on the global policy agenda (Entwisle et al., 2016; Letta et al., 2022). As early as the First IPCC Report, migration was identified as a potential short-term impact of climate change threatening human settlements (Ferris, 2020; IPCC, 1992). Since then, climate change and its impact on human migration have been at the forefront of research and policy-making (Kaczan & Orgill-Meyer, 2020).

In 2018, the United Nations Global Compact for Safe, Orderly and Regular Migration (GCM), adopted by the UN General Assembly, formally recognised environmental factors and climate change as key drivers of migration (United Nations, 2018). Furthermore, migration has been integrated into the Sustainable Development Goals (SDGs) under Target 10.7 which aims to "facilitate migration and mobility of people in an orderly, safe, and responsible manner, including through the implementation of planned and well-managed migration policies", (United Nations, 2016) Additionally, point 49 of Decision 1/CP.21 of the Paris Agreement on Climate Change called for the establishment of a mechanism ‘to develop recommendations for integrated approaches to prevent, minimize and address displacement associated with the adverse effects of climate change’ (UNFCCC, 2015).

Projections indicate that a global temperature increase of 2 °C or more above pre-industrial levels will significantly increase migration flows in the coming decades (Hoegh-Guldberg et al., 2019). Between 2008 and 2021, an estimated 318 million people migrated due to climate change (Sakapaji, 2023). Some projections indicate that the number of people who could move due to climate-related factors by 2050 could reach 1.2 billion (Narayanan et al., 2023). The World Bank's Groundswell report also estimates that there will be around 216 million new climate-induced internal migrants by 2050 in the six World Bank regions: sub-Saharan Africa, North Africa, East Asia and the Pacific, South Asia, Eastern Europe and Central Asia, and Latin America (Clement et al., 2021). The least developed countries, particularly those in the South, are the most affected due to their great vulnerability to the harmful effects of climate change, such as floods, droughts and rising sea levels (Almulhim et al., 2024; Sakapaji, 2023).

As one of the most vulnerable regions to climate change (Serdeczny et al., 2017), Sub-Saharan Africa is expected to experience a significant increase in displaced populations. According to Müller et al. (2014), the region is particularly at risk due to its high exposure to climate stressors and limited adaptive capacity. The IPCC Sixth Assessment Report projects that with 1.7 °C of warming by 2050, between 17 and 40 million people in sub-Saharan Africa could be forced to migrate internally. Drivers of this migration include water stress, declining agricultural productivity, and rising sea levels (Trisos et al., 2022).

Internal migration has a complex set of positive and negative impacts. It serves as a household resilience mechanism, allowing individuals to seek better economic opportunities and diversify income sources, which can alleviate poverty and reduce inequality (Zoma et al., 2024). It also serves as a strategy for households to diversify income sources and mitigate risks associated with agricultural uncertainty (Zahonogo, 2011). However, this movement also poses challenges such as increased pressure on urban infrastructure and services, which can lead to overcrowding and the proliferation of informal settlements (Crawley & Teye, 2023). The influx of migrants into certain rural areas has been linked to increased land use change, including deforestation and soil degradation, as migrants clear land for cultivation (Nébié & West, 2019).

1.3 Problem Statement

Burkina Faso has a long history of migration (Olsen, 2014; Tapsoba et al., 2022), dating back to the colonial era when state policies and economic structures shaped labour mobility and regional migration (Azianu et al., 2023; Coulibaly, 1986). While past migration patterns were largely influenced by economic and political factors, climate change has emerged as a significant driver of internal migration in recent decades (De Longueville et al., 2019; Nébié & West, 2019). Rising temperatures, irregular rainfall, and increasing desertification are altering agricultural productivity and water availability, forcing many rural populations to migrate in search of better living conditions.

Census data from INSD (2022) indicate a substantial increase in internal migration, with a reported 729.69% cumulative rise between 1975 and 2019 and an average annual growth rate of 16.58%. This increasing migration is intensifying demographic pressure and competition for land and natural resources, leading to widespread and escalating land conflicts in Burkina Faso.

Without effective policies, climate-induced migration may intensify poverty and hinder development efforts by straining resources, destabilizing labour markets, and increasing land conflicts (Rigaud et al., 2021). Poorly planned migration may lead to socio-economic and environmental challenges, such as resource conflicts, labour imbalances, and land degradation (Aweda et al., 2024; Bauloz et al., 2020; Gausset, 2008). However, with proper governance, migration can also serve as a development catalyst, enhancing labour distribution, innovation, and economic resilience through remittances (Bank, 2005; Castañeda et al., 2024).

Despite the growing body of research on climate-related migration, comparative evidence on its influence on internal migration remains scarce (Hoffmann et al., 2024). While existing studies have explored inter-provincial migration patterns and environmental drivers (Henry et al., 2003, 2004a, 2004b), the role of rainfall variability in migration decisions (Smith, 2012), and population perceptions of migration (Sanfo et al., 2017), there remains a significant gap in understanding rural-to-rural migration trends, particularly among farming households facing climate-induced stressors. More recently, Nébié & West, (2019) conducted a case study on migration and land-use change between the provinces of Bam (a departure area) and Sissili (a destination area). While these studies provide valuable insights, they do not fully capture the complex interactions between climate change and rural-to-rural migration, particularly the decision-making processes and future migration trends among rural households.

Furthermore, a critical gap remains in the development of localised migration scenarios that reflect Burkina Faso's socio-economic and environmental realities. Existing global migration models often fail to account for local conditions, leading to inaccurate projections and ineffective policy interventions. Developing context-specific migration scenarios is essential for national and local development planning. Accurate data on migration patterns will enable policymakers to formulate targeted strategies that enhance climate adaptation and migration governance.

1.4 Objectives of the study

1.4.1 Main Objective

The main objective of this study is to assess the impacts of climate change on internal migration in Burkina Faso.

1.4.2 Specific Objectives

Specifically, the study seeks to:

i. develop migration scenarios from the perspective of local stakeholders on the factors shaping future migration trends;
ii. analyse the determinants and impact of internal migration on household welfare of destination migrants; and
iii. assess the relationship between drought and internal migration.

1.5 Research Question

This research seeks to address the following questions:

i. How can migration scenarios be developed from the perspective of local stakeholders, and what factors influence how they project future migration trends?
ii. What are the key determinants of climate change-induced internal migration, and how does it affect the welfare of households in destination areas in Burkina Faso?
iii. Is there a relationship between the trend in internal migration flows and droughts in Burkina Faso?

1.6 Justification of the Study

This study is essential for understanding the role of climate change in shaping internal migration patterns in Burkina Faso, a country highly vulnerable to climate variability due to its limited economic development and widespread poverty. With 43.2% of the population living in poverty as of 2021 (INSD, 2021), and the Human Development Index ranking Burkina Faso 185th out of 193 countries in 2023 (UNDP, 2024), the country faces significant socio-economic challenges that exacerbate the effects of environmental changes. The National Climate Change Adaptation Plan has identified agriculture and water resources as the most climate-sensitive sectors (MERH, 2015), and these vulnerabilities are already forcing rural populations to migrate in search of more stable livelihoods. As weak economic growth and inflation continue to drive more people into extreme poverty (World Bank, 2023a), understanding migration as both an adaptation strategy and a socio-economic phenomenon becomes crucial for effective policy responses.

Existing migration studies have primarily focused on global and regional migration trends or urban migration dynamics, often overlooking how climate-induced stress factors influence migration within rural areas. This research seeks to bridge this gap by developing migration scenarios that integrate the perspectives of local stakeholders, thereby capturing the specific socio-economic and environmental realities that drive migration decisions in Burkina Faso. While scenario-based approaches have long been employed in environmental assessments future (Nicholls et al., 2018 ; Rounsevell & Metzger, 2010), their application to internal migration, particularly at the local level, remains limited. Most migration scenarios are downscaled from global models (Kebede et al., 2018), failing to reflect local-specific drivers and adaptation mechanisms. By employing a participatory approach that engages local actors, this study ensures that migration scenarios are grounded in empirical realities, making them more useful for policymakers and development planners. These insights will contribute to better governance of migration by integrating it into broader climate adaptation strategies, rather than treating it as a mere reaction to environmental distress.

Additionally, the study investigates the determinants and impact of internal migration on the welfare of destination households, an area that has been largely overlooked in previous research. While the relationship between climate change and migration has been established (Berlemann & Tran, 2020; Mastrorillo et al., 2016) , most studies have focused on international migration or rural-to-urban movement, neglecting the dynamics of rural-to-rural migration. In Burkina Faso, where agriculture remains a key livelihood, erratic rainfall, rising temperatures, and land degradation are forcing rural communities to migrate to other rural areas in search of more fertile land and better economic opportunities (Sanfo et al., 2017 ;Henry et al., 2003). The financial contribution of migrants through remittances is significant, with remittances in 2015 amounting to 3.6% of GDP, surpassing official development assistance (OCDE/ISSP, 2017). However, the long-term impacts of rural-to-rural migration on household welfare remain poorly understood. This study aims to quantify these effects, correcting methodological biases often found in migration research by incorporating marginal treatment effects to address selection bias (Abel et al., 2019; De

Longueville et al., 2020). The findings will help design more effective policies for managing migration and enhancing economic resilience in climate-affected communities.

Burkina Faso’s vulnerability to climate change, particularly in relation to drought, underscores the importance of this study. Historically, rainfall fluctuations have triggered migration from northern regions to western provinces and urban centers (Sawadogo, 2022; Sy et al., 2021), with pastoralist communities abandoning traditional livelihoods due to declining water availability (Traore & Owiyo, 2013). Despite these trends, existing research often lacks a direct link between physical drought data, such as the Standardized Precipitation Index (SPI) and the Standardized Precipitation-Evapotranspiration Index (SPEI) and actual migration data (Henry et al., 2004; Sy et al., 2021). Recent studies emphasize the need to integrate such climate indicators with migration data to better understand climate-induced mobility (Hermans & McLeman, 2021). Thus, knowledge gaps persist regarding localised effects of climate variability on migration flows, particularly concerning drought intensity, frequency, and duration (Cattaneo & Robinson, 2019; Hermans & McLeman, 2021).

Beyond filling empirical gaps, this research has direct policy implications. By developing localised migration models based on empirical data, it will enable policymakers to design targeted strategies that integrate migration into broader development planning. Context-specific migration scenarios will allow for more accurate projections, helping to mitigate negative impacts while leveraging migration as a tool for economic resilience and social stability. The study aligns with Burkina Faso’s National Migration Strategy (SNMig), contributing to Strategic Axes 1 and 4, which focus on strengthening rural-urban complementarities and deepening knowledge of migration. It also supports global frameworks such as the Sustainable Development Goals (SDG 10.7) and the Global Compact for Safe, Orderly, and Regular Migration (United Nations, 2018). Ultimately, the findings will provide valuable insights for national and local decision-makers, reinforcing climate resilience and sustainable development efforts in Burkina Faso.

1.7 Organisation of the Study

This thesis is structured as follows:

Chapter One serves as the general introduction, presenting the background of the study, the research problem, the objectives, and the associated research questions. It also highlights the significance of the study while defining its scope and limitations.

Chapter Two is dedicated to the literature review, covering key concepts related to climate change, its causes, impacts, and adaptation strategies with a particular focus on climate-induced migration. It explores migration theories, the relationship between climate change and migration, as well as the socio-economic drivers and consequences of climate-induced migration. Furthermore, this chapter identifies existing research gaps in internal migration studies related to climate change and emphasizes the need to address these gaps.

Chapter Three describes the study areas and the research methodology used to achieve the study's objectives. It provides an overview of the geographical areas under investigation and details the methodological approaches employed for data collection and analysis.

Chapter Four focuses on specific objective one, which aims to develop migration scenarios from the perspective of local stakeholders. It highlights the key factors influencing migration flows and proposes key future migration factors based on stakeholders' perceptions.

Chapter Five addresses specific objective two, which seeks to assess the impact of internal migration on the household welfare of climate-induced migrant households in Burkina Faso. It examines the socio-economic and climatic determinants of migration and analyses the effects of migration on the welfare of households in destination areas.

Chapter Six discusses specific objective three, presenting an analysis of drought and its relationship with migration in the Comoé and Boulkiemdé provinces. This chapter explores the correlation between drought indices and migration trends, illustrating how climatic conditions influence migration decisions in these two regions.

Finally, Chapter Seven presents the general conclusion and recommendations. It synthesizes the key findings of the study, provides a broader reflection on climate-induced migration in Burkina Faso, and offers policy recommendations to guide public policies and adaptation strategies.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter explores key concepts of the research, examines major migration theories, reviews empirical studies on climate change and migration, and analyses migration's impact on household welfare. Additionally, it investigates the link between drought and migratory patterns.

2.2 Review of Key Concepts

In migration studies, specifically in relation to climate and the environment, the choice of terms is of great importance. In general, the definitions given to the terminologies used in the field of migration are not normative and are not the subject of an international consensus either. But defining them does make it possible to situate the reality or phenomenon being referred to, and thus to better identify its implications in terms of rights and obligations and the players involved.

2.2.1 Migration

Migration is a difficult phenomenon to grasp from both a theoretical and a practical point of view; indeed, any definition of this phenomenon takes into account both temporal and spatial dimensions, hence the diversity of methods of approach.

However, it is defined by the International Organisation for Migration (IOM) as "the movement of persons away from their place of usual residence, either across an international border or within a State" (Sironi & Emmanuel, 2019). In general, time and space are two key criteria taken into account in the definition of migration.

In Burkina Faso, the Institut National de la Statistique et de la Démographie (National Institute of Statistics and Demography) considers time to be at least six months, or with the intention of spending at least six months away from one's usual place of residence. The spatial criterion refers to the crossing of administrative borders (villages, communes, departments, countries, etc.). This institute, therefore, defines migration as "any movement of an individual from one administrative entity (the commune being the smallest entity considered) to another for a stay of at least six months or with the intention of residing there for at least six months" (INSD, 2009).

From the above, we define migration as any movement of a person or group of persons from one locality to another within or outside the country, for whatever reason (social, economic, political, environmental or climatic) or in whatever manner (voluntary or forced), for a stay of at least six months or with the intention of residing there for at least six months.

2.2.2 Internal Migration

In their glossary of migration, Sironi & Emmanuel (2019) define it as "the movement of people within a state involving the establishment of a new temporary or permanent residence." We, therefore, note that in this form of migration, the movement of migrants is contained within the boundaries of the territory of their country of origin. It should be noted that this migration may be temporary or permanent.

In the context of Burkina Faso, this refers to all movements between administrative entities that result in a stay in the place of arrival of at least six months (or with the intention of residing there for at least six months) (INSD, 2009). Internal migration can take place between regions of the country; in which case it is known as inter-regional migration. Within a region, migration may take place between provinces, in which case it is known as intra-regional or inter-provincial migration. It can also take place between municipalities within provinces, leading to intra-provincial or inter-municipal migration.

It is this particular form of migration within the boundaries of the territory of Burkina Faso that is the subject of this study. However, the study is not interested in all internal migration but is specifically interested in rural-rural.

2.2.3 Rural-rural Migration

This is a form of internal migration defined in the glossary on migration as "the movement of people from one rural area to another for the purpose of establishing a new residence" (Sironi & Emmanuel, 2019). In this study, rural-rural migration refers to the movement of a person or group of people inside Burkina Faso, from one rural area to another for a variety of reasons.

Although all the reasons for rural-rural migration will be analysed, particular attention is paid to the link between migration and climate and environmental change.

2.2.4 Rural-urban Migration

Rural-urban migration is another form of internal migration defined as "the movement of people from a rural to an urban area for the purpose of establishing a new residence" (Sironi & Emmanuel, 2019).

In our case, it means any movement of people from rural areas of Burkina Faso to urban areas of the same country. As with rural-rural migration, the study will pay particular attention to the link between this form of migration and the climate/environment. This leads us to talk about environmental and climatic migration.

2.2.5 Environmental Migration and Climate Migration

One of the most widely accepted definitions is given by Chazalnoël & Randall (2021). For them, environmental migration refers to "any movement of persons or groups of persons who, mainly for reasons related to sudden or progressive environmental change adversely affecting their lives or living conditions are forced to leave their usual place of residence or leave it of their own accord, temporarily or permanently, and who, as a result, move within or outside their country of origin or usual residence". It is important to highlight that the displacement of populations, in this case, is mainly the result of unfavourable environmental conditions.

As for climate migration, they consider it to be a sub-category of environmental migration. It refers to "a particular type of environmental migration, in which the modification of the environment is due to climate change" (Chazalnoël & Randall, 2021). Migration is thus associated with increased vulnerability for the individuals who migrate, especially if it is forced. They point out, however, that migration can also be a form of adaptation to environmental stressors, helping to build the resilience of affected individuals and communities.

For the purposes of this study, we will not make a clear-cut distinction between environmental migration and climate migration, as the two concepts are very closely related and interconnected. It is difficult to clearly dissociate migration induced by environmental change from that induced by climate change (De Sherbinin et al., 2022). Indeed, environmental changes are impacts of climate change and environmental changes can also exacerbate climate change (IPCC, 2021). As a result, it is not easy to say with certainty whether a migratory movement is caused by environmental change or by climate change. To overcome these difficulties, we will use the terms "climate migration" and "environmental migration” interchangeably to designate this form of migration induced by sudden or gradual environmental change, climate-induced or not.

2.2.6 Internally Displaced Persons

The United Nations Commission on Human Rights defines internally displaced persons as "persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters and who have not crossed an internationally recognized State border" (Ní Ghráinne, 2022; UN Commission on Human Rights, 1998).

This case is mentioned here because of the large number of internally displaced persons (IDPs) that Burkina Faso has been experiencing since the security crisis of 2015. This category of people is not taken into account in this study, even though their displacement is limited to within the borders of Burkina Faso.

2.2.7 Drought

Drought is a climatic phenomenon characterized by a prolonged deficit in precipitation, leading to significant hydrological imbalances and negative impacts on ecosystems, agriculture, and human activities. According to Wilhite and Glantz (1985) "drought is a prolonged period of below-normal precipitation that causes significant hydrological imbalances, resulting in water shortages for ecosystems, agriculture, and human activities." This definition emphasizes the hydrological impact of drought and its consequences on water resources. Similarly, Palmer (1965) defines drought as "a sustained and regionally extensive period of below-average precipitation, leading to adverse effects on soil moisture, water supply, and agricultural productivity." This approach highlights the agricultural and hydrological consequences of precipitation deficits, directly affecting crop productivity and the livelihoods of rural populations. Furthermore, the Intergovernmental Panel on Climate Change states that "drought is a period of abnormally dry weather long enough to cause a serious hydrological imbalance, affecting ecosystems, agriculture, and water supply" (Lavell et al., 2012). This definition incorporates the notion of climatic anomaly and emphasizes the duration of the event as well as its widespread effects.

Drought can be defined in many ways, depending on the subject of interest. It is often referred to as meteorological drought, hydrological drought, agricultural drought or even socio-economic drought, depending on whether the water shortage affects meteorological, hydrological, soil or social systems (Ding et al., 2020; Gu et al., 2020; Lu et al., 2017; Shi et al., 2018). In this study, we will limit the scope to 3 main types of droughts: meteorological drought, agricultural drought and hydrological drought.

2.2.7.1 Meteorological Drought

Meteorological drought is defined as a context marked by a significant decrease in the normal amount of precipitation in a given geographical area over an extended period of time (IPCC, 2023; Kubiak-Wójcicka et al., 2023). In this definition, precipitation levels and their deviation from the norm are emphasized as the main indicators of meteorological drought. Karievina et al. (2019) describe it as a stochastic natural hazard caused by a persistent shortage of precipitation, which negatively impacts the physical environment and water systems, disrupting the hydrological cycle of the area. These authors add the environmental and hydrological impacts of reduced rainfall.

2.2.7.2 Agricultural Drought

Agricultural drought refers to a significant reduction in soil moisture, necessary for the good development of vegetation (Tadesse et al., 2015). The authors underscore the complexity of this type of drought due to its slow onset and the vast areas it can affect, with variable spatial effects depending on vegetation cover and specific agroecological sub-regions. For Yee-Shan Ku and colleagues, agricultural drought can be understood as a situation where there is a shortage of precipitation, leading to a deficit in soil water and a reduction in the level of groundwater or reservoirs. This ultimately has an adverse impact on agriculture and crop production. In this definition, the crucial role of precipitation and soil water availability is evident (Ku et al., 2013).

2.2.7.3 Hydrological Drought

Hydrological drought is defined as a significant reduction in the availability of all forms of water in the terrestrial phase of the hydrological cycle, including surface water, snowmelt, spring discharge and groundwater (Goyal et al., 2017). The main cause of this phenomenon is the prolonged lack of precipitation, which leads to the drying up of lakes, reservoirs and rivers, as well as the depletion of groundwater resources. Tallaksen et al. (2023), for their part, describe hydrological drought as a condition that develops from a prolonged deficit in precipitation, often combined with high evaporation, leading to below-normal levels of flow in rivers, lakes and groundwater. This definition emphasizes the deficit in the meteorological water balance as a precursor to hydrological drought, highlighting the interconnectedness of meteorological and hydrological processes.

2.2.8 Standardized Precipitation Index (SPI)

The Standardized Precipitation Index is defined as the difference of precipitation from the mean for a specified time period divided by the standard deviation where the mean and standard deviation are determined from past records (Pieper et al., 2020; McKee et al., 1993). It is based on probability that represents the degree to which the accumulative precipitation of a specific period departs from the average state (Du et al., 2013). The SPI relies on two assumptions: (1) the variability of precipitations is much higher than that of other variables, such as temperature and potential evapotranspiration (PET), and (2) the other variables are stationary (i.e., they have no temporal trend) (Blain et al., 2022; Vicente-serrano et al., 2010).

2.2.9 Standardized Precipitation Evapotranspiration Index (SPEI)

The standardized precipitation evapotranspiration index (SPEI) was first proposed by Vicente-serrano et al. (2010) as an improved drought index that is especially suited for studies of the effect of global warming on drought severity (Beguería et al., 2014). Similar to SPI, SPEI considers surface evapotranspiration due to the background of global warming and replaces precipitation in SPI with the difference between monthly precipitation and potential evapotranspiration (Liu et al., 2021). SPEI has a higher utilization rate than other indices, and its main advantage is the ability to detect the effect of changes in evapotranspiration and temperature concerning global warming (Nejadrekabi et al., 2022). It can be calculated for time steps of as little as one (1) month up to forty-eight (48) months or more (WMO, 2017). The multi-scalar nature of the SPEI enables the identification of different drought types and drought impacts on diverse systems (Ndehedehe, 2023). The SPEI method uses “climatic water balance”, the difference between precipitation and reference evapotranspiration (P–ETo), instead of precipitation (P) as the input.

2.2.10 Drought Propagation

It is possible to move from meteorological drought to agricultural and hydrological drought. This process, which consists of moving drought conditions from their meteorological origin to their agricultural and hydrological impact is called propagation. It is complex and depends on several factors, including climatic conditions, the characteristics of the basins and human activities. For drought management and mitigation strategies to be effective, they must be based on a good understanding of spread.

Following these clarifications of some key terminology, we review the literature on the link between climate/environmental change and migration in the next section.

2.3 Theories of Migration

A theory is a structured framework that synthesizes conceptual definitions, empirical parameters, and predictive elements to model real-world phenomena. It functions as a systematic set of propositions that delineates key variables, establishes relationships among them and formulates an explanatory model applicable across diverse contexts (Bannister et al., 2018; Narasimhan, 2014). A well-constructed theory not only identifies fundamental components but also defines its scope, ensuring precision in its domain (De Sherbinin et al., 2022). In essence, a theory is not merely an abstract construct but a coherent, testable framework designed to explain, predict, and structure knowledge within a specific field of study (Epstein, 2022)..

Migration theories seek to explain various aspects of migration, including who migrates, why they migrate, the types of mobility involved, the factors influencing migration choices, and the conditions shaping return migration (Czaika & Reinprecht, 2022). Social scientists employ theoretical frameworks to provide systematic explanations for migration patterns and behaviours (De Haas, 2021). These frameworks not only facilitate the interpretation of empirical observations but also integrate disparate findings into a cohesive analytical perspective (De Sherbinin et al., 2022).

Early migration theories were primarily grounded in economic determinism and rational choice theory which focuses on individual decision-making and economic incentives. However, as migration research evolved, scholars began incorporating broader social, political, and structural determinants into their analyses. The following sections explore key migration theories and highlight their contributions and limitations.

2.3.1 Neoclassical Approaches to Migration

The neoclassical economic approach conceptualizes migration as a rational, utility-maximizing decision undertaken by individuals seeking to improve their economic well-being (Piguet, 2013; Massey et al., 1993; Haas et al., 2019). This model assumes that individuals compare their current economic conditions with the potential benefits of relocation, primarily influenced by wage differentials and employment opportunities (Borjas, 2015; Clemens & Pritchett, 2019). Within this framework, migration is seen as one of several strategies to improve socioeconomic conditions, alongside education, job mobility, and financial decision-making (Leslie & Richardson, 1961; Trask, 2022).

A defining characteristic of this approach is its focus on wage disparities as the primary driver of migration. According to this model, migration generally flows from low-wage to high-wage regions, contributing to the equalization of geographic income differences (Grogger & Hanson, 2011; Milivinti, 2019). The Harris & Todaro (1970) model expanded this framework by incorporating expected wages rather than just actual wage differences, emphasizing risk and uncertainty in migration decision-making (Beine et al., 2011).

A crucial extension of the neoclassical model is the concept of migration selectivity, which suggests that identical structural conditions affect individuals differently based on personal characteristics, skills, and risk tolerance (Chiswick, 1999; Czaika et al., 2021). Additionally, the idea of 'present preference', a key assumption in neoclassical economics, posits that individuals apply a discount rate to future migration earnings, valuing immediate benefits over long-term uncertain rewards (Czaika & Reinprecht, 2022).

Despite its foundational role in migration studies, the neoclassical approach has been widely criticised for its narrow focus on individual decision-making and economic incentives (Porumbescu, 2018). Critics argue that migration is not purely an economic decision; it is shaped by social, cultural, institutional, and political factors (Zhou & Mahmud, 2023). The OECD (1978) further contends that wage-centered explanations fail to capture the broader structural conditions from which migration emerges. The limitations of the neoclassical model led to the emergence of alternative frameworks, such as the New Economics of Labour Migration (NELM), which shifts the analytical focus from individuals to households.

2.3.2 New Economics of Labour Migration (NELM)

The New Economics of Labour Migration (NELM) emerged as an alternative to neoclassical migration theories, shifting the analytical focus from individuals to households as decision-making units. Pioneered by Stark & Bloom (1985) and further developed by subsequent scholars (De Haas, 2021; Way, 2018), NELM challenges traditional economic models that view migration solely as a response to wage differentials. Instead, it posits that migration is a collective household strategy used to mitigate financial risks, overcome market imperfections, and enhance economic resilience (Taylor, 1999). Unlike neoclassical models that emphasize rational individual choices based on maximizing income, NELM asserts that households strategically send migrants abroad as a means to manage market imperfections in their home countries (Massey et al., 1993; Stark & Edward, 1991). These imperfections include limited access to credit, insurance, and capital, particularly in developing economies, where migration serves as a self-insurance mechanism (Mendola, 2012). Households often send migrants abroad not solely for higher wages but to secure financial stability through remittances (De Haas, 2021; Taylor et al., 2004)

The concept of risk diversification is central to NELM, particularly in economies with weak financial institutions (Taylor, 1999). Studies indicate that households engaging in migration are not necessarily the poorest, but have enough resources to facilitate migration (Massey et al., 2023; Stark & Taylor, 1991). This explains why middle-income households exhibit the highest migration rates, while the poorest lack migration resources and the wealthiest have fewer incentives to migrate (De Haas, 2021). A fundamental aspect of NELM is the role of remittances (financial transfers from migrants to their families), which serve as an informal financial safety net (Dridi et al., 2019) (Ratha, 2013). Unlike neoclassical theories that focus on individual wage gains, NELM highlights how remittances contribute to household resilience, enabling investments in education, property, and entrepreneurship (World Bank, 2023b). In agrarian economies, remittances help buffer households against economic shocks, crop failures, and volatile labour markets (Dewaard & Ha, 2019). (De Haas, 2021; Massey et al., 2023)

Beyond household-level impacts, remittances have significant community-wide effects. They finance infrastructure projects, school developments, and healthcare services, compensating for weak government support (Dridi et al., 2019; Nanziri & Mwale, 2023). Thus, migration under NELM is not just an individual pursuit but part of a broader socioeconomic strategy. NELM also introduces the concept of migration selectivity, emphasizing that migration is not random but highly structured based on household priorities (Hunter & Simon, 2023). Households tend to send individuals who have the highest potential for successful migration and employment, often favouring young, working-age members with the necessary education, skills, and social connections (Van de Werfhorst & Heath, 2019).

While NELM has been widely influential, it has faced several critiques. One key limitation is its assumption of households as unified decision-making entities, which disregards internal power dynamics, gender inequalities, and conflicting interests within families (Garip, 2012). For instance, feminist scholars argue that NELM does not fully account for gendered migration patterns, as women often face additional legal, economic, and social constraints when migrating (Hall & Cleton, 2025; Oishi, 2005). Moreover, Hughes (2021) criticizes NELM for its microeconomic focus, which neglects broader structural forces such as government policies, labour demand, and historical migration networks. This critique aligns with macro-level theories like Migration Systems Theory, which emphasises how migration is embedded in global economic structures (Massey et al., 2023). Another critique concerns NELM's limited explanation of long-term migration trends. While it effectively explains why migration begins, it does not sufficiently address how migration patterns persist across generations. Scholars like Bakewell (2010) and De Haas (2010) argue that migration is sustained even when initial economic incentives decline due to transnational networks and path dependencies. These critiques paved the way for broader migration theories, such as Migration Systems Theory, which examines the interconnectedness of migration processes across different scales.

2.3.3 Migration Systems as an Analytical Lens

Migration systems theory offers an alternative to neoclassical economic models by focusing on the interconnections between regions of origin and destination rather than viewing migration as a series of isolated individual choices. This framework highlights migration as a self-sustaining process influenced by economic, social, cultural, and political linkages (Bakewell et al., 2012; Fussell et al., 2014). Unlike neoclassical models, which emphasize individual economic rationality, migration systems theory accounts for the reciprocal exchanges of people, capital, information, and policies that shape long-term migration patterns (Mabogunje, 1970; Massey et al., 2023).

Originally rooted in functionalist social theory, migration systems theory emerged in response to increasing global migration flows in the 1980s and 1990s (Fawcett, 1989). As scholars gained access to global migration data, they identified patterns showing that once migration pathways are established, they tend to persist due to institutional, kinship, economic, and policy-driven reinforcements (Dewaard & Ha, 2019; Hauer et al., 2020). This theory incorporates broader influences such as historical colonial relationships, political alliances, cultural ties, and technological advancements, making migration patterns more predictable over time (Garip & Asad, 2015; Hollifield et al., 2022). Migration systems analysis also considers how policy changes, labour market fluctuations, and crises in one region impact migration flows globally, reinforcing the idea that origin and destination countries are interconnected (Knill & Steinebach, 2022).

One of the most critical factors in migration systems is social networks, which facilitate migration continuity by reducing costs and uncertainty for new migrants (Blumenstock et al., 2023; Sahai & Bailey, 2022). These networks consist of interpersonal connections that provide financial support, employment opportunities, and guidance for new migrants (Garip & Asad, 2016; Gurak & Caces). Social networks also function as informal integration mechanisms, helping migrants access housing, legal assistance, and social services in destination countries (Massey, 1988; Fussell & Massey, 2022).

A key aspect of migration networks is cumulative causation, whereby migration becomes self-sustaining over time, even if the original push and pull factors change (Haug, 2008; Sanderson, 2014). Modern research highlights how digital communication technologies, such as social media and mobile platforms, enable migrants to maintain transnational connections and real-time access to migration-related information (Dekker & Engbersen, 2014; McAuliffe et al., 2017).

Despite its broad applicability, migration systems theory has faced several critiques. One major limitation is its focus on the persistence of migration systems rather than their initial formation (Bakewell, 2010; De Haas, 2010). The theory explains how migration continues but provides less insight into why certain migration corridors develop while others do not (Bakewell et al., 2012). Another key critique concerns its static nature, as it often underestimates the impact of external shocks such as policy shifts, geopolitical conflicts, and economic crises on migration networks (McAuliffe & Oucho, 2024). Scholars argue that migration systems should be seen as fluid and evolving structures rather than fixed pathways (De Haas, 2021).

Recent research explores the role of environmental factors in migration systems, particularly how climate change and ecological degradation shape migration flows (Hunter et al., 2015; Mcleman, 2020; Cattaneo et al., 2019). Issues such as sea-level rise, droughts, and extreme weather events can disrupt traditional migration patterns, which create new displacement trends and accelerate rural-to-urban migration (Mcleman, 2020; Rigaud et al., 2021).

Additionally, institutionalizing climate migration policies suggests that environmental migration is becoming a structured part of global migration systems rather than merely a reactionary movement (Blake et al., 2021; Koskina et al., 2024). This calls for an expansion of migration systems theory to incorporate climate-induced displacement, adaptive migration strategies, and international governance (Melde et al., 2017; Kaczan & Orgill-Meyer, 2020).

Recent studies emphasize the role of environmental stressors in modifying established migration networks, further integrating climate factors into migration systems theory (Hunter et al., 2015; Mcleman, 2020). Recognizing the need for a broader explanatory framework, scholars have increasingly incorporated micro-level decision-making perspectives alongside macro-structural analyses. This shift has led to the refinement of Push-Pull Models, which emphasize the specific factors influencing individual migration choices

2.3.4 Push-Pull Perspectives on Migration

The previous discussion on migration systems theory highlighted the macro-structural factors that shape migration flows through historical, economic, and social linkages between regions. However, migration is also influenced by individual decision-making processes, which are best understood through micro-level frameworks. One of the most widely recognized micro-theoretical models in migration research is Lee's (1966) "push-pull" framework, which seeks to explain how individuals decide whether to migrate based on a combination of push factors (conditions that compel departure from an origin) and pull factors (conditions that attract migrants to a destination).

This model is frequently categorized within neoclassical migration theory, as it assumes that individuals weigh the costs and benefits of migration before making a rational choice (Hochleithner & Exner, 2018). Push factors at the origin often include economic hardship, such as unemployment, low wages, and high cost of living, as well as political instability, violence, and environmental degradation, all of which drive migration decisions (Black et al., 2013). Conversely, pull factors in destination areas, such as higher wages, employment opportunities, political stability, and improved quality of life, tend to attract migrants (Alvarado & Massey, 2010).

While widely used in migration studies, the push-pull model has been criticised for being overly deterministic, often portraying migration as a simple cause-and-effect process in which individuals passively respond to external conditions(De Haas, 2010). Critics argue that this framework fails to adequately account for the agency of the migrant, treating migration as a mechanical response to economic and political disparities rather than a complex decision-making process shaped by aspirations, risk assessments, and social influences (Bakewell, 2010; Carling & Schewel, 2018). Additionally, historical and structural factors, such as colonial legacies, trade relationships, and migration policies, are often overlooked in traditional push-pull models, leading scholars to argue for more nuanced approaches that integrate transnationalism, networks, and global inequalities (Bakewell, 2014; De Haas, 2021).

To address these critiques, Van Hear et al. (2018) propose an expanded framework, known as the "push-pull plus" model, which introduces a more nuanced categorization of migration drivers. This framework moves beyond a simplistic binary classification of push and pull factors, emphasizing the interactive and multi-layered nature of migration influences. It incorporates four interrelated categories of migration drivers: predisposing drivers, proximate drivers, precipitating drivers, and mediating factors.

Predisposing drivers refer to long-term structural conditions that set the context for migration including economic inequalities, demographic pressures, historical migration patterns, and structural labour market disparities (Huang & Butts, 2023; Koczan et al., 2021). These factors do not directly trigger migration but create an environment where migration is more likely to occur. Proximate drivers are more immediate pressures that increase the likelihood of migration, such as localized economic recessions, armed conflicts, environmental degradation, or discriminatory policies (A. Bank et al., 2017). Unlike predisposing drivers, proximate factors are short-term catalysts that elevate migration probabilities in specific contexts. Precipitating drivers serve as direct and immediate triggers that compel individuals to migrate. These include job loss, violent conflicts, extreme weather events, political crises, and sudden policy shifts (Van Hear et al., 2018). These are often the final triggers that push individuals to leave, particularly when combined with predisposing and proximate drivers. Mediating factors are conditions that either enable or constrain migration, such as transportation infrastructure, visa regimes, border policies, social networks, financial resources, and access to migration information (Van Hear et al., 2012). Even in the presence of strong push factors, migration may not occur if mediating factors are absent or restrictive (Van Hear et al., 2018). This multi-dimensional approach provides a more dynamic and context-sensitive explanation of migration, demonstrating how structural, immediate, and individual-level factors interact to shape migration decisions.

Although the Push-Pull Plus framework addresses several limitations of traditional push-pull models, it still faces certain critiques. Some scholars argue that it remains too focused on external conditions without sufficiently incorporating subjective migration aspirations, perceptions, and agency (Carling & Collins, 2018). For instance, individuals may migrate not just due to economic constraints but because of perceived opportunities, personal ambitions, or social status aspirations, elements that are difficult to quantify within push-pull models (Abdul-razak et al., 2023)

Another ongoing debate concerns the role of historical and institutional contexts in migration decisions. Some researchers argue that push-pull models, even in their expanded form, still do not fully capture the path-dependent nature of migration corridors, which are often shaped by colonial histories, long-standing trade relationships, and diasporic ties (Bakewell, 2014; De Haas, 2021). These insights suggest that push-pull frameworks should be integrated with migration systems theory to account for the historical evolution of migration flows.

A final critique relates to environmental migration, which does not always fit neatly into economic push-pull models. Climate change and environmental stressors such as droughts, rising sea levels, and desertification often act as slow-onset migration pressures, making them difficult to classify within traditional push-pull categories (Hunter & Simon, 2023; Mcleman, 2020). These factors often interact with social vulnerabilities, governance structures, and adaptive capacities, necessitating broader theoretical models that integrate climate resilience and displacement studies (Rigaud et al., 2021). While the Push-Pull Model explains migration through economic and structural factors, it overlooks the role of social networks in shaping migration decisions. To address this gap, the next section explores network theory and social capital which intend to illuminate how interpersonal connections facilitate or constrain migration.

2.3.5 Network Theory and Social Capital

The relationship between interpersonal connections and migration dynamics is closely linked to two foundational concepts: migratory chains and social capital. On the one hand, the idea of migratory chains emphasizes the role of pre-existing migration pathways, where earlier migrants facilitate the movement of subsequent migrants by providing information, resources, and logistical support (D'Angelo & Ryan, 2024; OECD, 1978). On the other hand, social capital theory, as introduced by Portes (1998), highlights how social relationships function as assets that can either facilitate or constrain migration. This perspective has led to a shift in the way migration is conceptualized, moving from a disruptive event to an ongoing process that fosters transnational connections across multiple geographic spaces (Faist, 2021; Massey, 1990; Schapendonk, 2022)

Within this framework, migration is no longer seen as a purely individual decision but rather as one embedded within social structures, where potential migrants are linked to family, community members, and cultural networks that shape their migration decisions (Mazzucato, 2021). These networks serve as key migration facilitators by providing financial assistance, employment opportunities, housing support, and crucial legal or bureaucratic guidance in the destination country (Chang, 2020; Williams et al., 2020). However, migration networks can also act as constraints, as they may spread discouraging information about migration prospects, reinforce economic dependencies, or create additional obligations for migrants (Faist, 2021; Keskiner et al., 2018)

Two key concepts—cumulative causation and migratory channels—help explain why migration continues even when the initial driving forces behind it diminish. These concepts illustrate how migration systems, once established, tend to sustain themselves through social capital and institutional linkages, which shape return migration dynamics and migrant retention in host countries (Garip & Asad, 2016; Massey et al., 1999)

Despite its contributions to migration research, network theory has faced criticism for overemphasizing the role of familial and community networks in migration decisions while underestimating structural and economic factors (De Haas, 2021; Sha, 2021). Some scholars argue that focusing too much on networks as the primary explanation for migration overlooks broader political, economic, and labour market conditions that influence migrant flows (Piché, 2014; Schapendonk, 2022).

Additionally, critics point out that while social networks can facilitate migration, they can also reinforce inequalities by disproportionately benefiting those with stronger pre-existing connections, leaving more marginalized groups with limited access to migration opportunities (Keskiner et al., 2018). The unequal distribution of social capital means that migration networks do not function uniformly for all individuals, particularly for women, undocumented migrants, and refugees who may face additional constraints in mobilizing network resources (Merry et al., 2017; Sha, 2021). Each migration theory explains migration from different angles but remains incomplete. Economic models focus on individual choices, while network and systems theories highlight social and structural influences. To fully capture migration's complexity, scholars advocate for theoretical pluralism, and this integrates multiple perspectives for a more comprehensive understanding.

2.3.6 Theoretical Pluralism

The preceding sections have introduced the key theoretical approaches used to explain migration at both the individual and household levels. As noted by Piguet (2013) migration is an inherently multidimensional phenomenon, influenced by a complex interplay of socio-political, economic, cultural, and environmental factors. Migration decision-making is rarely a purely rational economic calculation; instead, it occurs under varying degrees of constraint, shaped by social structures, institutional frameworks, and personal aspirations (Carling & Collins, 2018; Lu, 1999). This complexity explains why migration outcomes are often not binary; individuals may choose to migrate or stay based on a multitude of intersecting factors (Piguet, 2013).

Ndione (2009) highlights that both the desire and ability to migrate stem from a combination of personal characteristics, socioeconomic trajectories, exposure to information, social networks, and the broader political-economic context of both the origin and destination countries. This means that migration theories must account for both structural and agency-driven factors, as migration is not determined by a single explanatory variable but rather by a combination of interconnected influences (Bakewell, 2010; De Haas, 2021).

Despite this complexity, theorizing migration is not an impossible task. While migration has multiple causes and expressions, scholars argue that a pluralistic theoretical approach offers the most comprehensive framework for understanding migration patterns (De Haas, 2008; Massey et al., 1993; Piguet, 2013). Instead of relying solely on one explanatory model, theoretical pluralism integrates insights from multiple disciplinary perspectives to construct a more holistic understanding of migration processes (Piché, 2013).

Theoretical pluralism is particularly valuable because it allows for the simultaneous consideration of different explanatory factors rather than forcing migration research into a single paradigm (Bakewell, 2010; De Haas, 2021). This approach does not simply add up different variables but instead assesses their interactions within specific contexts (Piché, 2013). Empirical investigations help determine the relative weight of different factors, recognizing that migration is often shaped by threshold effects and non-linear relationships (Czaika & Reinprecht, 2022).

For example, the relationship between household income and migration propensity has been shown to follow a non-linear, bell-shaped curve (Clemens & Mendola, 2020; Pardede et al., 2020). In many cases, the poorest individuals lack the financial means to migrate, while the wealthiest have fewer incentives to leave. Migration is thus more common among those who reach a certain middle-income threshold, where they possess sufficient resources to move but still face economic uncertainty in their home country (Clemens & Mendola, 2020; De Haas, 2021).

Additionally, theoretical pluralism accounts for the temporal evolution of migration patterns, recognizing that migration can be self-sustaining over time. Once migration flows become established, social networks and institutional linkages create conditions for continued migration, even if the original drivers have weakened (D'Angelo & Ryan, 2024; Garip & Asad, 2016). This dynamic approach also allows for the integration of macro (structural), meso (network), and micro (individual) levels of analysis, providing a more nuanced understanding of how migration decisions are made and sustained (Piché, 2013).

While adopting a pluralistic theoretical framework may result in less overall coherence than adhering to a single school of thought, it offers greater flexibility in capturing the complexity of migration processes (Czaika & Reinprecht, 2022). This is particularly important when studying environmental and climate-related migration where multiple interacting factors (including economic vulnerability, policy responses and local adaptation strategies) must be considered (Bettini, 2017).

This study adopts a theoretical pluralism approach to move beyond rigid models and develop nuanced, context-sensitive explanations that account for the diverse trajectories of migration across temporal and spatial dimensions. While this approach may reduce overall theoretical coherence compared to a single-framework perspective, it enhances analytical flexibility, enabling a more comprehensive understanding of the complexity and diversity of environmental and climatic migrations.

2.4 Climate Change/Environmental Change and Migration Nexus

Since the IPCC and Stern publications (IPCC, 2007; Stern, 2007) on future 'flows' of substantial numbers of environmental migrants (Piguet, 2022), the relationship between environmental change and migration has been a focus of debate in the media and political discourse over recent years (Bettini, 2013). The same interest from the scientific community in the question can be seen with a significant body of empirical evidence being produced on environmental and climate-related migration (Piguet et al., 2018 ; Hoffmann et al., 2018). In this section, we present a review of the literature on the link between migration and climate/environmental change.

2.4.1 Climate and Migration Nexus in the World

At the global level, extensive research has explored the relationship between climate change and migration. While the role of climate as a direct driver of migration remains debated, studies increasingly recognise that environmental pressures interact with economic, social, and institutional factors to shape migration decisions.

Empirical evidence suggests that climate variability contributes to migration, particularly in regions highly dependent on agriculture. For instance, a global study using panel data from 142 origin countries and 19 destination countries found a positive correlation between temperature increases, precipitation changes, and international migration. Countries with strong reliance on agriculture exhibited greater migration outflows under climatic stress, reinforcing the role of economic vulnerability in shaping climate-related migration (Backhaus et al., 2015). Similar trends have been observed in Africa, where climate change influences migration to Organisation for Economic Co-operation and Development (OECD) countries. A time-series analysis of migration flows from 1980 to 2015 demonstrated that climate has non-linear effects on migration, with agricultural economies experiencing greater mobility in response to temperature fluctuations and extreme weather events (Wesselbaum, 2021). These findings highlight the complex interactions between climate stress, economic dependency, and migration outcomes.

Beyond agriculture, extreme weather events also shape migration decisions. Long-term data on migration flows to the United States suggest that hurricanes significantly impact mobility, particularly from countries with strong diasporic networks. The presence of established migrant communities appears to facilitate migration following climatic shocks, illustrating the role of social capital in mediating environmental migration (Mahajan and Yang, 2020). In India, where agriculture remains a dominant livelihood, climate variability has been found to increase internal migration. An analysis of census data from 1991 and 2001 revealed that states experiencing frequent droughts exhibit higher rates of interstate migration, particularly in rural-to-rural flows. This effect is magnified in agricultural regions where severe droughts disrupt economic stability and livelihoods (Dallmann & Millock, 2017).

Further research in India using panel data and meteorological records underscores the differentiated effects of climatic shocks on migration patterns. While adverse weather events increase rural-to-urban migration, they appear to suppress rural-to-rural and international migration, suggesting that economic constraints limit mobility for certain populations (Sedova & Kalkuhl, 2020). These findings resonate with evidence from Brazil, where climate projections indicate that migration rates will rise by 9.65% under future climate scenarios. However, this shift is expected to exacerbate regional inequalities, as wealthier areas attract migrants while less developed regions experience depopulation and economic decline (Oliveira and Pereda, 2020).

The impact of climate change on migration is not uniform across geographic contexts. In New Zealand, for example, regional migration responses to climatic variations remain minimal due to strong institutional adaptation mechanisms. While changes in weather patterns are statistically significant, they exert little influence on internal migration trends, highlighting the importance of economic stability and governance in mitigating migration pressures (Cameron, 2018). Conversely, in Mongolia, extreme winter conditions, known as "dzuds," significantly increase internal migration, with effects persisting for up to two years after the event. These patterns indicate that in harsh climatic environments, migration often functions as a delayed response to cumulative stress rather than an immediate reaction to individual weather events (Roeckert and Kraehnert, 2022).

In South Africa, migration responses to climate stress vary by socioeconomic status and racial demographics. An analysis of census data and climate records found that extreme temperature events and abnormal rainfall patterns increase migration, but these effects are most pronounced among Black and low-income populations. Wealthier and White populations exhibit greater resilience, suggesting that economic capacity and historical inequalities shape migration responses to climate shocks (Bannor et al., 2023; Mastrorillo et al., 2016).

Further illustrating the heterogeneous impacts of climate change on migration, research in Indonesia found that temperature anomalies, rainfall levels, and monsoon variability influence migration patterns in diverse ways. Climate-related migration outcomes depend on factors such as gender, household agricultural dependency, and regional economic conditions, underscoring the limitations of one-size-fits-all migration models (Thiede & Gray, 2017). Similarly, in Malawi, climate change has been found to create more barriers to migration than opportunities. Survey data reveal that while climatic stress does not increase migration aspirations among rural populations, it reduces their actual capacity to migrate by diminishing financial resources and social capital. As a result, acute shocks, rather than facilitating migration, often leave vulnerable populations trapped in place, reinforcing the concept of climate-induced immobility (Fernández et al., 2024; Kalantari et al., 2024).

Overall, the literature highlights that climate change does not operate as an isolated migration driver but interacts with economic structures, institutional frameworks, and social networks to influence migration patterns. While in some contexts, climate stress increases migration flows, in others it restricts mobility by depleting resources necessary for relocation.

2.4.2 Nexus in West Africa

As in the rest of the world, the relationship between climate change and migration has been the subject of numerous studies in West Africa, although it remains a complex and contested issue. While some researchers argue that environmental stressors such as droughts, land degradation, and erratic rainfall directly trigger large-scale migration, others emphasize the indirect role of climate stress by exacerbating economic vulnerabilities and reducing agricultural productivity, which in turn drives migration (Teye & Nikoi, 2022).

Historical evidence suggests that environmental constraints have long shaped migration patterns in the region. For example, during the famines of 1953–1954, 1972–1973, and 1983–1985 in rural northwest Nigeria, affected populations sought refuge in savannah areas where they could access wild food, fodder, and firewood, reinforcing long-standing rural-to-rural migration patterns (Grolle, 2015). Similar adaptive responses to environmental crises have been documented in other parts of the Sahel, where mobility has historically served as a strategy for coping with resource scarcity (Land & Hummel, 2013). However, while migration has functioned as a traditional survival strategy, its long-term sustainability is increasingly questioned, particularly as climate change accelerates environmental degradation and limits available resources (Black et al., 2011; Rigaud et al., 2018).

Beyond direct environmental stress, the economic consequences of climate variability play a crucial role in shaping migration decisions (Haq et al., 2025). In Niger, for example, persistent droughts, the shrinking of Lake Chad, and challenges surrounding the River Niger have intensified economic hardship, forcing many to migrate in search of better opportunities (Afifi, 2011; Okpara et al., 2015). This relationship between environmental stress and economic vulnerability has led to the concept of "environmentally induced economic migration," where climate factors indirectly drive migration by deepening poverty and reducing livelihood security (Afifi, 2011). Similar patterns have been observed in Benin, where soil degradation has led to increased migration to more fertile central regions. However, differences in soil fertility alone do not fully explain migration decisions. Factors such as land tenure security, agricultural policies, and broader economic opportunities significantly influence whether individuals choose to migrate or remain in place (Doevenspeck, 2011).

Recent research in Ghana further illustrates the link between environmental change and migration. A study utilizing the Normalized Difference Vegetation Index (NDVI) to analyse migration patterns found that north-to-south migration flows are closely correlated with regions exhibiting greater vegetation cover (Van der Geest, 2011). This suggests that access to natural resources plays a pivotal role in shaping migration choices (Safi et al., 2024). However, while climate-related stressors create additional migration pressures, they do not always serve as direct triggers. Instead, socio-demographic factors such as age, household size, and pre-existing migration networks are often stronger predictors of migration intentions. This supports the argument that individuals make migration decisions based on a combination of environmental pressures and personal circumstances rather than reacting to climate change in isolation (Abu et al., 2014).

Migration dynamics in West African coastal areas further illustrate the complexity of the climate-migration nexus. In Ghana’s Volta Delta, for example, recurrent flooding poses a persistent threat, yet migration decisions are often influenced more by social structures, economic conditions, and political considerations than by direct exposure to flood risks (Abu et al., 2022). Many indigenous households in the Greater Accra Metropolitan Area remain reluctant to relocate despite repeated flood events due to strong cultural ties, social cohesion, and land tenure concerns (Codjoe et al., 2017). This aligns with findings from Senegal, where similar reluctance to migrate has been attributed to the perceived cultural and economic costs of displacement (Addaney et al., 2023). Additionally, while estuarine ecosystems and marine resources attract settlers to coastal zones, declining fish stocks and diminishing economic opportunities are increasingly driving migration as a livelihood adaptation strategy (Kutir et al., 2024).

The literature on the climate-migration nexus in West Africa underscores several critical insights. First, environmental stressors influence migration but rarely act as sole determinants; migration decisions are shaped by a confluence of environmental, economic, and political factors (Rigaud et al., 2018). Second, migration serves as both a reactive and proactive adaptation strategy, depending on the severity of environmental shocks and the availability of alternative livelihood opportunities (Black et al., 2011). Third, extreme environmental conditions, such as recurrent droughts and floods, may sometimes suppress migration rather than trigger it, leading to climate-induced immobility where affected populations lack the resources to move (Benveniste et al., 2022). Finally, migration itself can create new environmental pressures in destination areas, necessitating policies that balance migration management with sustainable resource use.

2.4.3 Climate and Migration Nexus in Burkina Faso

In Burkina Faso, the literature on the link between climate change and migration is not as abundant as elsewhere in the world but it is growing. While climate variability, particularly erratic rainfall, land degradation, and droughts, plays a significant role in shaping migration patterns, it does not act in isolation (Ancey et al., 2024). Socioeconomic conditions, such as employment opportunities, literacy levels, and land tenure systems, also contribute to migration decisions (Langill et al., 2023). Understanding this nexus requires considering both environmental stressors and broader structural determinants.

Ecological degradation has long been identified as a key driver of internal migration, particularly in rural areas where households depend on subsistence agriculture (Henry et al., 2003). Studies indicate that rainfall variability, declining soil fertility, and land scarcity at the origin contribute to migration decisions. However, their influence appears to be slightly less pronounced than that of socio-demographic factors, such as population density, household size, and access to financial resources (Borderon et al., 2019). Similar findings have been reported in other Sahelian countries, where livelihood insecurity rather than absolute environmental scarcity drives migration (Cepero et al., 2021). Furthermore, in Burkina Faso, high literacy rates and economic activity at both the origin and destination play an important role in influencing migration flows, highlighting that migration is not only a survival mechanism but also a means of economic advancement (Nébié & West, 2019).

The type and duration of climate stress influence migration outcomes. Long-term environmental degradation, such as soil exhaustion and deforestation, exerts a stronger influence on migration decisions than short-term climatic shocks like droughts (Henry et al., 2004a). This aligns with findings from neighboring Mali, where chronic land degradation rather than seasonal droughts has been linked to permanent outmigration (Benjaminsen et al., 2022). Interestingly, while migrants from drier regions tend to engage in long-term migration, extreme rainfall deficits reduce the likelihood of short-term, long-distance migration (Henry et al., 2004b). This suggests that extreme environmental stress can sometimes lead to climate-induced immobility, a phenomenon where resource depletion makes migration financially impossible (Benveniste et al., 2022).

Future migration trends will depend not only on climate change but also on governance structures and institutional responses. Simulation studies using agent-based models predict that drier climate conditions will lead to increased international migration, particularly when coupled with inclusive and well-connected social and political governance (Kniveton et al., 2011). Conversely, migration flows are lower under wetter climate scenarios with restrictive and exclusionary governance policies. This suggests that while environmental pressures may trigger migration, the scale of movements is influenced by state policies that facilitate or restrict migration opportunities (Schewel et al., 2024).

Burkina Faso’s National Adaptation Plan recognizes migration as a key climate adaptation strategy (Ministry of Environment, Resources, Fishery , 2015). However, many policies remain reactive rather than proactive, often failing to integrate migration into long-term development planning (McOmber, 2020). Evidence from Niger suggests that when local governance supports adaptation initiatives, such as climate-resilient agriculture and alternative livelihoods, migration rates tend to decline (Jegen, 2020). These findings underscore the importance of integrating migration planning into climate adaptation frameworks in Burkina Faso.

The relationship between climate variability and migration has been analysed using both qualitative and quantitative approaches. Retrospective focus group discussions across Burkina Faso found that migration rates peaked under moderate rainfall conditions, whereas both extreme drought and excessive rainfall suppressed migration flows (Smith, 2012). This suggests that migration is not solely a reaction to climate stress but rather a strategic decision based on economic viability. If conditions become too extreme, migration becomes a less viable option due to financial constraints, further reinforcing climate-induced immobility (Black et al., 2013).

At a global scale, research using cluster analysis has identified land degradation as the most significant environmental constraint influencing migration in both Burkina Faso and Northeast Brazil (Neumann et al., 2015). However, at the national level, rainfall variability and land degradation were found to be equally significant drivers of intraprovincial migration, indicating regional heterogeneity in migration drivers. Similarly, rising temperatures have been linked to declining migration rates, as some populations become trapped in environmentally degraded regions with insufficient resources to relocate (Gray & Wise, 2016).

High-resolution climate data further reveal that heat waves inhibit migration, reinforcing the climate-induced immobility hypothesis (Nawrotzki and Bakhtsiyarava, 2016). At the local level, migration decisions are strongly linked to land productivity, tenure security, and water access (Audia, 2018). Surveys and in-depth interviews conducted in southwest Burkina Faso highlight that soil degradation, insecure land tenure, and declining rainfall are primary push factors, whereas fertile land, reliable agricultural productivity, and tenure security serve as key pull factors for migrants (Sanfo et al., 2017).

Migration itself has environmental consequences, particularly in destination areas where resource pressures may increase. For instance, land-use change and migration trends between Bam and Sissili provinces indicate that migrant-receiving regions experience intensified environmental degradation, while migrant-sending areas see moderate land-use change (Nébié and West, 2019). Similar patterns have been documented in Ghana's Northern and Brong-Ahafo regions, where internal migration has led to deforestation and overgrazing (A. B. Owusu et al., 2024). Over time, such dynamics may alter migration patterns, potentially stabilising or even reversing flows as environmental degradation reaches critical thresholds.

The literature on climate and migration in Burkina Faso underscores several critical insights. Climate stressors influence migration but rarely act in isolation. Migration decisions are shaped by a combination of environmental, economic, and political factors. Long-term environmental degradation drives permanent migration, whereas extreme climate shocks can lead to immobility.

2.5 Impacts of Migration

Researchers have been interested in the economic, social, and political impacts of migration. In this section of the study, we will examine the work that has already been done to gain a better understanding of the subject and to identify any gaps that our study will contribute to filling.

2.5.1 Impact of Migration in the World

Extensive research has explored the global impacts of migration, particularly in terms of household income, welfare, and employment quality. Studies indicate that migration generally leads to improved financial conditions for migrant households, although disparities remain across different income levels.

For instance, an analysis of the Vietnam Household Living Standards Surveys using Blinder–Oaxaca decomposition and quantile regression techniques found that households with migrants experienced higher income levels than non-migrant households. Migration notably enhanced expenditures at lower and median income percentiles, though no substantial effect was observed at higher income levels (Pham et al., 2022) . Similarly, research utilizing fixed-effects regression demonstrated that international remittances significantly improved household income and expenditure in Vietnam (Cuong & Linh, 2018).

In Pakistan, a study assessing the employment quality of migrant workers and its impact on rural households revealed that migration led to increased incomes and better living conditions in urban areas. However, migrant workers often lacked sufficient social protection, highlighting a critical policy concern (Mukhtar et al., 2018). Additional research in Punjab, using the propensity score matching method, found that remittances significantly increased household expenditure on both food and non-food items, thereby enhancing recipient households' welfare (Javed et al., 2017).

Ethiopian studies tracking migrants and non-migrants over 15 years indicated a substantial improvement in migrants' welfare, including a 145% increase in non-food consumption and enhanced dietary quality compared to non-migrants (De Brauw et al., 2018). Further analysis of migration trends over several decades emphasized the positive role of international remittances in reducing urban poverty (Assaminew et al., 2011). Similarly, a study in Bangladesh found that migration plays a crucial role in improving household food security by enabling families to access more stable income sources, reducing vulnerability to seasonal agricultural shocks (Hoque et al., 2024). Overall, while migration presents numerous economic opportunities, it also poses challenges such as labour market integration and social security access.

2.5.2 Impact of Migration in West Africa

West Africa experiences significant internal and international migration flows, influencing various socio-economic aspects of both sending and receiving communities. Migration, particularly through remittances, has been identified as a crucial mechanism for reducing poverty and improving household welfare, though its impact varies depending on migration type and destination (Nanziri & Mwale, 2023). Several studies have explored how migration affects poverty reduction, income inequality, and economic resilience in the region.

Households with international migrants often experience a notable reduction in poverty and improved living standards due to remittance inflows. An analysis of rural emigration in southern Ethiopia found that international migration increases household consumption per adult equivalent by approximately 29.8%, leading to lower poverty incidence, depth, and severity (Eshetu et al., 2023). Similarly, studies across sub-Saharan Africa suggest that a 10% increase in remittance flows is associated with a 1% reduction in per capita poverty levels and reduced income inequality, underscoring the role of remittances in financial inclusion and household resilience (Gupta et al., 2009; Şanli et al., 2024).

Migration has also been linked to improved household welfare and regional economic development. Remittances play a significant role in reducing poverty across different geographical and political regions, particularly in urban areas where their contribution to decreasing income inequality is greater than in rural areas (Fonta et al., 2011). Similar patterns have been observed in Nigeria, where remittances positively influence household welfare, contributing to better health, education, and investment outcomes (Akanle & Adesina, 2017).

The economic benefits of migration extend beyond remittances. Internal migration, particularly rural-to-urban mobility, has been found to improve household economic stability in many parts of West Africa. In Ghana, households with urban migrants tend to have higher levels of welfare compared to those without migrants, reflecting the economic opportunities available in cities (Ackah & Medvedev, 2012). However, rural-to-rural migration does not always yield the same benefits, as households with members migrating to other rural areas often experience no significant improvements in welfare.

Migration's impact on agricultural production and land use varies depending on the context. While migration can provide financial resources that facilitate investment in agriculture, it can also lead to labour shortages in farming communities. A study in Brong Ahafo, Ghana, found that migrant farmers generated income through land leasing and timber sales, benefiting both the migrants and indigenous landowners (Owusu, 2007). Moreover, remittances from rural migrants improved household welfare in origin communities by supporting education, food security, and other essential needs. These benefits led Owusu (2007) to describe migration as a "win" for the region and the migrants themselves.

Despite these positive effects, migration also presents challenges. The departure of skilled individuals can lead to labour shortages, particularly in key economic sectors such as agriculture (Macaluso, 2023). Additionally, migration-induced urbanization has placed significant pressure on infrastructure and social services in major West African cities (Cobbinah et al., 2015). Understanding the nuanced impacts of migration is essential for designing policies that maximize its benefits while mitigating its challenges.

2.5.3 Impact of Migration in Burkina Faso

While the impact of migration has been extensively documented across Africa and globally (Siddiqui, 2012), the literature on Burkina Faso remains comparatively limited, though growing. Studies examining migration in Burkina Faso reveal a complex interplay between economic opportunities, income inequality, and agricultural productivity.

The effects of migration on income inequality depend on the economic status of migrant households. Migration itself does not appear to affect rural income inequality directly, but remittances can either exacerbate or reduce disparities depending on the socioeconomic background of migrants (Roland, 2015). When migrants come from wealthier households, remittances tend to increase inequalities. However, when poorer households can send migrants abroad, remittances contribute to reducing disparities (Dabiré & Soumahoro, 2024).

The long-term impact of migration on income inequality follows a dynamic pattern. An analysis of migration between Burkina Faso and Côte d'Ivoire shows that, in the short term, remittances increase income inequalities between families that can send migrants abroad and those that cannot. However, in the long term, lower emigration costs, facilitated by migrant networks and remittances, help reduce these inequalities by enabling less wealthy households to participate in migration (Tapsoba et al., 2022).

Migration also contributes to improvements in education and living conditions. Households with a higher proportion of migrants have better living standards and higher school attendance rates (Dabiré & Soumahoro, 2024). Additionally, evidence suggests that migration encourages greater household investment in children's education, particularly in rural areas where access to schooling remains limited (Bayala, 2023).

The role of migration in rural economies is mixed. While remittances from international migrants contribute significantly to household well-being, migration within Africa tends to have weaker effects. Research on four villages in Burkina Faso's Central Plateau found that intercontinental migration improved household welfare considerably, as migrants' remittances allowed families to invest in health, education, and business activities (Wouterse, 2006). In contrast, continental migration within Africa had limited benefits, as it primarily resulted in a reduction of household labour without significant remittance inflows.

Migration affects agricultural productivity in diverse ways. While migration can reduce available labour in agricultural communities, it can also encourage shifts toward non-agricultural economic activities. A study based on the new economy model of labour migration found that households with migrants had lower agricultural incomes but higher earnings from non-agricultural activities, reflecting a shift in rural livelihoods (Zahonogo, 2011). This suggests that migration fosters economic diversification, with households relying more on non-farm income sources to sustain themselves.

Climate variability further complicates migration dynamics. Migrant remittances play a crucial role in enhancing food security and mitigating the adverse effects of climatic shocks. A study utilizing the standardized precipitation and evapotranspiration index (SPEI) found that remittances significantly reduce food insecurity risks by providing financial support during drought periods (Tapsoba et al., 2023). This highlights the importance of migration as an adaptation strategy in the face of climate change, particularly for vulnerable rural households.

Overall, migration in Burkina Faso presents both opportunities and challenges. Remittances contribute to poverty alleviation, improved education, and economic diversification, but migration can also widen inequalities and reduce labour availability in rural communities.

2.6 Relationship between Drought and Migration

Drought has surfaced as a crucial factor driving internal migration globally, affecting the relocation of populations in search of improved living conditions (Berlemann & Steinhardt, 2017). The connection between drought and migration is complex, typically shaped by socio-economic influences, governance practices, and the degradation of environmental quality (Hermans & McLeman, 2021). Globally, research has indicated that severe climatic events, particularly extended periods of drought, drive at-risk populations to relocate in their quest to access vital food and water resources, enhance their economic conditions and avoid conflicts that are aggravated by the lack of resources (Black et al., 2011; Zickgraf, 2018).

In the context of West Africa, characterized by pronounced climatic variability, drought has emerged as a particularly adverse phenomenon, resulting in the displacement of communities reliant on rain-fed agricultural practices (Mastrorillo et al., 2016). The IPCC report from 2014 highlights that the Sahel are experiencing an uptick in both the frequency and severity of droughts, which significantly jeopardizes food security and economic stability, consequently driving people from rural areas to cities in search of better prospects in urban settings.

In Burkina Faso, the effects of drought on internal migration are observable, as the country struggles with continuous food crises tied to climatic shifts (Nawrotzki et al., 2016). Research suggests that populations in the Sahelian region are progressively vacating their residences in pursuit of more dependable agricultural conditions and enhanced access to resources (Schraven et al., 2020). Migration patterns in Burkina Faso typically involve the movement from rural areas to urban centers, with males exhibiting a notable tendency to leave their residences in search of job and educational opportunities (FAO, 2016). Additionally, there are significant instances of internal migration within rural areas, where families relocate to different communities in pursuit of better agricultural land or more favourable climatic conditions (Sanfo et al., 2017; Zougmoré et al., 2016). Consequently, comprehending the dynamics of drought-induced migration is imperative for policymakers striving to formulate sustainable adaptation strategies and bolster resilience against prospective climatic disturbances.

CHAPTER 3

METHODOLOGY OF THE STUDY

3.1 Introduction

This chapter provides a comprehensive overview of the methodological framework employed in this study. It begins with a detailed presentation of the study area followed by an analysis of demographic characteristics and migration dynamics. Additionally, the chapter outlines the specific methodologies used to address each research objective, ensuring a systematic approach to data collection and analysis.

3.2 Study Area

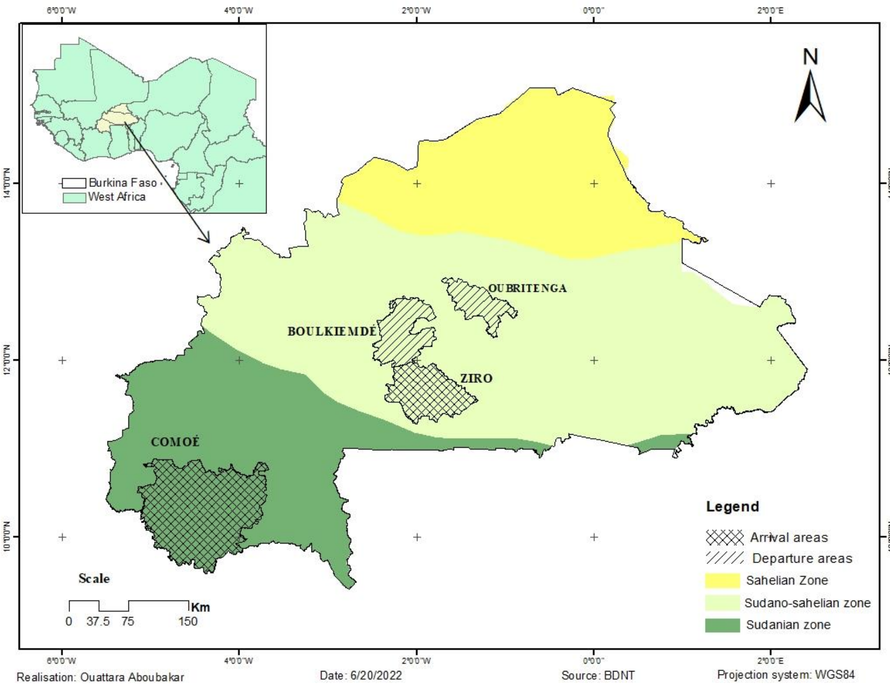


Figure 3.1: Map of the study sites
Source: BNDT 2012

This study was conducted in Burkina Faso across four sites, comprising two migrant origin sites and two migrant destination sites, as illustrated in Figure 3.1.

The departure sites, Oubritenga and Boulkiemdé provinces, are located in the Sudano-Sahelian zone. The province of Boulkiemdé lies between 12°14'59" north latitude and 2°22'03" west longitude. Located in the centre-west of the country, it is bordered to the north by the provinces of Passoré and Kourwéogo, to the west by the province of Sanguié, to the south by the provinces of Sissili and Ziro, to the south-east by the province of Bazèga and to the east by the provinces of Kadiogo and Kourwéo-go. It covers an area of 4,269 km^2. The Boulkiemdé is situated within the Sudano-Sahelian zone, characterised by a semi-arid climate with a shorter rainy season lasting 4 to 5 months (Guinko, 1984; Zoundi et al., 2024). The annual rainfall ranges between 600 and 900 mm, while average annual temperatures range from 20 °C to 37 °C (INSD, 2022; Zoundi et al., 2024). The local economy is also centred on agriculture; however, it is less diversified due to water scarcity and limited agricultural potential (Coly et al., 2024; Zoundi et al., 2024). These environmental, climatic and economic constraints have resulted in high levels of out-migration (INSD, 2022).

The province of Oubritenga is located between 12°35′00″ north latitude and 1°25′00″ west longitude. Situated in the central part of Burkina Faso, it is bordered to the north and northeast by the province of Sanmatenga, to the northwest by the province of Passoré, to the west by the province of Kourwéogo, to the south by the province of Kadiogo, to the southeast by the provinces of Kadiogo and Ganzourgou, and to the east by the province of Ganzourgou. Covering an area of 2,778 km^2, the province consists of seven municipalities. The province experiences a Sudano-Sahelian climate, similar to that of Boulkiemdé, characterised by an annual rainfall ranges between 600 and 800 mm. (Guinko, 1984; Zoundi et al., 2024). The average annual temperatures vary between 18 °C and 39 °C, resulting in a thermal amplitude of 21 °C. Oubritenga is an important agricultural zone, with the majority of the population engaged in rain-fed farming and livestock rearing. The province’s strategic location near the capital, Ouagadougou, fosters economic exchanges and migration. However, climate variability, water scarcity, and land degradation pose significant challenges to sustainable development and food security.

The destination sites are the Comoé and the Ziro province. The province of Comoé lies between 10°14′32″ north latitude and 4°23′58″ west longitude. Located in the extreme southwest of Burkina Faso, it is bordered to the north by the province of Houet, to the north-west by the province of Kénédougou, to the north-east by the province of Bougouriba, to the west by the province of Léraba, to the east by the province of Poni and to the south by the Republic of Côte d'Ivoire. It covers an area of 15405 km^2. It lies within the Sudanian zone, characterised by a tropical climate with a relatively extended rainy season, lasting approximately 5 to 6 months (Guinko, 1984; Sodore et al., 2023). Annual rainfall averages between 800 and 1,200 mm, while average annual temperatures range from 17 °C to 36 °C, with a thermal amplitude of 19 °C (INSD, 2022; Sodore et al., 2023). Economically, Comoé Province is predominantly agrarian, relying heavily on rain-fed agriculture (92.2% of households), with key crops including maize, millet, and legume (INSD, 2023). Livelihoods are largely based on subsistence farming and livestock rearing, making the region vulnerable to prolonged droughts (Coly et al., 2024). However, its relatively abundant natural resources and agricultural opportunities contribute to a higher degree of resilience compared to more arid regions. This economic and ecological advantage has made Comoé a key destination for internal migrants seeking improved agricultural opportunities and better living conditions (INSD, 2022).

The province of Ziro is located between approximately 11°23′00″ north latitude and 2°47′00″ west longitude. Situated in the centre-west of Burkina Faso, it shares borders with the province of Boulkiemdé to the north, the province of Bazèga to the east, the province of Sissili to the south, and the province of Sanguié to the west. Covering an area of around 5,139 km^2, Ziro lies in the transition zone between the Sudanian and Sudano-Sahelian zones (Worou et al., 2019), characterized by an annual rainfall ranging between 700 and 1,000 mm, while average temperatures fluctuate between 18 °C and 38 °C, resulting in a significant thermal amplitude of 20 °C (Etongo et al., 2015). Economically, Ziro is predominantly agrarian, with the majority of households engaged in rain-fed agriculture and livestock farming (Worou et al., 2019). Despite periodic climate variability, the province of Ziro remains an important agricultural hub, attracting seasonal and permanent migration from neighbouring areas in search of better farming opportunities (Nana, 2018).

3.2.1 Demographic Characteristics of the Study Area

According to the final results of the 2019 general population census (INSD, 2022), the provinces from which the migrants depart, Oubritenga and Boulkiemdé, have 314,609 and 6,870,709 residents respectively. In the province of Oubritenga, 52.19% of the population are women and in Boulkiemdé they represent 52.19% of the population. For example, in the province of Oubritenga 86.13% of households live in rural areas and in Boulkiemdé this figure is 67.69%. Population densities in the provinces of Oubritenga and Boulkiemdé are 110.7 inhabitants/km^2 and 161.3 inhabitants/km^2 respectively. These values are well above the national average of 75.1 inhabitants/km^2. These migrant departure areas are therefore among the most densely populated provinces in Burkina Faso.

The provinces of destination for migrants, Comoé and Ziro, have 633,043 and 241,731 residents respectively. Women represent 51.5% of the population in Comoé and 52.17% in Ziro. The majority of households in these provinces live in rural areas (70.7% in Comoé and 85.5% in Ziro). Population densities in Comoé and Ziro are 42.8 inhabitants/km^2 and 45.7 inhabitants/km^2 respectively. Far below the national average of 75.1 inhabitants/km^2, these values place these destination areas among the least densely populated provinces in the country.

3.2.2 Migration Dynamics in the Study Area

The 'Plateau Central or Plateau Mossi' which includes our two migrant departure sites in this study, is known to be an important emigration region in Burkina Faso (Nébié & West, 2019 ; Reij et al., 2005). Inhabitants of this area, mostly of the Mossi ethnic group used to migrate to Côte d'Ivoire, although this has decreased over time and with the political upheavals that this country has experienced (Deshingkar, 2012; Songre et al., 2018). Kazianga & Wahhaj, (2020) conducted migration surveys in the Central Plateau and Centre-West regions of Burkina Faso, regions in which the two migrant departure sites in this study are located. The results of their survey which covered 20 villages show that 83% of rural households in these areas have at least one permanent or temporary migrant.

The first internal migratory flows date back to the 1970s and 1980s when Burkina Faso experienced droughts (Nana, 2018; Ouedraogo et al., 2010). At that time, internal migrants came mainly from the 6 main emigration centres, namely the provinces of Yatenga, Sanmatenga, Boulkiemdé, Passoré, Kadiogo and Oubritenga l'Oubritenga (Nébié, 1996; Zongo, 2009). These flows were mainly directed towards the country's old cotton-growing zone, the heart of which is located in the Mouhoun, Banwa, Tuy Balé, Houet and northern Kénédougou provinces (Ouedraogo et al., 2009; Paré et al., 2008; Zongo, 2009).

The provinces of Comoé and Ziro recorded the first arrivals of internal migrants at that time, but these flows remained relatively moderate until the early 1990s (Nana, 2018; Ouedraogo et al., 2010). The old cotton-growing zone became saturated in the 1990s, and migrants faced insecurity of land tenure (Claims/Issp, 2005; Nana, 2018). This area which used to be a destination for internal migrants, is gradually losing migrants to the new pioneer front, including the provinces of Comoé and Ziro. With the socio-political and land crisis that broke out in Côte d'Ivoire in early 2000, the Comoé and Ziro provinces also recorded the arrival of international migrants returning from Côte d'Ivoire. They also received migrants from the central plateau. This marked the beginning of an intensification of migrant flows towards the provinces of Comoé and Ziro (Nana, 2018; Zongo, 2009).

3.3 Data Analysis

3.3.1 Specific objective 1: Development of Migration Scenarios from the Perspective of Local Stakeholders

3.3.1.1 Migration Analysis Method

In this study, we have adopted the participatory approach to analyse migration. The adoption of this method by the researcher in the study of migration has been slower than in other areas of social science (Torres & Carte, 2014). It is a common approach in many fields, especially in public health studies (Sullivan et al., 2005; van den Muijsenbergh et al., 2020). However, it has not been widely used in migration studies (Torres & Carte, 2014). Nevertheless, it has the potential to provide a good understanding of the multiple and complex drivers of migration and its effects.

To analyse migration with stakeholders, we opted to use workshops. Workshops are a participatory analysis technique commonly used, similar to focus groups (Skop, 2006). They have the potential to generate spontaneous exchanges and interactions that lead to unexpected results, reflexivity and reciprocal learning. For the development of scenarios, the Story and Simulation (SAS) approach (Alcamo, 2008) have been adapted.

There are two main steps in this analysis: (i) identification and selection of the key stakeholders to be involved in the process at the four study sites, and (ii) organisation of workshops with the stakeholders identified at each site.

3.3.1.2 Identification and Selection of Key Stakeholders

A three-stage approach was adopted to identify stakeholders. The first involved identifying the initial stakeholders and contacting them by telephone. The second consisted of a physical meeting with these stakeholders and the identification of other stakeholders using the snowball method. The third consisted of choosing the most relevant stakeholders to be involved in the study.

- **Identification of the first stakeholders:** The initial stakeholders identified were the government's technical services, responsible for managing migration, agricultural production, and the environment. These technical services were contacted through the environmental services, which acted as our gateway. A meeting schedule was established with these stakeholders.

- **Field trips to make contact and identify stakeholders:** Field trips were conducted to each of the sites to meet the stakeholders. During these meetings, we presented the objectives of the study, which were to carry out a multi-actor analysis of migration in the context of environmental and climatic change. We emphasized the need for the scenarios to be developed by the stakeholders themselves to ensure they reflected the reality on the ground as closely as possible. Based on the information they received, they were asked to suggest other relevant stakeholders who could be involved in the study. In this way, we identified additional stakeholders who were recommended to us. A database of individuals likely to be involved in the process was subsequently created.
- **Choice of stakeholders:** The list of workshop participants was drawn up on the basis of the database that could be associated with them and that was compiled during the field visits. To ensure the representativeness of all stakeholder groups involved in migration management, the contrast sampling method (Avaro, 1997; Palinkas, 2015) was applied. To ensure that participants were those best suited to take part, the expert judgement method was applied. State technical services, local authorities, traditional authorities, NGOs, researchers, migrants and farmers' organisations were selected.

The choice of state technical services is justified by the fact that, as representatives of the various ministerial departments, they are responsible for implementing Burkina Faso's various policies at the local level. They are, therefore, key actors in addressing migration, agricultural, environmental and social issues.

Local authorities have been chosen because, in the context of decentralisation, they are the bodies responsible for social and economic development and for maintaining the ecological balance at the local level. Local development is designed, planned and implemented by local authorities. Migrants, therefore, always settle in a municipality that welcomes them and creates the conditions for their integration and socio-economic development. In this respect, local authorities are key actors.

The choice of traditional authorities is justified by the fact that in the context of Burkina Faso, they are of great importance. They enjoy a certain legitimacy among the population, who recognise and identify with them. Tradition and social cohesion are guaranteed by them.

They are the ones who hold the land and give it to the migrants. As such, they are the relevant actors to be involved in this process.

Researchers have been involved because they are responsible for investigating societal problems and phenomena, in order to understand and explain them and find solutions to inform and guide policies.

The choice of NGOs/CSOs is due to the citizen-watch role they play. Thus, they are very close to the people. They are therefore aware of the ills that undermine society. They are therefore important players to take into account when we seek to understand a phenomenon as complex as migration.

Migrants: they are the first to be affected and it would be inconceivable not to involve them. They were chosen during the identification of key migration stakeholders in each of the four provinces, using the snowball method. They are opinion leaders in their communities (formal or informal leaders of migrant groups). Given their position as leaders, they have a holistic knowledge of migrants' issues and can express their opinions publicly.

Farmers' organisations: these are the umbrella organisations that bring together the actors in a particular field of activity. They promote their activities and defend their interests. These structures bring together migrants to carry out their activities. They are therefore important to be taken into account in order to better understand the difficulties faced by migrants.

3.3.1.3 Migration Analysis Workshops

The migration analysis workshops at the local level lasted two (02) days and brought together around fifteen participants at each of the four sites (see lists of workshop participants in the appendix) from different localities in each of the provinces. The workshops with local stakeholders were held mainly in plenary sessions.

First, the workshop objectives, working methodology and expected results were presented. This provided an opportunity to explain to the participants the work that would be done and what was expected of them. As many participants were not fluent in French, the speeches were translated into Dioula and/or Mooré, the two local languages spoken by all the participants in the study sites. This allowed everyone to speak in the language of their choice (French, Mooré or Dioula). This ensured that the participants had a good understanding of the issues addressed and were able to participate fully in the discussions.

Secondly, the participants exchanged views openly on the topics discussed throughout the workshop. The consensual answers to the various questions asked were written down on Craft paper which was then used to produce a summary of the discussions.

The topics or themes addressed during these workshops included identifying migration stakeholders, identifying migration factors, identifying the impacts of migration, identifying stakeholders' needs, and proposing solutions for better migration management.

- **Brainstorming**

Before starting the brainstorming, in each site, the participants are first asked to give the migratory status of the area, i.e., to say whether we are in a migrant departure zone or a migrant arrival zone. This was used to validate the choice of migrant departure and destination sites.

The brainstorming consisted of giving the floor to the participants so that they could express themselves freely, without restriction or particular orientation (experiences, perceptions, problems, advantages, etc.). This helped to build participants' confidence through everyone's involvement in the discussions. The result was an overview of the migration phenomenon in each province.

- **Identification of stakeholders.**

The identification of stakeholders consisted of asking the questions like who are the people involved in the migration phenomenon? To make it accessible to the participants, the question was posed in several different ways: Who do you work with when you migrate? Who do you turn to when you are new to a locality? who do you turn to when you have problems, and who do you work with on your activities?

- **Identification of migration factors**

At this level, we are interested on the one hand in the factors that have influenced migration in the past and in the present and on the other hand in the factors that will influence migration in the future (the next twenty years). These factors include push factors in areas of origin and pull factors in areas of destination.

- **Identifying the impacts of migration**

To identify these impacts, participants were first asked to cite the advantages, benefits, or positive aspects of migration. Secondly, they were asked to name the disadvantages, losses, or negative aspects associated with migration.

- **Identifying stakeholders' needs**

Each of the stakeholders identified was asked to state their needs or to say what was required to better deal with the migration of farmers.

- **Development of scenarios**

After identifying the main factors attracting migrants to each of the provinces over the next twenty years, they were asked to classify the factors in order of importance. The two most important factors were chosen in each province to develop four scenarios. Migration and the socio-economic and political environment were described for each scenario.

3.3.2 Objective 2: Analysis of Determinants and Impacts of Internal Migration on Household Welfare of Destination Migrants

3.3.2.1 Conceptual Framework

Climate variability has emerged as a critical factor in socioeconomic transitions in vulnerable regions, particularly in the Sahel. Burkina Faso households face recurring environmental stressors such as water scarcity, prolonged droughts and soil degradation which disrupt their livelihoods and agricultural productivity. These conditions often compel households to adopt internal migration as a coping mechanism. The conceptual framework seeks to explore the mechanisms and relationship between these climate-induced stressors and migration choices on the welfare outcomes: total value of assets and remittance. Climate fluctuations serve as a significant driving force, altering traditional farming methods and limiting resource availability. Environmental shocks such as low rainfall or barren farmlands frequently force households to migrate in search of alternate livelihoods (Black et al., 2011). Poverty, a lack of credit, and poor education all contribute to vulnerability, making migration a plausible choice. Local economic conditions and household demographic features such as family size or household heads' ages also influence migration decisions (Aslany & Sommerfelt, 2020).

Internal migration develops as both an adaptive response and a risk to households. Migration enables households to diversify their income sources, minimize reliance on climate-sensitive agriculture and seek better climatic conditions in other areas (Maharjan et al., 2020). However, migration's success is determined by the availability of social networks, the capacity to integrate into the destination's economy and the expenses of relocation. Migration can help households by improving income, remittances, and access to services but it can also make them more vulnerable by altering family structures or raising household debt.

Household welfare is conceptualised in terms of economic resilience which is quantified using assets such as livestock, land value, durable items, and savings (Ngigi et al., 2021). Migration affects these welfare outcomes by influencing income creation, savings accumulation and the ability to invest in productive activities (Beegle et al., 2019). For example, remittances received by migrants may allow households to strengthen their resilience by purchasing assets or improving agricultural methods (Jalal et al., 2017). In contrast, unsuccessful migration may diminish household resources, making them more vulnerable to future climate shocks. The relationship between climate variability, migration, and household welfare is mediated by several mechanisms:

- Environmental Push: Climate-induced environmental degradation forces households to migrate as a survival strategy (Cattaneo et al., 2019).
- Socioeconomic Mediators: Variables such as pre-migration asset levels, access to credit, and household composition shape the decision to migrate and the potential benefits derived from it (Gray & Wise, 2016).
- Institutional and Spatial Factors: Proximity to urban centres, migration policies, and institutional support influence migration's effectiveness in improving welfare (Berlemann & Steinhardt, 2017). For example, better access to infrastructure in urban areas increases the likelihood of positive outcomes.

To maximize the benefits of migration while limiting its risks, tailored measures are required. Investments in rural infrastructure, climate adaptation measures, and access to financial services can all help lessen the need for distress migration while also supporting migrants at their destinations (Adger et al., 2019). Policies that encourage sustainable land use and climate-smart agriculture can address the core causes of migration by increasing resilience to climatic unpredictability (Rigaud et al., 2018). By evaluating this interaction, the framework emphasizes migration's dual significance as both coping mechanism and a potential vulnerability for climate-affected households (Black et al., 2011). The framework also highlights the importance of targeted policies to address the socioeconomic and environmental drivers of migration, ensuring that migration contributes positively to household welfare (Beegle et al., 2019). The following Figure 3.2 synthesises the conceptual framework.

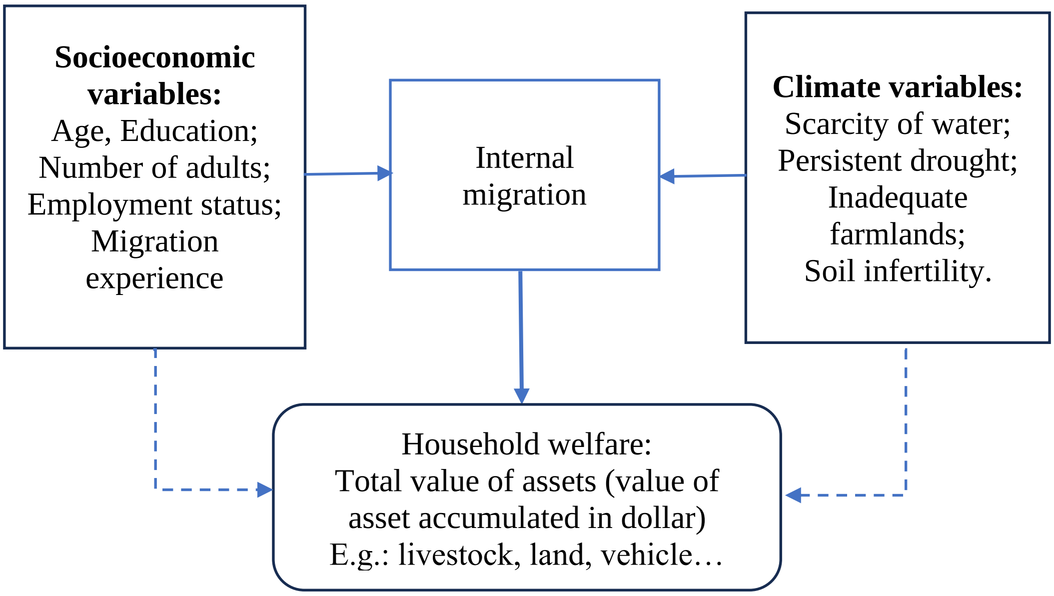


Figure 3.2: Conceptual framework
Source: Author's construct

3.3.2.2 Empirical Strategy

The marginal treatment effect (MTE) is a useful approach to estimate the impact of migration on assets by accounting for both observable and unobservable factors that influence migration decisions (Naidu et al., 2023). The MTE framework allows for heterogeneity in responses to migration across individuals and helps identify the impact of migration for individuals who are indifferent to migrating (i.e., marginal migrants) (Carneiro et al., 2011).

The empirical strategy for estimating marginal treatment effects (MTE) involves understanding how individuals or entities respond to a treatment at the margin, typically under selection bias or heterogeneous treatment effects. This is particularly relevant in migration studies, where traditional randomised controlled trials are not feasible due to ethical and logistical constraints (Cornelissen et al., 2016). MTE estimation relies on instrumental variables (IV) that influence the likelihood of treatment but do not directly affect the outcome, except through the treatment itself (Mogstad et al., 2024). These instruments help isolate variation in migration that is exogenous to household asset accumulation, reducing concerns about endogeneity (Bazzi & Clemens, 2013). A key empirical challenge is that migration is often endogenously determined, meaning that unobserved factors influencing migration may also impact household assets. To address this, the IV approach models migration decisions as a function of both observed and unobserved characteristics, ensuring that estimated effects reflect causal relationships rather than mere correlations (Imbert & Papp, 2020).

The MTE framework models the migration decision (treatment) using an unobserved latent variable that determines whether a household migrates. The migration decision equation is presented in Equation 3.1.

$$M_i = 1 \text{ if } Z_i \gamma + U_i > 0 \qquad (3.1)$$

where M_i is the migration status, Z_i is a vector of instrumental variables, γ is a parameter vector, and U_i is the unobserved component affecting migration (Mogstad et al., 2024).
The outcome equation, modelling the effect of migration on assets, is specified in Equation 3.2.

$$Y_i = X_i \beta + \delta M_i + \varepsilon_i \qquad (3.2)$$

where Y_1 is the household's asset level, X_i is a set of control variables, M_i is the migration status, δ is the treatment effect (impact of migration on assets), and ε_i is the error term.

The first Stage: Estimate the propensity score

We first estimate the probability of migrating (propensity score) using a probit model, as shown in Equation 3.3.

$$P\,(M_i = 1 |\; Z_i, X_i) = \phi\;(Z_i \gamma + X_i \beta) \qquad (3.3)$$

This propensity score represents the likelihood of migration for each household given the instruments and control variables(Wooldridge, 2016).

The Second Stage: Estimate Marginal Treatment Effects

The MTE is estimated by plotting the treatment effect at different quantiles of the unobserved component of migration decisions (e.g., different values of U_i . This is done by estimating treatment effects at various values of the propensity score $P(Z_i)$, which reflects the likelihood of migration for marginal households (Carneiro et al., 2011). The MTE at each quantile can be expressed as shown in Equation 3.4.

$$\mathrm{MTE(u)} = \partial\,(\mathrm{u}) \text{ where } \mathrm{u} = \mathrm{P(Z_i)} \quad (3.4)$$

This allows for capturing how the impact of migration on assets varies for individuals with different levels of unobserved factors influencing migration. To obtain consistent estimates of the treatment effect, we implement a two-stage IV approach:

First stage: Regress the migration decision M_i on the instruments Z_i and controls X_i.

Second stage: Regress household assets Y_i on the predicted migration status from the first stage, along with the control variables (Bazzi et al., 2016). The MTE framework provides a nuanced understanding of the impact of migration on household assets, capturing heterogeneity in treatment effects. This approach can help policymakers design targeted interventions that consider which households benefit most from migration and how migration affects asset accumulation for marginal migrants.

3.3.2.3. Data

The study utilized cross-sectional survey data collected in May 2024 from populations in 13 villages across 3 communes in the Comoé province. To gather data on migrants, a comprehensive questionnaire was developed as the primary research tool. This questionnaire, designed to capture both qualitative and quantitative data, included a mix of closed-ended and open-ended questions. The closed-ended questions provided predetermined categories for responses, such as binary options ("yes" or "no," "male" or "female") or a list of alternatives from which respondents could choose. Open-ended questions allowed farm households to elaborate in their own words, particularly for complex issues that required more detailed explanations, such as information on consumption expenditures. The data used for this study were collected using an interview method, either face-to-face or via telephone. Through these interviews, factors influencing households' migration decisions were identified. Additionally, responses regarding household assets (wealth), commonly used to assess welfare, provided insights into household welfare conditions. The questionnaire consisted of four subsections, labelled A to D. Section A gathered basic respondent identification details, including location, interview date, and the names of the respondent and enumerator. Section B focused on the socioeconomic characteristics of the household, while Section C captured data on both migrants and non-migrants. Section D collected information on household assets.

3.2.3.1.1 Sample Size Determination

To determine the sample size, we used Cochran's formula (Cochran, 1977). The choice of this formula is justified by the fact that the population size is large. Although we know the total population size of the province of Comoé, we do not know the proportion of migrants within this population. In such cases, as noted by Chaokromthong and Sintao, (2021), Cochran's formula is appropriate. This formula is presented in the Equation 3.5.

$$\mathrm{n} = \frac{\mathrm{Z}^2 \times \mathrm{p}(1-\mathrm{p})}{\mathrm{e}^2} \tag{3.5}$$

where n is the sample size, Z is the Z-score corresponding to a standard deviation of 1.96 for a 95% confidence level, and p is the estimated proportion of migrants. In our case, this proportion is unknown, so it is assumed to be 0.5, and e represents the margin of error, set at 5% (e=0.05) in this study. Based on this formula, the calculated minimum sample size for the study is 384, as shown in Equation 3.6. However, depending on the availability of financial resources, 109 individuals were added to the sample, increasing the total sample size to 493 and thereby enhancing its representativeness.

$$n = \frac{1.96^{\,2} \times 0.5(1-0.5)}{0.05^2} = 384 \tag{3.6}$$

Sample Techniques

The sampling technique used is multi-stage sampling. First stage: we purposively selected the province of Comoé based on statistics from the 4th and 5th General Population and Housing Census (GPHC) in Burkina Faso. In the 4th GCPH, Comoé province was the third most important destination for internal migrants, accounting for 5.7% of internal migration flows, after Kadiogo (30.1%) and Houet (11.6%), where the country's first and second largest cities are located, respectively (INSD, 2009). The region in which Comoé province is located recorded a positive migratory sole of 29,076. This proves that the area is indeed a destination for internal migrants (INSD, 2022). It should be noted that the province is the smallest unit of analysis of migration by the INSD. It is therefore the last administrative subdivision for which data on migration in Burkina Faso are available. Second stage: identification and selection of data collection municipalities in the province of Comoe. These choices were made based on information received on the presence of migrants in the communes, following the field trips that were carried out. The literature review also helped to guide the choice (Boyer & Néya, 2015; Nana, 2018). Third stage: selection of villages within these municipalities. This selection was made using the same method used to select the communes. It should be noted that in addition to the presence of migrants in the municipalities and the villages, accessibility in terms of security was a key determinant in the selection of municipalities and villages. Data was collected using the snowball method. Figure 3.3 below summarizes the sampling stages:

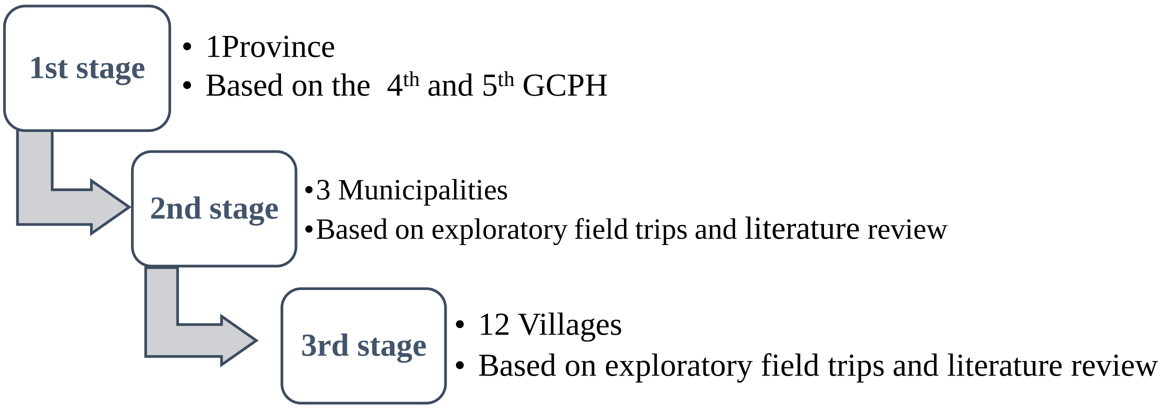


Figure 3.3: Sampling stages
Source: authors

3.3.3 Objective 3: Assessing the Relationship between Climate Variables and Internal Migration

3.3.3.1 Empirical Strategy

The empirical framework for the analysis of drought conditions involves several key steps, including (i) data preprocessing (Ogunjoa et al., 2019), (ii) the computation of drought indices (SPI and SPEI) (Akter et al., 2023), (iii) the computation of drought trend, intensity, duration, frequency, and return level (Nouri, 2020), (iv) the analysis of migration dynamics and (v) the computation of the Pearson correlation coefficient (r) (Secci et al., 2021).

3.2.3.1.2 Data Pre-processing

The initial step in the analysis involves preprocessing the dataset to ensure it is clean and structured for subsequent computations. The average daily temperature (T_{avg}) is calculated as the mean of the daily maximum temperature (T_{max}) and minimum temperature (T_{min}) as shown in Equation 3,7.

$$T_{avg,t} = \frac{T_{max,t} + T_{min,t}}{2} \quad (3.7)$$

Missing values in T_{avg} are addressed using linear interpolation, while missing precipitation values (RR_t) are replaced with zeros. This ensures a complete and continuous dataset, which is important for accurate index calculations.

3.2.3.1.3 Calculation of Drought Indices

Two indices are calculated to measure drought conditions: the Standardized Precipitation Index (SPI) (McKee et al., 1993; Peng et al., 2024) and the Standardized Precipitation-Evapotranspiration Index (SPEI) (Peng et al., 2024; Vicente-serrano et al., 2010). Both indices are computed over multiple time scales (s=1, 3, 6, 12) to capture both short-term, medium-term and long-term drought conditions.

Using both SPI and SPEI is important in this study to better reflect the specific climate conditions of Burkina Faso. Instead of relying on commonly accepted preferences or assuming that one index is always better than the other, this approach makes it possible to test, with actual data, which index, SPI, based on rainfall alone, or SPEI, which also accounts for temperature, provides a more accurate picture of drought impacts in this context.

- **SPI Calculation**

The SPI quantifies drought conditions based solely on precipitation data aggregated over a specific time scale (s). The SPI for a given time scale is calculated as shown in the Equation 3.8.

$$\mathrm{SPI_s} = \mathrm{F}^{-1}\big(\mathrm{G}(\mathrm{RR_{t:t+s}})\big) \quad (3.8)$$

where $RR_{t:t+s}$ is the total precipitation over the s-month time scale; G is the cumulative probability distribution of precipitation for the time series, and F^{-1} is the inverse of the standard normal distribution.

- **SPEI Calculation**

The SPEI incorporates the water deficit, which is the difference between precipitation and potential evapotranspiration (PET_t), to provide a more comprehensive drought measure. The water deficit over a given time scale is expressed in Equation 3.9.

$$\mathrm{SPEI_s} = \mathrm{F}^{-1}\big(\mathrm{G}(\mathrm{RR_{t:t+s}} + \mathrm{PET_{t:t+s}})\big) \quad (3.9)$$

The potential evapotranspiration (PET_t), is calculated using the Thornthwaite method shown in Equation 3.10.

$$\mathrm{PET}_{t:t+s} = 16\left(\frac{10\mathrm{T}_{avg,s}}{\mathrm{I}}\right)^{a} \quad (3.10)$$

Here, *I* is the annual heat index, a function of monthly average temperatures; a is an empirical parameter derived from the annual heat index *I*, and it is calculated as shown in the Equation 3.11.

$$a = 6.75 + 10^{-7}I^3 + 7.71 + 10^{-5}I^2 + 1.792 + 10^{-2}I \quad (3.11)$$

The Thornthwaite method is widely used for estimating PET in data-scarce regions, relying only on monthly temperature and latitude (Donohue et al., 2019; Tessema et al., 2020). Its simplicity suits Sub-Saharan Africa, where key climate data are often missing. Though less precise than models like Penman-Monteith, it remains effective for trend analysis in tropical climates (Shahid, 2011) and is integral to drought indices like SPEI (Vicente-Serrano et al., 2010). As climate change intensifies temperature-driven water stress, its relevance grows, especially in migration studies (Ozturk et al., 2021; Ma et al., 2022).

3.2.3.1.4 Trend Analysis

Linear regression, the Mann-Kendall test, and Sen's slope estimator are combined to ensure a comprehensive trend analysis. Linear regression quantifies the rate and direction of change but assumes linearity and is sensitive to outliers (Schreiber-Gregory et al., 2019). To validate the trend statistically, the Mann-Kendall test is applied, as it detects significant monotonic trends without assuming normality. Finally, Sen's slope estimates the trend's magnitude in a robust, non-parametric manner. This combination enhances reliability by integrating quantification (linear regression & Sen's slope) and validation (Mann-Kendall test) for a more accurate assessment of drought trends (Aditya et al., 2021; Gocic & Trajkovic, 2013).

- **Linear Regression**

Linear regression is first applied to quantify trends in SPI and SPEI over time. By assuming a linear relationship between time and the drought index it provides a straightforward estimation of trend direction and magnitude, particularly when changes follow a consistent pattern. The regression equation is given by the Equation 3.12.

$$\mathrm{Index}_s(t) = \beta_0 + \beta_1 . t + \epsilon \quad (3.12)$$

Where: $Index_s(t)$ is the SPI or SPEI at time *t*; β_0 is the intercept; β_1 is the slope of the trend line, which indicates the direction and magnitude of the trend; ϵ is the error term.

- **Mann-Kendall Test**

The Mann-Kendall test is a non-parametric method used to detect monotonic trends in drought indices. It does not assume a normal distribution making it well-suited for climate-related datasets that often exhibit variability and outliers (Gholami et al., 2022). The test evaluates the following hypotheses:

- H_0: No trend exists in the time series;
- H_1: A monotonic trend exists in the time series.

- **Sen's Slope:**

Sen's slope is used to estimate the magnitude of the trend detected by the Mann-Kendall test. It calculates the median slope between all possible pairs of data points, reducing sensitivity to outliers and ensuring robustness against non-normal distributions (Meals et al., 2011). The Sen's slope is computed as shown in the Equation 3.13.

$$\text{Sen's slope: } S = \text{median}\left(\frac{y_j - y_i}{x_j - x_i}\right) \times 100 \tag{3.13}$$

For j>i, and here, y_j and y_i are drought index values at times x_j and x_i.

3.2.3.1.5 Drought Intensity Analysis

Drought intensity measures the magnitude of drought conditions across severity categories (Spinoni et al., 2014). This helps evaluate how severe droughts are over the study period. It is classified based on the values of SPI or SPEI. The thresholds for classification are as shown in the Equation 3.14, based on the criteria proposed by McKee et al., (1993) and later applied to SPEI by Berhail & Katipoğlu, (2023) and Panigrahi & Vidyarthi, (2024).

$$\text{Severity} = \begin{cases} \text{Extreme drought,} & \text{Index} < -2.0 \\ \text{Severe drought,} & -2.0 \leq \text{Index} < -1.5 \\ \text{Moderate drought,} & 1.5 \leq \text{Index} < -1.0 \\ \text{Mild drought,} & -1.0 \leq \text{Index} < 0 \\ \text{No drought,} & \text{otherwise} \end{cases} \tag{3.14}$$

For each severity category, statistical summaries are calculated using the Equation 3.15.

$$\text{Mean intensity } (\mu)\text{: } \mu = \sum_{i=1}^{n} \text{Index}_i \tag{3.15}$$

Where *n* is the number of events in a given severity category.

The median intensity is the middle value of the index distribution for a severity category, calculated as shown by Equation 3.16.

$$\text{Range} = \{\text{Min}, \text{Max}\} \tag{3.16}$$

3.2.3.1.6 Drought Duration Analysis

Drought duration quantifies the persistence of drought events, measured as the number of consecutive months during which the drought index remains below zero (Gonza & Valde, 2006). To identify these events, a threshold-based approach was applied, aligning with the method of Wu et al. (2022). Specifically, a drought event indicator was assigned as presented in Equation 3.17.

$$\text{Drought event indicator} = \begin{cases} 1, & \text{if Index} < 0 \\ 0, & \text{otherwise} \end{cases} \tag{3.17}$$

To determine drought duration, consecutive months with a drought indicator of 1 were aggregated using Run-Length Encoding (RLE), a method also applied in drought analysis by Chelu (2024). The calculation is shown in Equation 3.18.

$$\text{Duration} = \sum_{\text{t}=1}^{\text{T}} \text{I}(\text{Index}_\text{i} < 0) \tag{3.18}$$

Where *I* is an indicator function that equals *1* if $\text{Index}_t < 0$, and T is the total number of months.

The mean duration was calculated as shown in Equation 3.19.

$$Mean\ duration = \frac{1}{n}\sum_{i=1}^{n} \text{Duration} \tag{3.19}$$

The median duration is the middle value of drought durations, and the maximum duration refers to the longest observed drought event.

3.2.3.1.7 Drought frequency analysis

Drought frequency refers to the number of drought events observed over the study period, categorized by severity (Veettil & Mishra, 2023). This measure provides insights into the occurrence patterns of droughts and helps in understanding their impacts over time (Aksoy et al., 2021). The frequency of drought events is calculated using Equation 3.20.

$$\text{Frequency} = \left(\frac{\text{Number of events by severity}}{\text{Total observations}}\right) \quad (3.20)$$

Where: Number of events by severity is the count of drought events within each severity category (e.g., mild, moderate, severe, extreme); Total observations refer to the total number of data points in the time series (Tahroudi et al., 2020).

Relative frequency is expressed as a percentage of all events and is calculated as shown in Equation 3.21.

$$\text{Relative Frequency (\%)} = \left(\frac{\text{Count by severity total events}}{\text{Total events}}\right) \times 100 \quad (3.21)$$

This approach has been widely used in drought studies to quantify recurrence patterns and analyse drought severity across different timescales (Gaznayee et al., 2022).

3.2.3.1.8 Return Level Estimation

The return level estimation involves analysing the probability of extreme drought occurrences over given time intervals using frequency analysis and statistical extreme value theory (Gumus, 2023). (Gumus, 2023). A crucial step in this estimation is the Combined Drought Index (CDI), which integrates both meteorological and hydrological drought indices to enhance the accuracy of return-level assessments (Wang et al., 2020).

- **Combined Drought Index**

The combined drought index (CDI) integrates the SPI and SPEI over 3, 6, and 12 months. This approach captures both short-term variability and long-term trends, which are essential for return level estimation (Laimighofer & Laaha, 2022). CDI is calculated as shown in the Equation 3.22.

$$\text{Combined Index} = \frac{1}{2}[0.2 \cdot (\text{SPI3} + \text{SPEI3}) + 0.2 \cdot (\text{SPI6} + \text{SPEI6}) + 0.1 \cdot (\text{SPI12} + \text{SPEI12})] \quad (3.22)$$

To weigh the combined drought index, higher weights were assigned to shorter time scales and lower weights to longer time scales. The SPI3/SPEI3 and SPI6/SPEI6 indices, which reflect the variability of short-term and medium-term droughts, were assigned a higher weight (0.20) to emphasize the immediate effects of drought conditions. Conversely, SPI12/SPEI12, which represent long-term trends, were assigned a lower weight (0.10) to prevent over-representation of persistent droughts. This weighting strategy aligns with methodologies used in multi-scalar drought assessment (Baik et al., 2022; Ozkaya, 2023).

- **Gumbel Distribution**

The intensity of extreme drought events was estimated for specified return periods using EVT, which involves fitting a Gumbel distribution to the drought index data. The Gumbel distribution is commonly used in hydrological and meteorological studies due to its suitability for modelling extreme events (Back & Bonfante, 2021; Osei et al., 2021). The cumulative distribution function (CDF) of the Gumbel distribution is defined in Equation 3.23.

$$F(x) = \exp\left(-\exp\left(-\frac{x-\mu}{\beta}\right)\right) \quad (3.23)$$

Where: x is the combined drought index; μ is the location parameter, indicating the central tendency of the distribution; β is the scale parameter, reflecting the spread of the distribution. The probability density function (PDF) of the Gumbel distribution is defined in Equation 3.24.

$$f(x) = \frac{1}{\beta}\exp\left(-\frac{x-\mu}{\beta}\right)\exp\left(-\exp\left(-\frac{x-\mu}{\beta}\right)\right) \quad (3.24)$$

where μ is the location parameter and β is the scale parameter. This formulation is widely used in extreme value theory to model the occurrence of extreme drought events (Chattamvelli & Shanmugam, 2021; Hansen, 2020).

Return Period and Return Level

The relationship between the return period (T) and return level (RT) is derived from the cumulative distribution function (CDF) of the Gumbel distribution, which is widely used in hydrological and meteorological extreme event analysis (Madhusudhan et al., 2022; Osei et al., 2021). The return period (T) is the expected time interval between events exceeding a certain threshold (R_T). It is linked to the return level (R_T) through Equation 3.25.

$$T = \frac{1}{1 - F(R_T)} \quad (3.25)$$

where F(R_T) is the cumulative distribution function (CDF) of the Gumbel distribution. This equation allows estimating how frequently extreme drought events occur based on historical data (Back & Bonfante, 2021).

The return level (R_T) for a given return period (T) is calculate using Equation 3.26.

$$R_T = \mu - \beta \ln\left(-\ln\left(1 - \frac{1}{T}\right)\right) \quad (3.26)$$

Where R_T is the return level for a return period T (e.g., 2, 5, 10, 20, 50, 100 years) (Anghel, 2024); μ is the location parameter, which indicates the central tendency of extreme values; β is the scale parameter, reflecting the spread of extreme values in the distribution.

By applying the Extreme Value Theory (EVT), the Gumbel distribution provides a reliable method for estimating future extreme drought events, improving drought risk management, and climate adaptation strategies (Back & Bonfante, 2021; Madhusudhan et al., 2022; Osei et al., 2021).

Fitting the Gumbel Distribution

The Gumbel distribution is fitted in 3 stages:

- data input: the combined drought index values (x) from the dataset are used as input data for the analysis. To focus on extreme drought events, a threshold can be applied to filter the data (for example, by selecting values where $x<-1$);
- parameter estimation: the parameters of the Gumbel distribution, namely the location parameter (μ) and the scale parameter (β), are estimated using the maximum likelihood estimation (MLE) method. This ensures the best fit of the distribution to the observed data (Tanprayoon et al., 2023);
- calculation of the return level: once the parameters μ and β have been estimated, they are used to calculate the return levels (R_T) for different return periods (T). Return levels represent the intensity of drought events expected to occur, on average, once every T years (Júnior et al., 2020).

3.2.3.1.9 Migration Dynamics: Empirical Strategy

Migration flows were modelled as a time series to capture temporal trends. The migration model is defined in Equation 3.27.

$$M_t^p = \{I_t^p, O_t^p\}, \quad \text{for } t = 1985.1996, 2006, 2019 \quad (3.27)$$

Where M_t^p is the migration dynamics for province *p,* in year *t*; *p* is the province; t is the year of observation; I_t^p Inflows of migrants at time *t*, in province *p*; O_t^p is the outflow of migrants at time *t*, in province *p*.

To know whether the province is gaining or losing population due to migration, net migration (N_t^p) is used. It is defined as the difference between inflows (I_t^p) and outflows (O_t^p) of migrants, as shown in Equation 3.28.

$$N_t^p = I_t^p - O_t^p \tag{3.28}$$

When $N_t^p > 0$, the province experiences a net gain in population due to migration, whereas when $N_t^p < 0$, it experiences a net loss. The time series of net migration is calculated for each province using Equation 3.29.

$$N_t^p, \qquad \text{for } t = 1985, 1996, 2006, 2019 \tag{3.29}$$

3.2.3.1.10 Pearson correlation matrix computation

The Pearson correlation matrix is a statistical method used to measure the strength and direction of linear relationships between multiple variables. It is applied in this study to analyse the relationships among SPI (3, 6, and 12), SPEI (3, 6, and 12), inflows, outflows, and net migration. The Pearson correlation coefficient (r) quantifies the degree of association between the drought indices (SPI and SPEI), and migration-related indicators (inflows, outflows, and net migration) and is calculated using the formula shown in Equation 3.30 (Mertler et al., 2022).

$$r_{XY} = \frac{Cov(XY)}{\sigma_X \, \sigma_Y} \tag{3.30}$$

where, X represents the drought indices (SPI and SPEI); Y represents migration-related indicators (inflows, outflows, and net migration); σ_X σ_Y are the standard deviations of X and Y; r_{XY} is the Pearson correlation coefficient between X and Y; Cov (X, Y) is the covariance between X and Y, and calculated as shown in Equation 3.31.

$$Cov(X, Y) = \frac{1}{n}\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y}) \tag{3.31};$$

where n is the number of data points, $\bar{X}$ and $\bar{Y}$ represent the mean values of X and Y, and σ_X and σ_Y denote their standard deviations (Šverko et al., 2022).

To standardise the variables, each variable is mean-centred and scaled by its standard deviation using the standard Z-score transformation, as shown in Equation 3.32.

$$Z_X = \frac{(X - \overline{X})}{\sigma_X}, \frac{(Y - \overline{Y})}{\sigma_Z} \tag{3.32}$$

Since Z_X and Z_Y are standardised, their standard deviations equal 1, which simplifies the correlation formula to Equation 3.33.

$$r_{XY} = \frac{\mathrm{Cov}(XY)}{1} \quad (3.33)$$

3.3.3.2 Data and Tools

This study relies on two primary datasets: climatic data and migration data. The climatic dataset includes daily precipitation records and minimum and maximum temperatures obtained from the National Meteorological Agency (ANAM). For Comoé Province, data were collected from the climatological station in Banfora (10° 38' 9.6" N, 4° 45' 39.6" W), while for Boulkiemdé Province, data were sourced from the synoptic station in Koudougou (12° 15' 5.04" N, 2° 24' 1.8" W). The dataset spans 62 years, from January 1, 1960, to December 31, 2022.

A pre-processing phase was conducted to identify and address missing values to ensure data accuracy and completeness. Spatial proximity imputation was applied using a climatic analogy approach, which transfers data from nearby stations within the same climatic zone to preserve consistency. Specifically, missing records from Banfora station (Comoé) were supplemented with data from Bérégadougou station, located less than 20 km away in the Sudanian climatic zone. Similarly, missing values from Koudougou station (Boulkiemdé) were replaced using data from Ouagadougou station, approximately 100 km away, situated within the Sudano-Sahelian climatic zone.

Migration data were obtained from the National Institute of Statistics and Demography (INSD), covering internal migration flows (inflows, outflows, and net migration) for Comoé and Boulkiemdé provinces. These data were collected during four General Population and Housing Censuses conducted in 1985, 1996, 2006, and 2019.

For the climatic analysis, precipitation and temperature data were processed using R statistical software (version 4.4.2; R Core Team, 2023). Specifically, we calculated the Standardized Precipitation Index (SPI) and the Standardized Precipitation-Evapotranspiration Index (SPEI) using the climpact package which is tailored for climate impact assessments.

CHAPTER 4

DEVELOPMENT OF MIGRATION SCENARIOS FROM THE PERSPECTIVE OF LOCAL STAKEHOLDERS

4.1 Introduction

Chapter Four analyses internal migration from the local stakeholders' perspective. It presents and discusses the results on actors involved in local migration management, the push and pull factors, and the main origins and destinations of migrants. Additionally, this chapter discusses the impacts of internal migration and presents scenarios on the future evolution of internal migration from the perspective of local stakeholders in the study sites.

4.2 Actors of Migration

The main actors identified in the various study sites are more or less the same and include migrants; tutors; the host community, i.e. the population of the host locality; state technical services (departments in charge of humanitarian action, environmental, agricultural), NGOs and CSOs; traditional authorities (landlords, village chief, land chief, lineage chief).

The study identified four main groups of institutions engaged in migration management: local populations, state actors, local collectivities, and civil society organizations (CSOs) and NGOs. These actors interact at multiple levels to shape migrants' social and economic integration, demonstrating a decentralized and multi-actor governance approach.

The local community, comprising migrants, host communities, village chiefs, landowners, and customary leaders, play a pivotal role in determining the success or failure of migrant integration. Village chiefs and traditional authorities mediate land access, resolve disputes, and facilitate social acceptance, echoing findings from other Sahelian countries where customary institutions significantly influence migration processes (Jegen, 2020). The importance of community-level mechanisms is further supported by research emphasising their role in land tenure regulation and conflict resolution in West Africa (Hagberg et al., 2019).

State institutions, including local administrative authorities, security forces, and technical services in agriculture, environment, and humanitarian action complement these efforts by providing formal regulatory frameworks, legal protections, and support services for migrants. In Burkina Faso, where statutory and customary land tenure systems often overlap, this coexistence can create legal ambiguity and institutional tensions. As highlighted by

Schierup et al. (2023), the interplay between formal state institutions and customary authorities is critical, particularly in fragile contexts where state presence is uneven and governance structures are fragmented. One notable example is the institutionalization of the Village Land Tenure Conciliation Commissions (CCFV), established under Law No. 034-2009/AN on rural land tenure and operationalized through Decree N°. 2012-263/PRES/PM/MATDS/MJ/MAH/MEDD/MEF. These bodies, composed of local stakeholders but formalised by the state, aim to resolve land disputes and harmonize tenure practices, illustrating how hybrid governance mechanisms are used to manage migration-related land issues.

Local municipalities, responsible for spatial planning and local development, also play an important role in migration management. Within their jurisdiction, they oversee land allocation, urban planning, and service provision, directly affecting migrants' living conditions. Their role is crucial in facilitating the integration of migrants into host communities and ensuring their access to essential services. However, as noted in similar contexts, the effectiveness of decentralized governance structures often depends on the capacity of local governments to coordinate migration-related interventions and manage demographic pressures (Bisong, 2022).

Civil society organizations (CSOs) and NGOs play a significant role in migration governance, providing technical and humanitarian assistance, advocating for migrant rights, and supporting livelihood programs. However, challenges such as overlapping mandates and weak coordination mechanisms among stakeholders can hinder efficiency, leading to fragmented migration policies and duplicated efforts (Schierup et al., 2023). This underscores the need for stronger collaboration between state and non-state actors to enhance policy coherence and ensure that migration contributes to both migrant resilience and local development.

Overall, the governance of migration in Burkina Faso reflects a complex network of interactions between traditional authorities, state institutions, local governments, and civil society actors. While community-based governance plays a crucial role in managing migration at the grassroots level, formal institutions provide the regulatory frameworks necessary for structured integration. Strengthening collaboration among these actors is essential to address governance gaps, improve coordination, and develop inclusive migration policies that support both migrants and host communities in a climate-affected region. Discussions with stakeholders resulted in the stakeholder map shown in Figure 4.1.

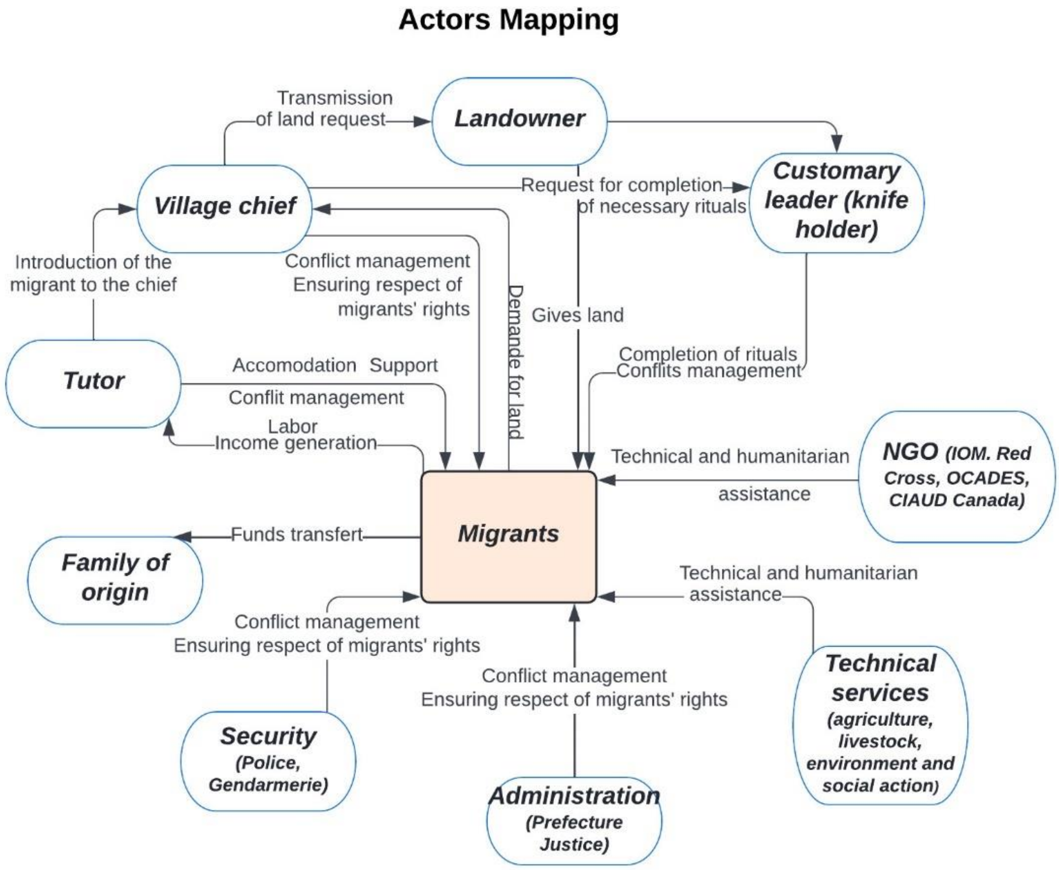


Figure 4.1: Actors Mapping
Source: Author’s construct

4.3 Migrants' Origins and Destinations

Discussions with stakeholders helped to identify the main origins and destinations of migrants. The discussions also made it possible to identify the main activities carried out by migrants in the destination areas. The main regions of origin of migrants in the provinces of Comoé and Ziro were classified from 1 to 3, with 1 corresponding to a small flow, 2 to a medium flow and 3 to a large flow. The same logic was applied to the departure provinces of Boulkiemde and Oubritenga in order to identify the main destination provinces. Figure 4.2 below summarises the regions of origin for migrants in the provinces of Comoe and Ziro (destination areas) and Figure 4.3 summarises destinations for migrants from Boulkiemde dans Oubritenga provinces (departure areas):

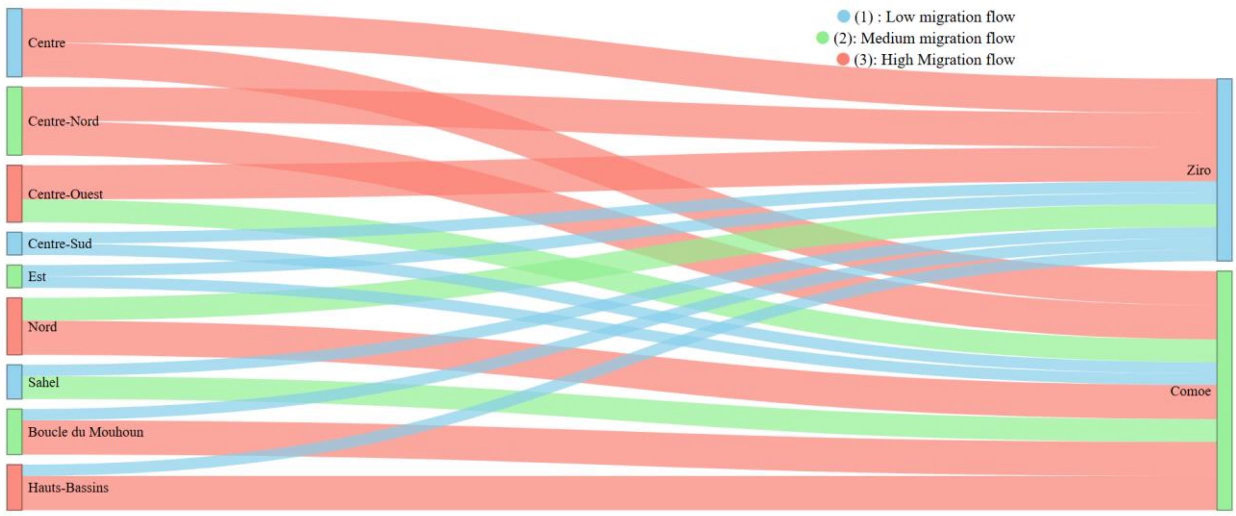


Figure 4.2: Mains origin of migrants in Comoé and Ziro provinces
Source: Author’s construct

The main regions of origin of migrants in the province of Comoé are the Centre, Haut-Bassin, North, Centre-North and North regions, each with a weight of 3, which corresponds to a large flow of migrants. In Ziro, migrants come mainly from the Centre, Centre-North and Centre-West regions. There are similarities and differences between these two provinces. Both provinces have large numbers of migrants from the Centre and Centre-North regions. They also both have small numbers of migrants from the East and Centre-Bassins regions which have many natives in the province of Comoé but very few in the province of Ziro.

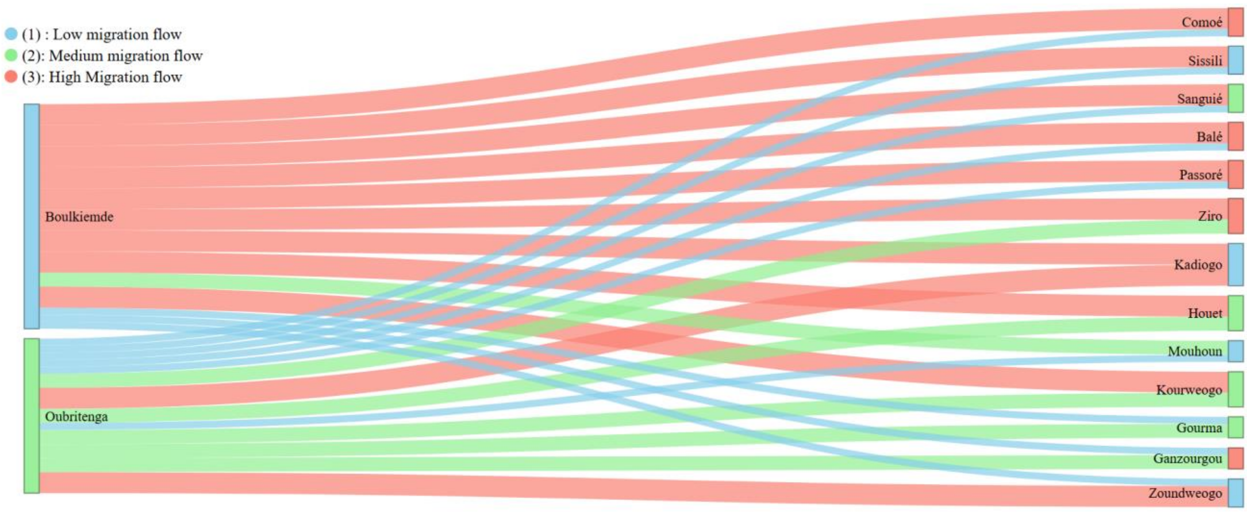


Figure 4.3: Mains destination of migrants from Boulkiemdé and Oubritenga provinces
Source: Author’s construct

In terms of destination, emigrants from the province of Boulkiemdé mainly go to the provinces of Ziro, Kadiogo, Houet, Sissili, Sanguié, Kadiogo and Passoré, each with a weight of 3. In Oubritenga, migrants mainly go to the provinces of Kadiogo, Zoundwéogo, Ziro and Houet, each with a weight of 3. There are also similarities between these two provinces. Each of these provinces sends a large number of migrants to Kadiogo, Ziro and Houet. But there are also differences: Zoundwéogo attracts many migrants from Oubritenga, whereas very few migrants from Oubritenga go there. The same is true of Sissili and Sanguié, as well as Passoré, which receive large numbers of migrants from Boulkiemdé, while few emigrants from Oubritenga go there.

4.4 Main Factors Driving Internal Migration

4.4.1 Push Factors in the Migrant's Departure Areas

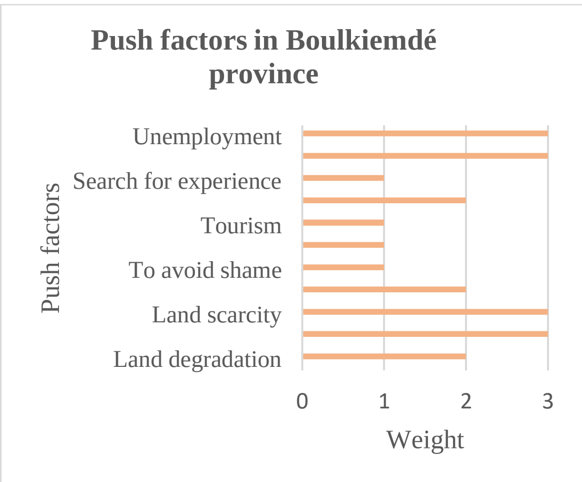
Figure 4.4 presents the push factors identified by stakeholders in the migrant departure areas. These factors include economic, socio-demographic, environmental and political. Poverty, unemployment, and land scarcity have been highlighted as key economic push factors. These findings align with recent studies showing that economic insecurity remains a primary driver of migration, particularly in rural areas with limited livelihood opportunities (Castelli, 2018; Czaika & Reinprecht, 2020). Nébié and West (2019), further show that land scarcity, often exacerbated by land degradation and unequal land access, has been a significant factor prompting rural migration in Burkina Faso. Similarly, Dolcerocca, (2022) highlights how land grabbing in densely populated regions of Burkina Faso is increasingly undermining rural livelihoods and traditional land tenure systems, thus contributing to emigration. This situation is further exacerbated by weak land governance and the commodification of land, which exacerbate social tensions and restrict local access to natural resources (Dolcerocca, 2022).

The appeal of informal activities such as gold panning has also been identified as a factor driving migration. This aligns with research on resource-driven migration, which highlights how individuals relocate in search of alternative income sources when formal employment opportunities are scarce (Hilson & Maconachie, 2020).

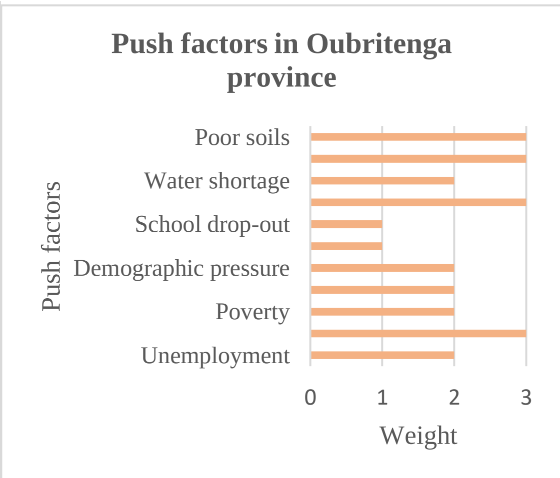
High population growth and social conflicts, including family disputes and banishment, have been reported to be significant socio-demographic factors in migration decisions. Rapid demographic growth exacerbates resource scarcity, increasing pressure on land, water, and employment, which in turn fuels migration (Gemenne & Blocher, 2016). Additionally, social conflicts and exclusion can also act as strong push factors, as individuals seek new environments where they can rebuild social ties or escape marginalisation (Carling & Talleraas, 2022). The study further highlights school dropout and the desire for adventure or new experiences as motivations for migration, particularly among young people. This aligns with research indicating that migration is often driven by aspirations for better educational or personal development opportunities, even when economic necessity is not the primary factor (De Haas et al., 2020).

Environmental factors such as drought, soil degradation, and declining water resources also play an important role in pushing people to migrate. Climate change has intensified these pressures, leading to reduced agricultural productivity and increasing the frequency of displacement in affected regions (Intergovernmental Panel on Climate Change (IPCC, 2023; McLeman, 2019). The link between environmental stress and migration has been widely documented, with studies showing that rural populations facing deteriorating environmental conditions often move toward urban areas in search of stability and alternative livelihoods (Borderon et al., 2019).

Political factors, including inadequate professional training and limited access to quality education, further contribute to migration. Weak investment in human capital and vocational training reduces employment prospects, pushing individuals toward regions with better opportunities (Clemens & Mendola, 2024; Mckenzie & Rapoport, 2010). Poor governance and ineffective policies in rural areas exacerbate these trends, reinforcing migration as a coping strategy (Adamson & Tsourapas, 2020).



a: Push factors in Boulkiemdé province



b: Push factors in Oubritenga province

Figure 4.4: Push factors in the Boulkiemdé and Oubritenga provinces
Source: Author

4.4.2 Pull Factors in Destination Areas

Figure 4.5 presents the push factors identified by stakeholders in the migrant destination areas. The discussions revealed that the factors encouraging the arrival of migrants are also social, economic, and environmental.

Migration is often influenced by a combination of push and pull factors, with destination areas offering opportunities that attract migrants. The study identifies favorable economic, social, environmental, and geographical factors as key drivers pulling migrants to these areas. These findings align with the broader literature on migration determinants, particularly in rural and semi-urban settings where economic opportunities and social networks play crucial roles (Haas et al., 2020; Czaika & Reinprecht, 2020).

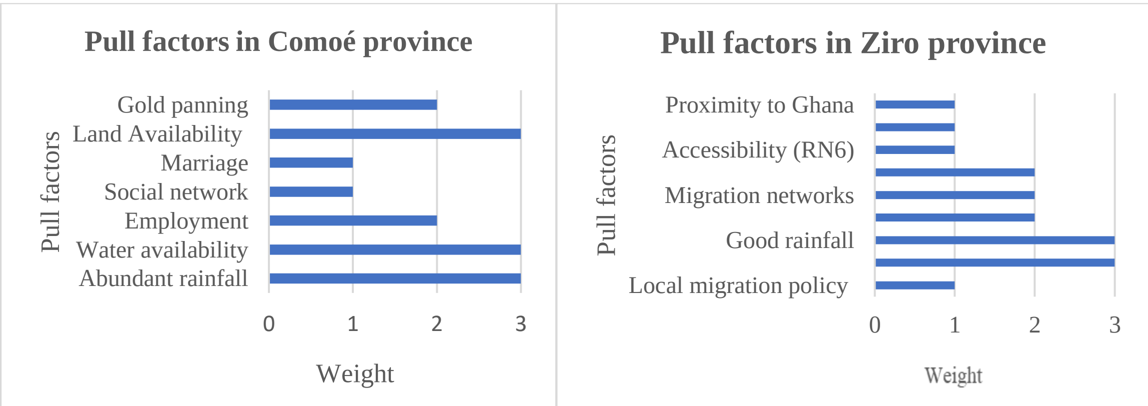
The presence of job opportunities, arable land, and a thriving trade sector in destination areas aligns with economic theories of migration, particularly the neoclassical perspective, which suggests that individuals migrate in response to wage differentials and employment opportunities (Harris & Todaro, 1970). The availability of gold panning sites as a pull factor supports findings from Hilson & Maconachie (2020), who highlight the role of artisanal mining in attracting labour migration, particularly in West Africa. Similarly, studies in sub-Saharan Africa have found that regions with agricultural potential and commercial activity often experience high levels of internal migration (Awumbila, 2017).

Social factors such as the presence of established migrant networks, local migration policies, and community hospitality play a crucial role in sustaining migration flows. The existence of social networks facilitates information sharing and reduces the risks associated with migration, making movement more accessible and attractive (Carling & Talleraas, 2022). Once migration patterns are established, networks perpetuate further movement by lowering costs and providing support structures for new arrivals (Dekker & Engbersen, 2012). Sha (2021) highlights that migrant network, consisting of kinship and friendship ties, act as social capital that reduces the risks and costs associated with migration, facilitating continued movement. These findings align with earlier research by Massey et al. (1993) while providing updated empirical evidence on the role of migrant networks in shaping migration flows. The role of marriage as a pull factor is consistent with findings from Yeung & Mu, (2020), who emphasize the significance of family and kinship ties in shaping migration decisions. Furthermore, local migration policies, such as those noted in Sapouy, indicate that institutional frameworks at the local level can influence migration trends, either by facilitating integration or imposing restrictions (Skeldon, 2018).

Environmental factors such as favorable rainfall, water availability, and arable land are also important drivers of migration to destination areas. This is in line with the environmental migration framework, which suggests that climate conditions shape human mobility, with people moving toward regions with better agricultural potential and stable water resources (IPCC, 2023; McLeman, 2019). Recent studies confirm that migration often follows patterns of resource availability, particularly in agrarian economies where rainfall variability significantly impacts livelihood security (Borderon et al., 2019).

The geographical accessibility of migration destinations, particularly via major road networks, plays a crucial role in shaping migration flows. The study highlights the strategic location of destination areas, with National Road 6 connecting Ouagadougou, Sapouy, and Léo to the Ghana border, while National Roads 1 and 7 link Ouagadougou to Bobo-Dioulasso and Bobo-Banfora to the Ivory Coast border. Research on migration corridors in West Africa suggests that well-developed road infrastructure facilitates movement, reduces migration costs, and significantly influences settlement patterns by linking rural areas to economic hubs (OECD/SWAC, 2025).

Overall, these findings align with established migration theories, particularly the push-pull framework (Lee, 1966), which suggests that migrants respond to the relative attractiveness of destinations based on economic opportunities, social support, environmental conditions, and accessibility.



a: Push factors in Boulkiemdé province

b: Push factors in Boulkiemdé province

Figure 4.5: Pull factors in the Comoé and Ziro provinces
Source: Author’s construct

4.4.3 Push Factors in the Next 20 Years

In order to identify these factors, participants were asked to project into the next 20 years whether the provinces of origin would remain departure zones or whether they would become destination zones. Their projections indicate that Oubritenga and Boulkiemdé will continue to experience significant out-migration, driven by environmental, economic, and political factors. These findings align with migration theories such as the push-pull model (Lee, 1966), environmental migration theory (McLeman, 2019), and structural migration perspectives (Skeldon, 2018), which highlight adverse conditions as key drivers of migration.

In Oubritenga province, drought and weak political incentives are expected to be the primary push factors. The impact of drought on migration has been widely documented, with climate change exacerbating land degradation and reducing agricultural productivity (Borderon et al., 2019; IPCC, 2023). Limited water resources further reinforces environmental stress, reinforcing findings that declining water availability contributes to rural exodus in sub-Saharan Africa (Rigaud et al., 2018). Additionally, the mention of insufficient incentives or political action suggests governance challenges, aligning with research indicating that weak institutional responses to climate change and economic hardship can intensify migration pressures (Czaika & Reinprecht, 2020).

In Boulkiemdé province, land shortages due to land grabbing, demographic growth, and the return of migrants, drought and unemployment are seen as critical push factors. Drought, a major environmental stressor, reduce agricultural productivity and worsens food insecurity, forcing residents, especially farmers, to migrate. This aligns with environmental migration studies that link arid conditions and climate variability to increased rural out-migration (IPCC, 2023). The scarcity of arable land is one of the most important drivers of migration in many African regions, particularly as land tenure conflicts and large-scale land acquisitions restrict access to farmland (Sullivana et al., 2023). The return of former migrants may also place additional pressure on land and resources, leading to new waves of out-migration. Demographic growth, coupled with limited employment opportunities and inadequate training, aligns with findings that rapid population increases in rural areas often drive young people to seek opportunities elsewhere (Sakketa, 2023). Moreover, unsuitable education and lack of job opportunities highlight structural economic challenges that push individuals toward migration, supporting findings that investment in vocational training and labour market policies can significantly reduce migration pressures (Anda-León et al., 2023).

Among these factors, drought and the insufficiency of political incentives were presented as the two most important factors of future repulsion in Oubritenga. In Boulkiemdé, insufficient land and unsuitable training were identified as the two most important factors of repulsion in the future.

4.4.4 Pull factors in the next 20 years

Looking ahead, participants in the destination areas projected that these regions will continue to attract migrants over the next 20 years. Their expectations align with migration theories, particularly the push-pull model (Lee, 1966) and structural migration theories (Skeldon, 2018), which emphasises the enduring role of economic opportunities, resource availability, and social integration in shaping migration flows.

In Comoé province, the anticipated pull factors include the expansion of integrated farms, processing industries, and agricultural potential, which indicate a shift toward a more structured and diversified rural economy. This aligns with studies showing that agribusiness development and value chain integration in rural Africa can create employment and encourage migration to farming regions (Brauw & Bulte, 2021; Losch, 2016). Additionally, gold panning remains a key driver of migration, consistent with previous findings that artisanal mining attracts large numbers of labour migrants in West Africa (Hilson & Maconachie, 2020). The combination of good rainfall and agricultural expansion suggests that climate conditions will continue to play a crucial role in sustaining livelihoods and attracting migrants, supporting research on environmental migration theory (IPCC, 2023; McLeman, 2019).

In Ziro province, migration is expected to persist due to land availability, relatively good rainfall, hospitality, and flourishing trade. The significance of land availability as a pull factor supports findings that regions with accessible farmland continue to attract migrants from overpopulated or land-scarce areas (Schürmann et al., 2022). Meanwhile, hospitality and social integration reflect the role of social capital in migration, reinforcing network-based migration theories (Y. Zhang et al., 2023), which argues that positive reception in host communities can enhance migration flows. Lastly, the growth of trade and commercial activities aligns with research showing that economic diversification beyond agriculture creates stable labour markets, making migration more attractive (Awumbila, 2017).

The two most important pull factors in the future, in the opinion of stakeholders in Comoé, are rainfall and gold panning. In Ziro, on the other hand, relatively good rainfall and the availability of land are seen as the two most important factors.

4.5 Impacts of Migration

Discussions with workshop participants revealed that migration has both positive and negative impacts.

4.5.1 Positive Impacts of Migration

In the areas of departure, the workshop participants felt that migration had many advantages for the people who stayed behind. In departure areas, migration enhances economic stability and household well-being, primarily through remittances. These financial transfers help cover daily expenses, repay debts, fund children's education, and improve healthcare access, reinforcing findings that remittances strengthen socio-economic resilience in migrant-sending regions (Adams & Cuecuecha, 2013; Ratha et al., 2019).

Additionally, returning migrants drive rural development by investing in livestock, creating jobs, and improving infrastructure. Their contributions enhance agricultural productivity, boost local employment, and support housing upgrades, trends observed in many migrant-dependent economies (Clemens & Ogden, 2019; Dabiré & Soumahoro, 2024). Migration also facilitates knowledge transfer, with migrants introducing modern farming techniques and business practices, aligning with research on migration-driven skill acquisition and technology adoption (Gibson & Mckenzie, 2012).

Beyond economic benefits, migration reinforces family bonds through sustained financial and emotional support. Its role in strengthening intergenerational ties and enhancing living conditions is widely documented in migration literature (Bernard & Perales, 2024).

In destination areas, migration catalyses economic growth. Migrant labour boosts agricultural production, consistent with studies showing that migrants play a crucial role in labour-intensive sectors, particularly in rural economies (Brauw & Giles, 2018). Migration also stimulates trade, enhances food security, and improves nutritional conditions in host regions. The strong work ethic of Mossi migrants, as highlighted by participants, reflects broader migration studies that emphasize migrants' adaptability and industriousness (Van Hear, 2014).

4.5.2 Negative Impacts of Migration

Despite its benefits, migration also has social, economic, and environmental drawbacks. In departure areas, the loss of able-bodied workers, especially young migrants, leads to labour shortages in local economies. This aligns with findings that rural-urban migration can weaken agricultural productivity and increase dependency ratios in origin areas (Losch, 2016). Migration also disrupts family structures, with prolonged separations contributing to marital conflicts, household instability, and children dropping out of school. Additionally, the erosion of cultural traditions due to migration is a well-documented concern, as younger generations become detached from local customs and language (Atobatele & Mouboua, 2024; Popescu & Pudelko, 2024). For migrants themselves, health risks and economic insecurity pose major challenges. Many migrants return home ill and impoverished, highlighting the precarious nature of informal labour migration, where lack of healthcare access and social protection increases vulnerability (Hagose et al., 2023; Kunpeuk et al., 2022). The exploitation of migrants, including low wages, property dispossession, and unsafe working conditions, aligns with global findings on migrant labour abuses (Alffram et al., 2023; International Labour Organization, 2021). In destination areas, migration can strain social cohesion due to cultural clashes and demographic pressures. Participants noted that non-compliance with local customs can lead to social tensions, a common issue in migration studies where cultural integration varies across host communities (Portes & Rumbaut, 2014). Linguistic changes, such as the dominance of Morée over Nouni in Ziro, highlight how migration influences language shifts and cultural assimilation (Maitz, 2014; Thomason, 2015). The environmental impacts of migration, particularly land conflicts and resource depletion have, align with research on migration-induced land tenure disputes and environmental degradation (Cotula et al., 2019; IPCC, 2023). Participants specifically mentioned land expropriation, deforestation, and pollution linked to gold panning, reinforcing studies that link informal mining to soil degradation and water contamination (Hilson et al., 2017).

4.6 Local Scenarios Developed from the Stakeholders' Point of View

The scenarios were constructed based on the two push and pull factors considered to be the most important over the next 20 years. Table 4.1 shows the two push factors in each departure zone and the two pull factors in each destination zone, for the next 20 years.

Table 4.1: The two main push and pull factors over the next 20 years in each province

Provinces	Type of factors	1st factor	2nd factor
Oubritenga	Push factor	Drought	Incentive or political actions
Boulkiemdé	Push factor	Lands availability	Inadequate training
Comoé	Pull factor	Good rainfall	Gold panning
Ziro	Pull factor	Good rainfall	Land availability

Source: Author's construct

In each province, the two most important push or pull factors over the next 20 years were used to develop 4 scenarios. Figure 4.6 show the scenarios developed for each site.

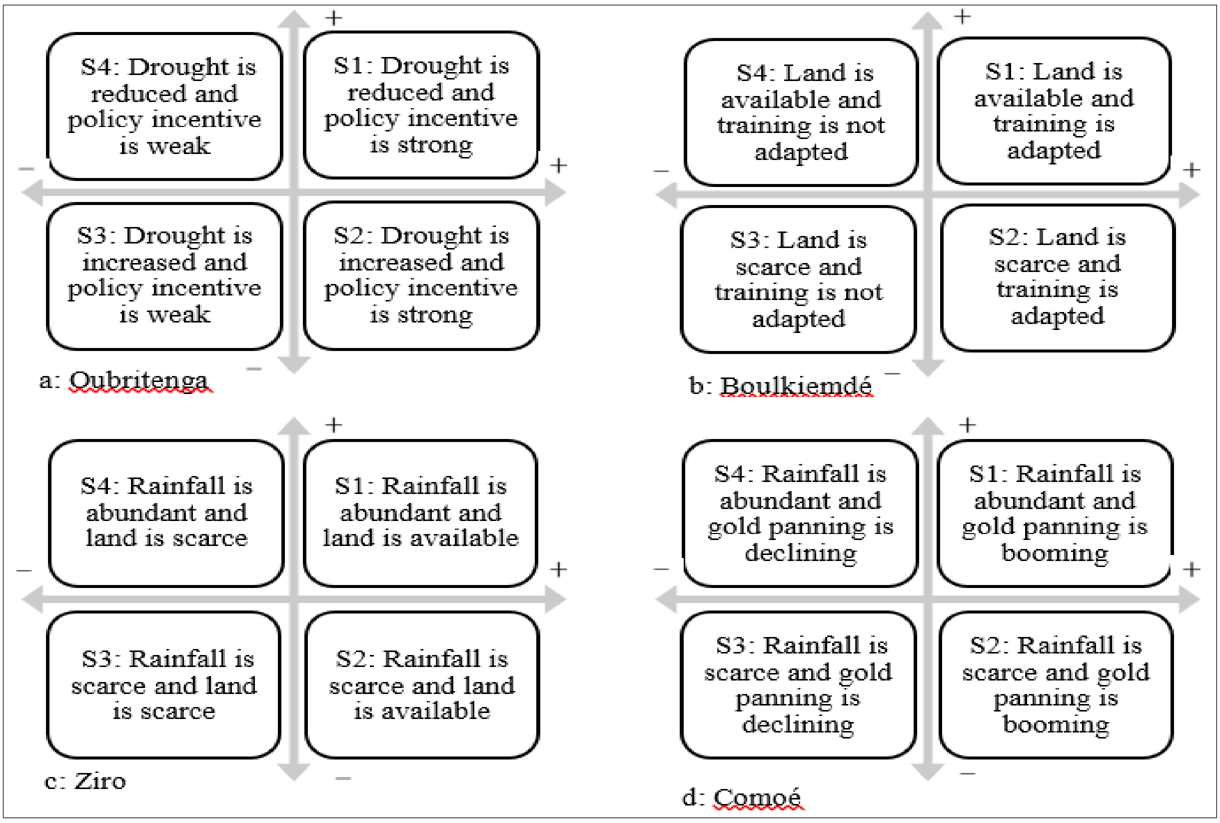


Figure 4.6: Local Scenarios for migration in the study sites
Source: Author's construct

The four scenarios developed for each province (Figure 4.6) provide a framework for assessing how migration trends might evolve over the next two decades, depending on environmental, economic, and political conditions. This type of scenario-based approach aligns with migration forecasting models used in environmental and economic migration studies (Czaika & Reinprecht, 2020; Rigaud et al., 2018). By analysing different combinations of climate conditions, land availability, policy responses, and economic opportunities, these scenarios help anticipate potential migration pressures and responses.

i. Oubritenga Province (a): The Role of Drought and Political Incentives

The four scenarios for Oubritenga (**a**) emphasise the interplay between climate conditions (drought) and governance (political incentives) in shaping migration dynamics. Scenario S3 (worsened drought + weak political incentive) represents the most critical push factor combination, likely exacerbating out-migration due to worsening agricultural conditions, food insecurity, and lack of institutional support. This aligns with studies indicating that drought intensification in politically unstable regions significantly accelerates rural exodus (IPCC, 2023).

Conversely, S1 (reduced drought + strong political incentive) presents an optimal scenario for migration reduction, suggesting that climate adaptation strategies combined with effective governance could enhance resilience and limit forced migration (O’Brien & Barnett, 2013). These findings reinforce the importance of investment in climate resilience policies, water resource management, and economic incentives to retain populations in rural areas.

ii. Boulkiemdé Province (b): Land Availability and Training Adaptation

In Boulkiemdé, the four scenarios (**b**) highlight the impact of land accessibility and vocational training quality on migration decisions. S3 (land scarcity + inadequate training) represents the most challenging scenario, likely increasing youth out-migration due to restricted agricultural livelihoods and limited job market integration (Baumüller et al., 2025). Research shows that land scarcity often triggers migration in agrarian economies, as individuals relocate to areas with better land tenure security and economic prospects (Benson et al., 2017).

On the other hand, S1 (land availability + adapted training) offers an ideal scenario, where improved education and agricultural land access support local economic development and reduce migration pressures. This underscores the need for land tenure reforms and skills-based training programs as migration mitigation strategies (Lawry et al., 2023).

iii. Ziro Province (c): Rainfall and Land Availability as Migration Determinants

For Ziro, the four scenarios (**c**) assess the interaction between climate conditions (rainfall levels) and land accessibility. S3 (scarce rainfall + scarce land) is the most concerning scenario, as water shortages and land pressure directly threaten agricultural livelihoods, making migration a necessary survival strategy (Rigaud et al., 2018). This scenario is consistent with environmental migration theories that emphasize how climate variability and land degradation drive population displacement (McLeman, 2019).

Conversely, S1 (abundant rainfall + available land) presents an optimal scenario where sufficient resources reduce migration incentives, supporting findings that stable environmental conditions and land security contribute to population retention in rural economies (Borderon et al., 2019).

iv. Comoé Province (d): Rainfall and Gold Panning as Economic Drivers

In Comoé, migration patterns are economically driven, influenced by gold panning and rainfall patterns. S3 (scarce rainfall + declining gold panning) presents the greatest risk for increased migration, as both agriculture and mining livelihoods would be compromised, leading to economic distress and forced movement (Hilson et al., 2013). Research indicates that gold panning serves as a major informal employment sector in West Africa, attracting large numbers of migrants (Hilson & Maconachie, 2020), and a downturn in this sector could significantly impact migration flows.

S1 (abundant rainfall + booming gold panning), on the other hand, would likely result in higher in-migration, as both agriculture and artisanal mining offer viable economic opportunities. This scenario highlights the role of resource-based migration, where individuals move in response to economic prosperity rather than distress (Awumbila, 2017).

4.7 Summary

This study confirms that migration is a complex and dynamic process shaped by economic, social, demographic, and environmental factors. The push-pull framework proposed by Lee (1966) remains relevant for understanding migration patterns, as it captures the interplay between adverse conditions in areas of origin and opportunities in destination areas. In regions of departure, poverty, unemployment, land scarcity, and environmental stressors such as drought and land degradation emerge as key drivers of migration. Meanwhile, destination areas attract migrants through better economic prospects, access to arable land, more favourable climatic conditions, and established social networks that facilitate integration. Rather than being a response to isolated factors, migration is shaped by the interaction of multiple economic and environmental pressures. The participatory approach adopted in this study has provided valuable insights into local perceptions of migration, capturing nuanced realities that conventional analyses may overlook. By involving local stakeholders, the study has generated scenarios that illustrate potential migration trends under different socio-economic and environmental conditions. Favourable scenarios suggest a decrease in outmigration as conditions improve in areas of origin, while unfavourable scenarios indicate that migrants continue to move despite environmental and economic challenges, drawn by the relative advantages of destination regions. Overall, the findings underscore the interconnected nature of migration drivers and the need for a contextualized understanding of mobility trends. Addressing migration effectively requires recognising both the structural constraints in areas of origin and the opportunities that shape settlement patterns in destination regions.

CHAPTER 5

ASSESSING THE IMPACT OF INTERNAL MIGRATION ON THE HOUSEHOLD WELFARE OF CLIMATE-INDUCED MIGRANT HOUSEHOLDS IN BURKINA FASO

5.1 Introduction

Chapter Five analyses how climate-induced internal migration affects household wellbeing in Burkina Faso. It presents and discusses the results of descriptive statistics, including Pearson's Chi-square test, which measures the association between internal migration and climate variables, and the t-test, which compares socio-economic and climate variables between migrants and non-migrants. The chapter then presents empirical findings, detailing the drivers of climate-induced internal migration and the determinants of outcome variables.

5.2 Association between Internal Migration and Climate-induced Variables

Table 5.1 provides data on the association between internal migration and various climate-related variables, using Pearson Chi-square tests to assess the significance of these relationships as well as the key implications of the findings presented: Inadequate Rainfall: shows a significant association between internal migration and inadequate rainfall ($p < 0.01$). Migrants are more likely to come from areas with inadequate rainfall (94.18%) than non-migrants (5.82%). This suggests that rainfall shortages may be a critical driver of migration, potentially due to its impact on agricultural productivity and livelihoods. Poor Soils indicate a significant relationship between poor soils and migration ($p < 0.01$). A higher percentage of migrants (93.56%) come from areas with poor soil conditions. This implies that soil fertility problems contribute to internal migration as people move in search of more arable land or better economic opportunities. Also, Persistent Drought is another climate factor closely linked to migration. The report highlights that 97.39% of migrants come from areas experiencing persistent drought ($p < 0.01$). Drought impacts agriculture, which could force people to migrate in search of better livelihoods.

The relationship between land degradation and migration is also significant ($p < 0.01$). This implies that areas suffering from land degradation see a higher proportion of migrants (96.12%), which further emphasizes the environmental challenges driving migration. Meanwhile, extreme weather conditions show a notable association with migration ($p < 0.05$). About 87.80% of migrants come from areas affected by extreme weather, compared to 70.58% of non-migrants. Inadequate Farmlands and Water Scarcity also show a significant relationship of ($p < 0.01$) and ($p < 0.05$) with migration respectively. This also confirms that the majority of migrants come from areas with these challenges, reinforcing the role of resource scarcity in driving migration. While wildfires, floods, and erosion show high percentages of migrants from affected areas, the associations are not statistically significant. This indicates that, while these factors may be present in migration-prone regions, they are not as strong drivers as other variables like drought or poor soil. Poor Crop Yields as well as Insufficient Resources: Poor crop yields, insufficient natural pasture, water for animals, and precipitation show highly significant relationships with migration ($p < 0.01$). Migrants overwhelmingly come from areas where these agricultural resources are lacking, pointing to the pressures that reduced agricultural productivity places on households, leading them to migrate. The table indicates that soil infertility is strongly associated with migration ($p < 0.01$), with 95.65% of migrants coming from areas where this problem is prevalent. Overall, the Environmental Stressors findings suggest that particularly those affecting agricultural productivity, are key drivers of internal migration. Inadequate rainfall, soil degradation, and persistent drought are especially influential. The data implies the need for targeted policies that address climate-related vulnerabilities, particularly in regions experiencing severe droughts, poor soils, and resource scarcities. Hence, the strong association between migration and environmental degradation highlights the urgency for promoting sustainable agricultural practices, such as soil conservation and water management, to reduce the need for migration.

Table 5.1: Association between internal migration and climate-related variables

Climate variables	Status of migration			Pearson Chi-square
	Non-Migrants N=138 (27.99%)	Migrants N=355 (72.01%)	Total	
Inadequate rainfall				
No	127	177	304	74.7520***
	41.78	58.22	100.00	
Yes	11	178	189	
Total	5.82	94.18	100.00	
Poor soils				
No	125	166	291	78.8929***
	42.96	57.04	100.00	
Yes	13	189	202	
Total	6.44	93.56	100.00	
Persistent drought				
No	135	243	378	47.9437***
	35.71	64.29	100.00	
Yes	3	112	115	
Total	2.61	97.39	100.00	
Land degradation				
No	134	256	390	37.5442***
	34.36	65.64	100.00	
Yes	4	99	103	
Total	3.88	96.12	100.00	
Extreme weather conditions				
No	133	319	452	5.5362**
	29.42	70.58	100.00	
Yes	5	36	41	
Total	12.20	87.80	100.00	
Inadequate farmlands				16.8143***
No	136	305	441	
	30.84	69.16	100.00	
Yes	2	50	52	
Total	3.85	96.15	100.00	
Scarcity of water				
No	136	331	467	5.6113**
	29.12	70.88	100.00	
Yes	2	24	26	
Total	7.69	92.31	100.00	
Wildfires				
No	138	351	489	1.5676
	28.22	71.78	100.00	
Yes	0	4	4	
Total	0.00	100.00	100.00	
Floods				
No	138	351	489	1.5676
	28.22	71.78	100.00	
Yes	0	4	4	
Total	0.00	100.00	100.00	
Erosion				
No	138	350	488	1.9636
	28.28	71.72	100.00	
Yes	0	5	5	
Total	0.00	100.00	100.00	
Poor crop yields				
No	127	150	277	100.0119***

	45.85	54.15	100.00	
Yes	11	205	216	
Total	5.09	94.91	100.00	
Insufficient natural pasture				
No	133	312	445	14.0043***
	29.89	70.11	100.00	
Yes	5	43	48	
Total	10.42	89.58	100.00	
Insufficient water for animals				
No	133	312	445	8.1492***
	29.89	70.11	100.00	
Yes	5	43	48	
Total	10.42	89.58	100.00	
Insufficient precipitation				
No	131	290	421	13.9619***
	31.12	68.88	100.00	
Yes	7	65	72	
Total	9.72	90.28	100.00	
Soil infertility				
No	135	289	424	22.2516***
	31.84	68.16	100.00	
Yes	3	66	69	
Total	4.35	95.65	100.00	

*** denotes significance at 1% level, ** denotes significance at 5% level, * denotes significance at 10% level

Source: Authors' computations

5.3 Descriptive Statistics of Variables used in the Regression Models

Table 5.2 describes the socioeconomic and climate variables associated with migration, comparing characteristics between migrants and non-migrants. Based on the table, Total Value of Assets: Migrants tend to have higher asset values (mean = 1256.65) compared to non-migrants (mean = 719.58). However, the mean difference (-537.07) is statistically significant, implying that non-migrants hold significantly fewer assets than migrants. This suggests that migration could be a strategy employed by wealthier individuals or families to protect or increase their assets. Migrants are significantly older (mean = 50.27 years) than non-migrants (mean = 43.08 years), with a mean difference of -7.19. This indicates that migration might be more common among older individuals, possibly because they have had more time to accumulate resources, build family networks, or develop a greater need for relocation to improve livelihoods. Also, the average level of education is much higher among non-migrants (mean = 4.91) compared to migrants (mean = 2.04), with a significant mean difference of 2.87. This suggests that less-educated individuals are more likely to migrate, potentially seeking opportunities that they cannot access locally due to their lower education levels. For Family Structure, migrants tend to have more dependents (mean = 9.74) than non-migrants (mean = 7.14), with a significant difference of -2.60. This suggests that larger family sizes might drive migration, possibly as a survival strategy to secure more resources or improve living conditions for dependents.

Similarly, migrants have more under-aged members in their families and more adults, which could indicate higher responsibilities and a need for better income-generating opportunities through migration. Non-migrants are more likely to be employed (mean = 0.82) as compared to migrants (mean = 0.68). The mean difference of 0.14 suggests that migration could be motivated by a lack of stable employment in origin areas, with individuals moving to seek better job prospects. Moreso, migrants are much more likely to have migration experience (mean = 0.71) compared to non-migrants (mean = 0.13), with a large mean difference of -0.58. This points to a cycle where those with prior migration experience are more likely to migrate again. The significant difference in skills acquisition (-0.07) indicates that migrants may move to enhance their skills, which could provide better economic opportunities elsewhere. Migrants have significantly larger farm sizes (mean = 2.65 hectares) than non-migrants (mean = 0.46 hectares). This suggests that migration might be a strategy employed by those with more extensive agricultural investments to either expand their operations or find better land conditions. Livestock ownership is slightly higher among migrants (mean = 0.48) as compared to non-migrants (mean = 0.38), further emphasizing that migrants tend to have more agricultural assets.

Exclusion Restriction Variable: The distance from destination to origin is much greater for migrants (mean = 291.53) as compared to non-migrants (mean = 92.22). This large mean difference (-199.30) implies that migrants travel much farther, suggesting that migration is a significant decision likely driven by large-scale economic or environmental challenges. Climate Variables and Migration such as Insufficient Water for Animals suggest that migrants are more likely to face challenges related to water scarcity for animals (mean = 0.12) than non-migrants (mean = 0.04). This implies that climate-induced water shortages may be pushing people to migrate. The significant difference in the scarcity of water between migrants (mean = 0.07) and non-migrants (mean = 0.01) shows that water shortages in general are a key factor driving migration. Also, migrants are more likely to come from areas experiencing persistent drought (mean = 0.32) than non-migrants (mean = 0.02), highlighting the role of drought in driving migration, likely because of its severe impact on agricultural productivity and livelihoods. Migrants are also more likely to be from regions with inadequate farmlands (mean = 0.14) and infertile soils (mean = 0.19), both of which significantly differ from non-migrants (means = 0.01 and 0.02, respectively), suggesting that deteriorating land quality is a crucial factor in the decision to migrate. Finally, migrants appear to have more agricultural assets but face significant environmental challenges. Migration may be seen as an economic strategy to mitigate risks associated with climate variability, seek better employment opportunities, and expand agricultural operations while climate factors, water scarcity, drought, and soil infertility are major drivers of migration, underscoring the critical role of climate change in shaping migration patterns. Adaptation measures, such as improving water access, enhancing soil fertility, and increasing farm productivity, could reduce migration pressures.

Table 5.2: Descriptive characteristics of variables used in the regression models

Variables	Definitions of variables	Migrants N=355 (72.01%)		Non-Migrants N=138(27.99%)		Mean Difference
		Mean	SD	Mean	SD	
Outcome variables						
Total value of assets	Value of Household accumulated assets including livestock, farmland, vehicles in dollars	1256.65	2791.20	719.5789	1169.40	-537.07**
Remittances	Value of remittances in dollars	205.44	400	69.17	201.13	-136.27***
Socioeconomic variables						
Age	Number of years of respondents	50.27	13.68	43.08	12.92	-7.19***
Age squared	(Age x Age)/100	27.13	14.22	20.22	11.60149	-6.92***
Gender	1 if the respondent is a Male, 0 otherwise.	0.90	0.02	0.94	0.02	0.04
Education	Number of years of formal education	2.04	3.88	4.91	5.28	2.87***
Number of under-age	Number of members in the household who are less than 18 years	4.131	3.67	3.07	3.03	-1.05***
Number of Adult	Number of members of the household aged 18 or over	5.67	4.39	4.36	3.19	-1.32***
Number of dependents	Count of individuals who rely on the head of household	9.74	7.04	7.14	5.67	-2.60***
Employment status	1 if the respondent is employed, 0 otherwise.	0.682	0.47	0.82	0.39	0.14***
Number of years Migration	Number of years spent in the current destination	56.17	539.77	2.86	7.10	-53.31
Migration experience	1 if it’s the respondent's first time migrating, 0 otherwise.	0.71	0.46	0.13	0.34	-0.58***
Sociocultural links	1 if respondents have Sociocultural links, 0 otherwise	0.076	0.27	0.029	0.17	-0.05*

Lack of commercial opportunities	1 Lack of commercial activities, 0 otherwise	0.13	0.33	0.07	0.26	-0.05*
Skills acquisition	1 if the respondent has acquired skills, 0 otherwise.	0.10	0.30	0.04	0.19	-0.07**
Farm size	Cropland area in hectares	2.65	6.01	0.46	2.40	-2.19***
Livestock	Number of live stocked	0.48	0.50	0.38	0.49	-0.09*
Climate Variables						
Insufficient water for animals	1 if respondents have experienced insufficient water for animals, 0 otherwise.	0.12	0.33	0.04	0.19	-0.08***
Scarcity of water	1 if respondents have water scarcity, 0 otherwise	0.07	0.25	0.01	0.12	-0.05**
Persistent drought	1 if respondents have experienced persistent drought, 0 otherwise	0.32	0.47	0.02	0.15	-0.29***
Inadequate farmlands	1 if respondents have inadequate farmlands, 0 otherwise	0.14	0.35	0.01	0.12	-0.13***
Soil infertility	1 if respondents have soil infertility, 0 otherwise	0.19	0.39	0.02	0.15	-0.16***
Exclusion Restriction						
Distance from Destination to Origin	Distance from the destination to the origin of migrants	291.53	191.64	92.22	192.91	-199.30***

*** denotes significance at 1% level, ** denotes significance at 5% level, * denotes significance at 10% level
Source: Author's computations; Conversation rate: 1 dollar=625 FCFA

5.4 Empirical results

5.4.1 Factors Influencing Climate-induced Internal Migration

Table 5.3 presents the results of both selection and outcome model analysing the drivers of internal migration among destination households., with the following significant variables emerging:

Education of migrants has a negative and significant impact on migration, suggesting that higher education levels reduce the likelihood of migration. This reflects that better-educated individuals are more likely to find opportunities in their place of origin, reducing their need to migrate. Studies have shown that education can be a key factor in retaining individuals in local areas, especially where economic conditions allow for professional employment (Asad & Garip, 2019). Furthermore, better education often correlates with a stronger social safety net, reducing the pressure to migrate for economic reasons. The number of years an individual has spent migrating has a positive and significant coefficient, indicating that the longer an individual has been migrating, the more likely they are to continue migrating internally. This might suggest a form of path dependency, where initial migration leads to further relocations due to accumulated knowledge and social networks in new regions (Charles-Edwards et al., 2019).

Once individuals gain migration experience, they are better equipped to navigate challenges, making future migrations more probable. Also, experience with initial migration is highly significant, with a strong positive effect, suggesting that having experience with an initial migration significantly increases the likelihood of subsequent migrations. Early migration could provide individuals with crucial skills and networks, lowering the barriers to future moves. Evidence suggests that early exposure to migration increases mobility later in life (Bryceson & Vuorela, 2020). The findings also reveal a significant positive relationship between sociocultural links and migration. This suggests that migrants are more likely to relocate to areas where they have existing networks of friends or family. These findings align with the literature on "migration networks", which shows that social ties play a crucial role in providing support and reducing risks for migrants (Silva & Massey, 2015). Thus, strong sociocultural links can act as a "pull factor," drawing individuals toward familiar areas. Moreso, the lack of commercial opportunities harms migration, indicating that when there are fewer economic opportunities in the origin location, people are less likely to migrate. This might seem counterintuitive, but it reflects a common trend where limited resources may trap individuals in place, making migration financially impossible. Recent research in migration economics has discussed the concept of "immobility poverty," where the poorest individuals are unable to migrate due to a lack of resources (Hein De Haas, 2021). The exclusion restriction variable ‘Distance from Destination to Origin’ revealed a positive coefficient for distance indicating that longer distances between origin and destination increase the likelihood of migration. This result may indicate that distance alone is not a major deterrent to migration when there are other compelling factors such as better opportunities or stronger social links at the destination (Lichner et al., 2024).

Climate-related variables significantly affect migration, highlighting how environmental stressors, especially in rural agricultural communities, impact migration decisions. The variable ‘Insufficient water for animals’ has a significant negative effect on migration, meaning that areas experiencing water scarcity for livestock are less likely to see migration. This could indicate that migration is not an immediate option for individuals in these areas, likely due to the severe impact on livelihoods, which may trap them in place. Similarly, scarcity of water’s negative effect is seen with water scarcity in general, indicating that water shortages significantly reduce the likelihood of migration. Again, this may reflect the concept of "trapped populations," where extreme resource scarcity makes migration more difficult (Cattaneo & Peri, 2016). However, persistent drought has a strong positive effect on migration. This implies that drought conditions are a major driver of migration, likely due to the devastating impacts on agriculture and livelihoods. Inadequate farmlands also significantly increase the likelihood of migration. This suggests that when people can no longer sustain themselves through farming due to land limitations, they are more likely to migrate in search of better agricultural opportunities or non-farming employment. Lastly, soil infertility is another significant factor driving migration, which reflects the critical role that land quality plays in sustaining rural livelihoods. As soil fertility declines, migration becomes a necessary strategy to cope with reduced agricultural productivity (Pankhurst et al., 2013).

These results point to a complex interaction between socioeconomic, environmental, and network factors that influence internal migration. This emphasizes the importance of addressing both economic and environmental drivers to manage migration flows effectively.

Table 5.3: Drivers of internal migration by destination households

Variables	Selection	Outcome (Total value of assets)		Outcome (Value of remittances)	
		Migrants N=355 (72.01%)	Non-migrants N=138(27.99 %)	Migrants N=355 (72.01%)	Non-migrants N=138(27.99 %)
Socioeconomic factors					
Age	-0.0046	0.203**	-0.284**	0.37	-0.03
	(0.0350)	(0.095)	(0.113)	0.26	0.21
Age squared	0.0055	-0.214**	0.268**	-0.27	-0.02
	(0.0358)	(0.100)	(0.116)	0.27	0.23
Gender	-0.0895	1.205	0.686	-0.31	0.63
	(0.3228)	(1.215)	(1.331)	2.27	1.94
Education	-0.0512**	0.036	-0.058	0.24	-0.05
	(0.0200)	(0.046)	(0.057)	0.14	0.11
Number of Minors	0.0699	-0.186	0.185	-0.03	0.01
	(0.0475)	(0.130)	(0.157)	0.33	0.28
Number of adults	0.0410	0.021	-0.087	-0.28	-0.01
	(0.0414)	(0.100)	0.121	0.26	0.21
Number of dependents	-0.0223	0.102	-0.025	0.21	0.02
	(0.0380)	(0.084)	(0.109)	0.23	0.18
Employment status	0.3456	-0.284	0.660	-0.78	0.98
	(0.2584)	(0.668)	(0.736)	1.44	0.26
Number of years of migration	0.0883***	-0.284**	0.305**	-1.07***	1.02***
	(0.0154)	(0.121)	(0.123)	0.31	0.30
Migration experience	1.1725***	-2.463	2.099	-4.74	5.25
	(0.2287)	(1.821)	(1.960)	3.617	3.36
Socio-cultural links	1.1576**	0.724	-0.713	-16.15***	16.07***
	(0.5035)	(1.377)	(1.524)	4.010	3.632
Lack of commercial opportunities	-0.6756**	2.322	-2.521	-0.793	2.394
	(0.3019)	(1.728)	(1.876)	3.61	3.23
Skills acquisition	0.2766	2.636	-2.687	-6.74**	7.78**
	(0.3567)	(1.689)	(1.863)	3.42	3.03
Farm size in hectares	-0.0332	0.308	-0.306	0.64	-0.56
	(0.0261)	(0.196)	(0.200)	0.45	0.43
Livestock	0.2609	-1.100**	1.559***	1.86	-1.01
	(0.1789)	(0.450)	(0.533)	1.14	0.94
Climatic factors					
Insufficient water for animals	-0.9843**	2.297*	-1.575	0.395	-1.264
	(0.4479)	(1.390)	(1.495)	3.802	3.583
Scarcity of water	-1.4130**	1.751	-1.442	12.793	-13.601
	(0.6005)	(5.070)	(5.330)	14.810	14.338
Persistent drought	1.2965***	-2.830	2.999	-12.366	10.778
	(0.4547)	(3.428)	(3.504)	10.267	10.115
Inadequate farmlands	0.9041**	-2.663	2.799	-15.008	15.873
	(0.4385)	(3.714)	(3.871)	11.683	11.293
Soil infertility	0.9011**	0.510	-1.144	-5.218	4.837
	(0.3557)	(2.487)	(2.599)	5.932	5.669

Exclusion restriction					
Distance from Destination to Origin	0.0013***				
	(0.0005)				
Constant	-1.6425*	1.097	6.025	-2.367	1.289
	(0.9066)	(2.276)	(2.780)	6.187	4.891
Statistics					
Test of observable heterogeneity	0.06				
Test of essential heterogeneity	0.17				
Observations	493				

*** denotes significance at 1% level, ** denotes significance at 5% level,* denotes significance at 10% level

Source: Authors' computations

5.4.2 Determinants of the Outcome Variables

The text outlines the determinants of the total value of assets and remittances for migrants and non-migrants in relation to various socioeconomic and climate variables. For migrants, age has a significant positive influence on the total value of assets, while for non-migrants, it has a negative influence. This implies that older migrants tend to accumulate more assets, potentially due to experience and savings built up over time. In contrast, non-migrants may experience reduced asset accumulation with age, possibly due to fewer economic opportunities in their static environment. This suggests the importance of migration as a strategy for wealth accumulation (Vallejo & Keister, 2020). However, age squared shows a significant negative relationship for migrants and a positive one for non-migrants. This implies that the relationship between age and asset accumulation is nonlinear. For migrants, there may be diminishing returns to asset accumulation with age, while non-migrants may observe a slight increase in asset value as they age. This can be linked to the fact that as migrants grow older, they may send remittances or retire, which could reduce their asset accumulation.

Gender, Education, Number of dependents and Employment Status, none of these factors show significant effect for either group. These variables do not appear to significantly influence asset accumulation. However, the non-significance of these factors may point to the structural challenges that both groups face, regardless of gender or education level, highlighting that asset accumulation might be more closely tied to mobility and migration than to these demographic variables (Eroglu-Hawksworth, 2021; Vaira-lucero, 2012).

Migration experience shows a significant negative influence on the total value of assets for migrants, though it is not significant for non-migrants. Years of migration is also significant for both groups but with different effects. This suggests that while short-term migration might boost asset accumulation (since years of migration positively affects non-migrants asset accumulation), long-term migration could have diminishing returns or adverse effects, possibly due to adaptation challenges or high costs associated with long-term migration (Dustmann & Görlach, 2016). Additionally, Livestock ownership shows a significant negative effect for migrants and a positive effect for non-migrants. For non-migrants, livestock is an important asset class, contributing to their overall wealth. However, for migrants, livestock ownership might not be as significant, possibly because they invest more in other forms of assets or they face challenges in maintaining livestock while migrating.

In the case of the climate variables, insufficient water for animals: migrants who experience water scarcity have a significant positive impact on their total asset value, while for non-migrants, this effect is negative. This indicates that migrants facing water shortages for animals might diversify their income sources, such as selling livestock, leading to temporary asset growth. Non-migrants, in contrast, may be more reliant on livestock and thus experience losses when facing water shortages (Clemens & Pritchett, 2019). Persistent drought and inadequate farmland show no significant results for both groups, although their coefficients indicate potential impacts. The lack of significance may suggest that both groups are somewhat resilient to these climate variables or have developed coping mechanisms. However, these factors still carry high economic risk, especially for agricultural-dependent communities.

In the case of remittances, the number of years of migration indicates that the longer migrants are away from their households, the less likely they are to remit, according to a negative and significant association at 1%. As time goes on, migrants might encounter fewer financial responsibilities to their households, forge closer bonds with their host communities, or deal with rising personal expenses like relocating permanently or starting a family of their own (Mcmillan, 2020). Meanwhile, remittances received increase with the duration of migration, according to a positive and significant connection at 1% for non-migrants. The migrant's stable settlement in the host country may assist non-migrants (household members left behind), increasing their ability to remit over time (Collier et al., 2011). Sociocultural Links also showed a negative and significant relationship at 1% for migrants indicating a stronger sociocultural tie with the origin community, such as shared cultural norms or obligations and reduced remittances. This could result from increased non-monetary obligations or resource allocation to cultural activities rather than financial remittances (Ambrosius & Cuecuecha, 2016).

In contrast, a positive and significant relationship at 1% for non-migrants suggests that strong sociocultural links encourage higher remittances. Non-migrants may leverage these links to maintain emotional connections, request financial support, or negotiate remittances through shared networks and traditions (Boccagni & Decimo, 2013). Moreover, the negative relationship at 5% for migrants indicates that skill acquisition reduces remittances. Skilled migrants may prioritize self-investment, career advancement, or other financial goals over remitting funds to households (Docquier et al., 2015). However, migrants show that skill acquisition enhances households' financial stability, leading to greater remittances. Thus, skilled migrants are more likely to secure higher-paying jobs, increasing their ability to remit (Adams, 2011).

5.4.3 Average Treatment Effects of Internal Migration on Outcome Variables

Table 5.4 presents the impacts of migration on household total assets on the baseline model. The Average Treatment Effect (ATE) and Average Treatment on the Treated (ATT) estimates are all significant for the Total value of Assets. Specifically, the results imply that migration significantly increases household wealth by 36.01%. The ATE is 16.66 while the ATT is 22.66. The percentage change of 36.01% indicates that the effect of the treatment on those who received it (ATT) is 36.01% higher than the overall average effect (ATE). This suggests that the treatment significantly impacts those who migrated more than the general population or the average group. The Average Treatment on the Untreated (ATU) is 0.49, which is much lower than the ATE of 16.66. The percentage change of -97.06% shows that the effect of the migration on non-migrants is drastically lower compared to the overall average effect (ATE). Thus, it is almost negligible, which means that non-migrants experienced little to no benefit from it. This large negative percentage change implies that the migration is specifically beneficial for those who migrated but has very limited to no spillover effects on the non-migrants.

Overall, comparing the ATT of 22.66 to the ATU of 0.49 results in a percentage change of -97.84%, the significant negative change shows that the impact of migration on non-migrants (ATU) is much smaller than the impact on migrants (ATT). In other words, the treatment is highly effective for the treated individuals, but its effect on the untreated group is almost non-existent. This indicates that the intervention is targeted and beneficial for those who participate in it with minimal external benefits to others. This could be important for policy decisions, as it suggests that expanding the treatment to more individuals could be necessary to maximize its overall societal impact.

Nonetheless, the ATE for remittances is -41.94, indicating that migration has a negative overall impact on remittances. This implies that migration results in a notable drop in the number of remittances that migrants send home, which may be due to adjustments in their income or ability to do so. The impact of migration on people who decide to migrate is much more detrimental than the average effect, according to ATT (-61.71). This suggests that those who migrate are probably the ones who see the biggest drops in remittances, either as a result of shifting financial priorities, lower income, or increased living expenses. Interestingly, non-migrants' ATU is positive. This implies that remittances may rise for this group as a result of migration, perhaps as a result of better economic possibilities overseas than they currently have.

Table 5.4: Treatment effects of Migration on outcome indicators

	Total value of assets			Value of remittances		
Treatment effects	Coefficient	Standard Error	Percentage Change (%)	Coefficient	Standard Error	Percentage Change (%)
ATE	16.66**	7.09	16.66	-41.94**	14.98	(-41.94)
ATT	22.66**	9.74	36.01	-61.71**	21.08	(-61.71)
ATU	0.49	0.75	-97.84	6.93***	1.69	6.93)
Test of observable heterogeneity, p-value	0.06			0.00		
Test of essential heterogeneity, p-value	0.17			0.21		

*** denotes significance at 1% level, ** denotes significance at 5% level, * denotes significance at 10% level. The standard errors in parentheses were bootstrapped with 500 replications.

Source: Authors' computations

5.4.4 Marginal Treatment Effect (MTE) Curves

The two figures show how the unobserved resistance to treatment (propensity to migrate) affects the Marginal Treatment Effects (MTE) of migration on two distinct outcomes: (1) total asset values (figure: Figure 5.1A) and (2) remittances (Figure: 5.1B). The MTE curve illustrates how the treatment impact of migration differs for people with varying degrees of unobserved resistance to migration in the context of total values of assets. The effect starts higher for individuals with low resistance to migration (those more likely to migrate) and decreases as resistance to migration increases. The MTE estimate's 95% confidence interval (CI) is shown by the gray shaded area. The narrowing towards greater resistance suggests more accurate estimations in this range. The Average Treatment Effect (ATE), which is consistent throughout the population, is shown by the dashed red line. The MTE is higher than the ATE over the majority of the unobserved resistance distribution, suggesting that migration tends to have greater effects on total assets for those who are more inclined to migrate. As a result, migration constantly raises asset prices, especially for those with minimal resistance to migration. This implies that helping people who are already predisposed to migrate could improve their economic results.

Comparatively, remittances on the black MTE curve start with negative effects for individuals with a low resistance to migration but become positive for those with higher resistance. This suggests heterogeneity in the impact of migration on remittances. The wide confidence intervals at low resistance highlight significant uncertainty in the estimated effects for individuals who are more inclined to migrate. The ATE lies above zero, indicating a positive average effect of migration on remittances. However, the MTE suggests that for individuals with high unobserved resistance, the benefits are substantially higher, while for those with low resistance, the effects are negative or negligible. The effect of migration on remittances is more heterogeneous. While high-resistance individuals gain significantly, low-resistance individuals see negative or negligible impacts, potentially due to factors like different financial strategies or migration motives. This indicates that the effect of migration on remittances is negative or negligible for those with low resistance but positive for high-resistance individuals. This could reflect differing motives for migration (e.g., economic opportunity vs. family reunification) or varying ability to remit funds back home. Migration-related policies ought to take these distinctions into account thus, programs that assist high-resistance persons, for example, who are less likely to migrate independently, may yield higher remittance returns. On the other hand, measures that assist low-resistance people in building assets (such as investing possibilities or financial education) could be more advantageous to them.

Migration seems to have a more consistent positive effect on asset accumulation than on remittances. This could imply that migrants often prioritize building their wealth in their host towns rather than sending money back home. The negative effects of migration on remittances for low-resistance individuals might stem from factors like: higher consumption in the host towns, and longer family reunification processes which reduce the need for remittances. There is also a lack of stable financial foundation to remit significant amounts.

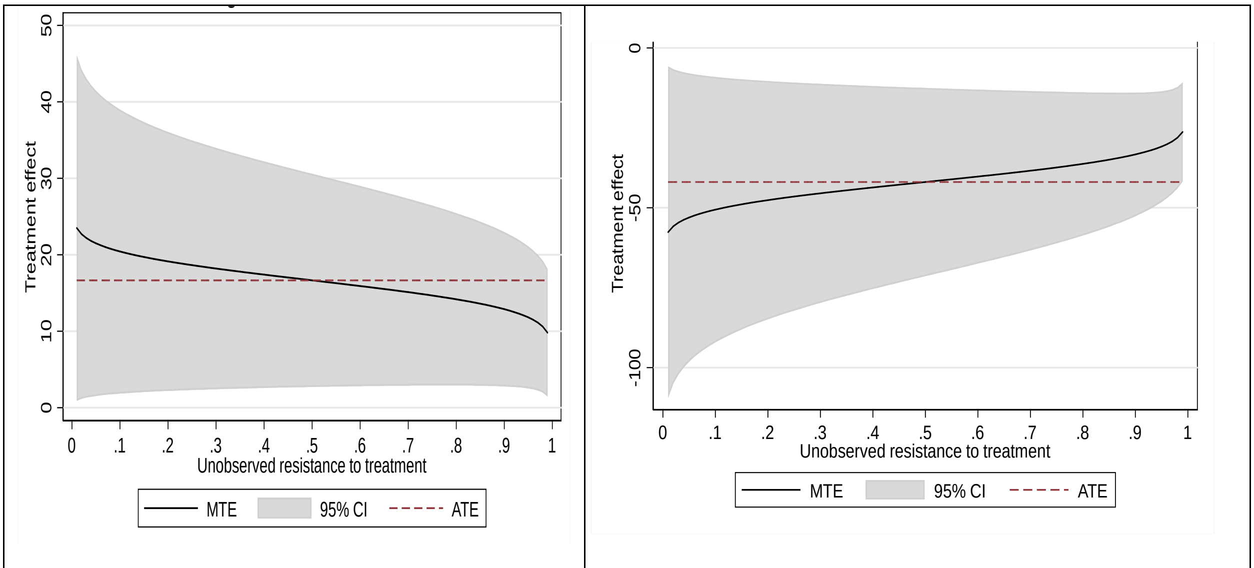


Figure: 5.1A: Marginal treatment effect on total value of assets	Figure: 5.1B: Marginal treatment effect on value of remittances

Figure 5.1: Marginal treatment effect on the total value of assets and remittances

Source: Generated from authors' computation

5.5 Summary

Climate-induced internal migration in Burkina Faso is primarily driven by environmental factors such as inadequate rainfall, soil degradation and persistent droughts, which severely affect agricultural productivity. The study confirms that migration is an important adaptation strategy for households in regions facing climate variability, particularly for those heavily reliant on agriculture. Migrants generally accumulate more assets than non-migrants, indicating that migration can be a means to secure better livelihoods and enhance household wealth. However, this opportunity is not accessible to all as extreme environmental degradation in some areas limits people's ability to migrate which ultimately traps them in poverty. The findings highlight the complex interplay between environmental stress, socio-economic factors, and migration decisions and underscore the importance of understanding these dynamics for more effective policy interventions.

Hence, we recommend the enhancement of climate-resilient agricultural practices to mitigate the drivers of migration. Burkina Faso should also invest in climate-resilient agricultural technologies and practices, such as improved irrigation systems, drought-resistant crops, and soil conservation techniques. These measures can help stabilise agricultural productivity in areas affected by climate variability, reducing the need for migration. Additionally, the government, in collaboration with development partners should implement programs aimed at improving soil fertility, preventing land erosion, and rehabilitating degraded lands. This will reduce migration pressures by improving local livelihoods. Since water scarcity is a key driver of migration, especially in agricultural communities, there should be an emphasis on improving access to water through the development of water storage and rainwater harvesting. Nonetheless, policies promoting efficient water use for farming and livestock will be essential to maintain agricultural productivity.

CHAPTER 6

ANALYSIS OF DROUGHT AND ITS RELATIONSHIP WITH MIGRATION IN THE COMOE AND BOULKIEMDE PROVINCES

6.1 Introduction

This chapter examines the relationship between drought and internal migration in Comoé and Boulkiemdé. It analyses drought trends, intensity, frequency, and duration using the Standardized Precipitation Index (SPI) and the Standardized Precipitation-Evapotranspiration Index (SPEI) across multiple time scales. The chapter further explores migration dynamics, including inflows, outflows, and net migration, to assess how drought variability influences these flows. Finally, it evaluates the strength and direction of correlations between drought indices and migration variables using the Pearson correlation matrix.

6.2 Drought Trends based on SPI and SPIE in Comoé and Boulkiemdé

The Standardized Precipitation Index (SPI) and Standardized Precipitation-Evapotranspiration Index (SPEI) are utilized to analyse drought trends in the provinces of Comoé (Sudanian zone) and Boulkiemdé (Sudano-Sahelian zone) across different temporal scales. While these indices are similar, the SPEI incorporates evapotranspiration, enabling a more comprehensive assessment of hydrological anomalies in the context of climate change. The trends revealed by the SPI and SPEI, validated through Sen's slopes and associated p-values, highlight distinct climatic dynamics across periods of analysis and regions studied.

6.2.1 Meteorological Droughts (SPI3 and SPEI3)

Meteorological droughts, measured through SPI3 and SPEI3 (short-term), reflect significant reductions in precipitation relative to short-term averages in the provinces of Comoé and Boulkiemdé. Figure 6.1 and 6.2 show the trend of meteorological drought in both provinces.

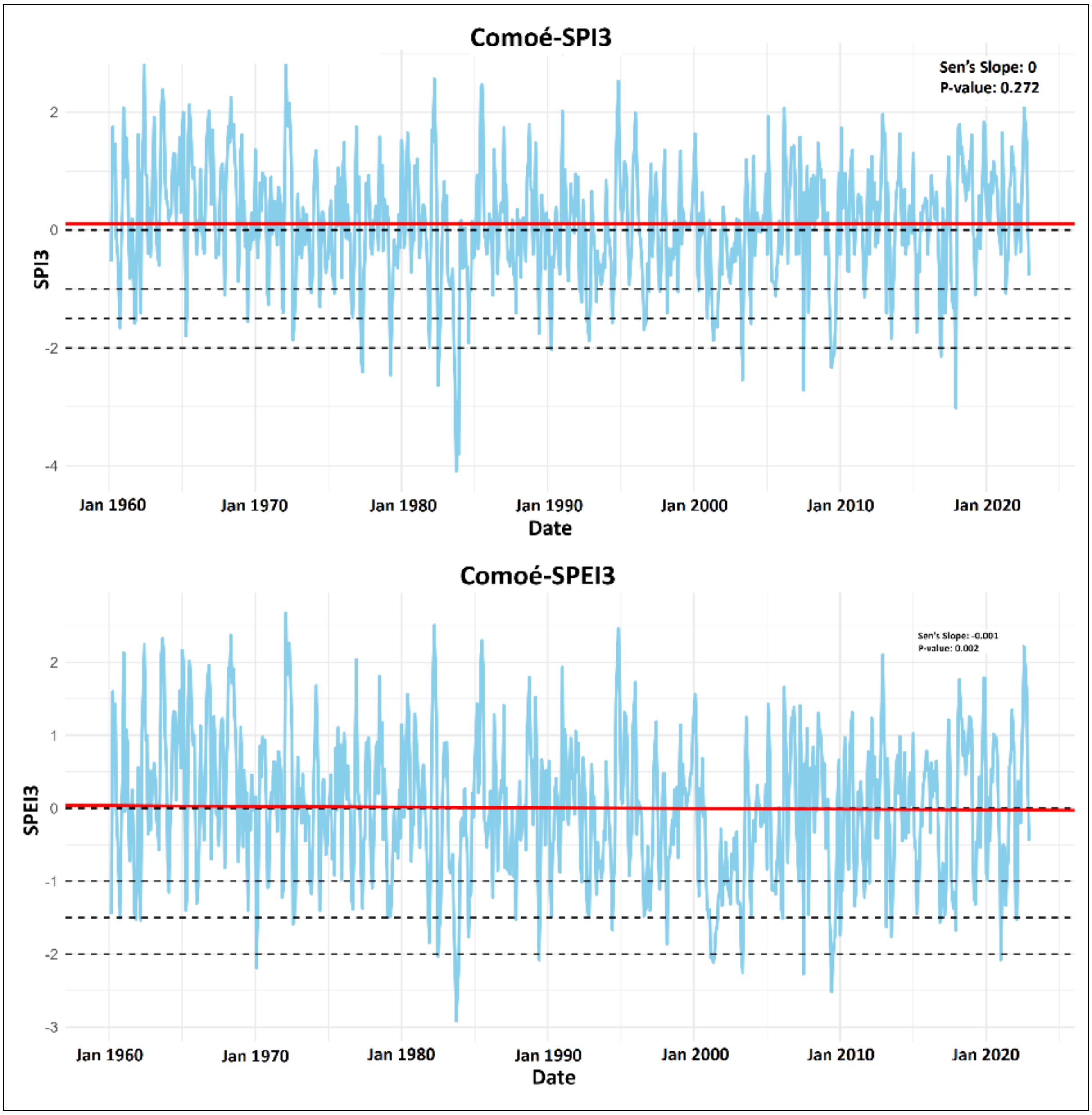


Figure 6.1: Trends in SPI3 and SPEI3 in the provinces of Comoé

Source: Author's Construct

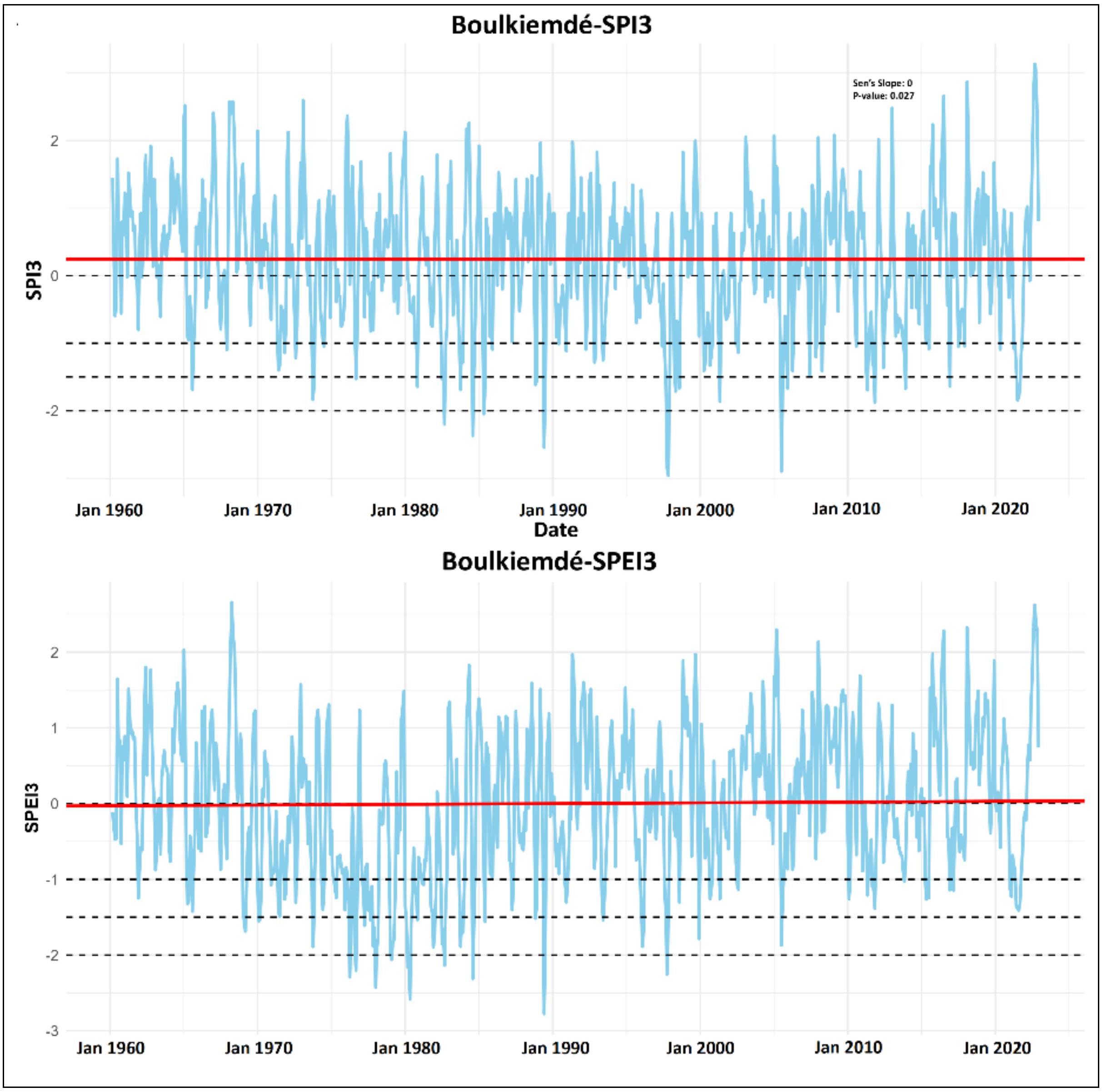


Figure 6.2: Trends in SPI3 and SPEI3 in the provinces of Boulkiemdé
Source: Author's Construct

SPI3 and SPEI3 display regular fluctuations around zero, indicating alternating wet (positive values) and dry (negative values) periods in the short term. In Comoé, SPI3 exhibits no significant trend (Sen's slope = 0, p-value = 0.144), suggesting relative stability despite recurrent climatic anomalies. Conversely, SPEI3 demonstrates a slight negative trend (Sen's slope = -0.001, p-value = 0.002), indicating a minor but statistically significant deterioration in hydrological conditions. This discrepancy reflects the increasing influence of evapotranspiration, highlighting heightened sensitivity to rising temperatures. These findings suggest a progressive increase in short-term droughts in this region which is consistent with observations of greater sensitivity to climatic disruptions in Sudanian zones, as reported by Dardel et al. (2014).

In Boulkiemdé, SPI3 shows a statistically significant trend (p-value = 0.026) despite a neutral Sen's slope. SPEI3 reveals a slight improvement in hydrological conditions (Sen's slope = +0.001, p-value = 0.000). These results suggest that the Sudano-Sahelian region occasionally benefits from localized rainfall, although the impact of rising temperatures remains moderate in the short term. These observations align with the work of Diasso and Abiodun (2017), who noted that Sudano-Sahelian zones, despite their high climatic variability, sometimes benefit from favourable seasonal precipitation.

6.2.2 Agricultural Droughts (SPI6 and SPEI6)

Agricultural droughts, measured through SPI6 and SPEI6 (medium term), refer to significant reductions in soil moisture required for optimal vegetation growth (Tadesse et al., 2015). Figure 6.3 and Figure 6.4 present SPI6 and SPEI6 trends for both provinces.

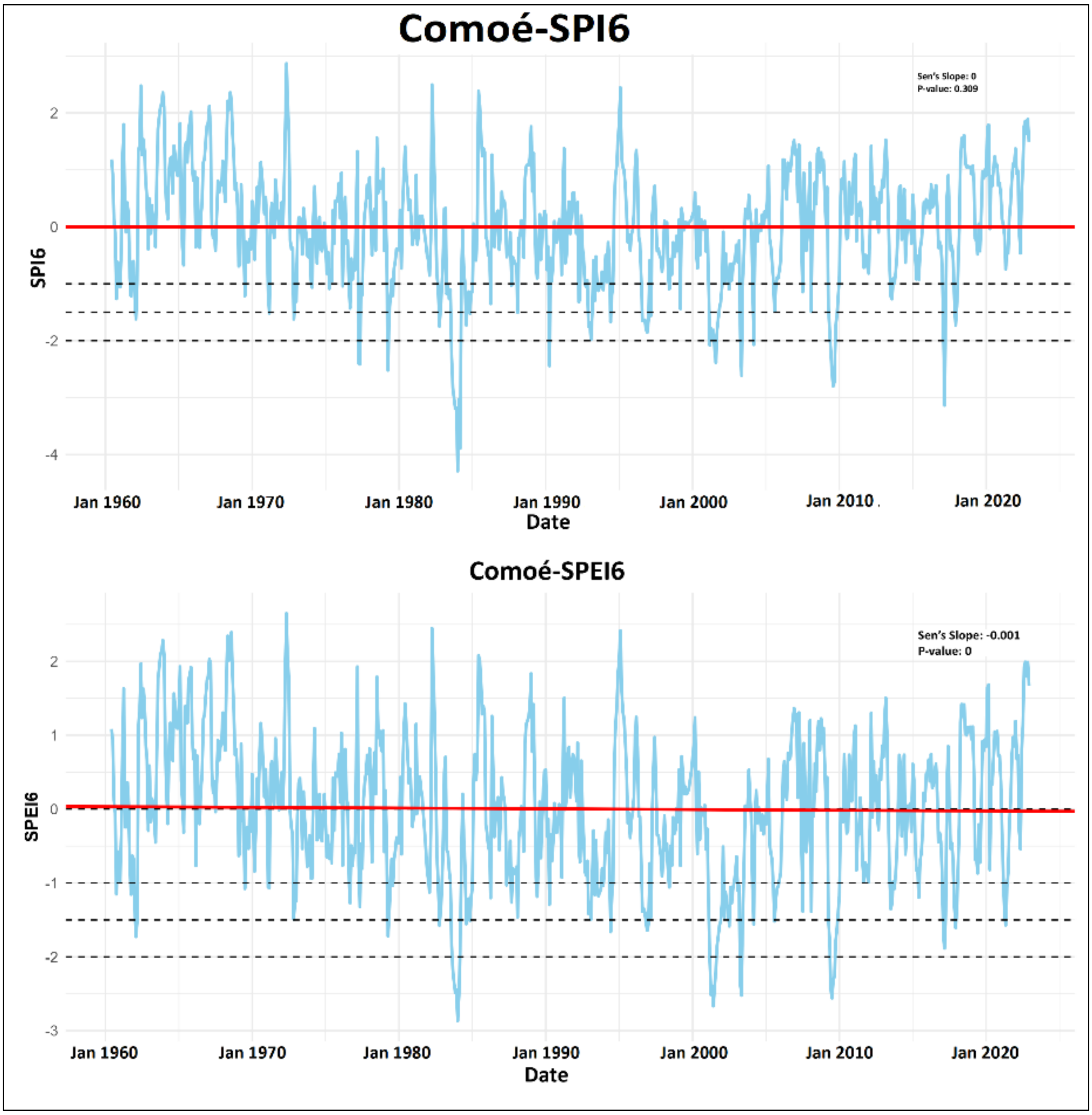


Figure 6.3: Trends in SPI6 and SPEI6 in the provinces of Comoé

Source: Author's Construct

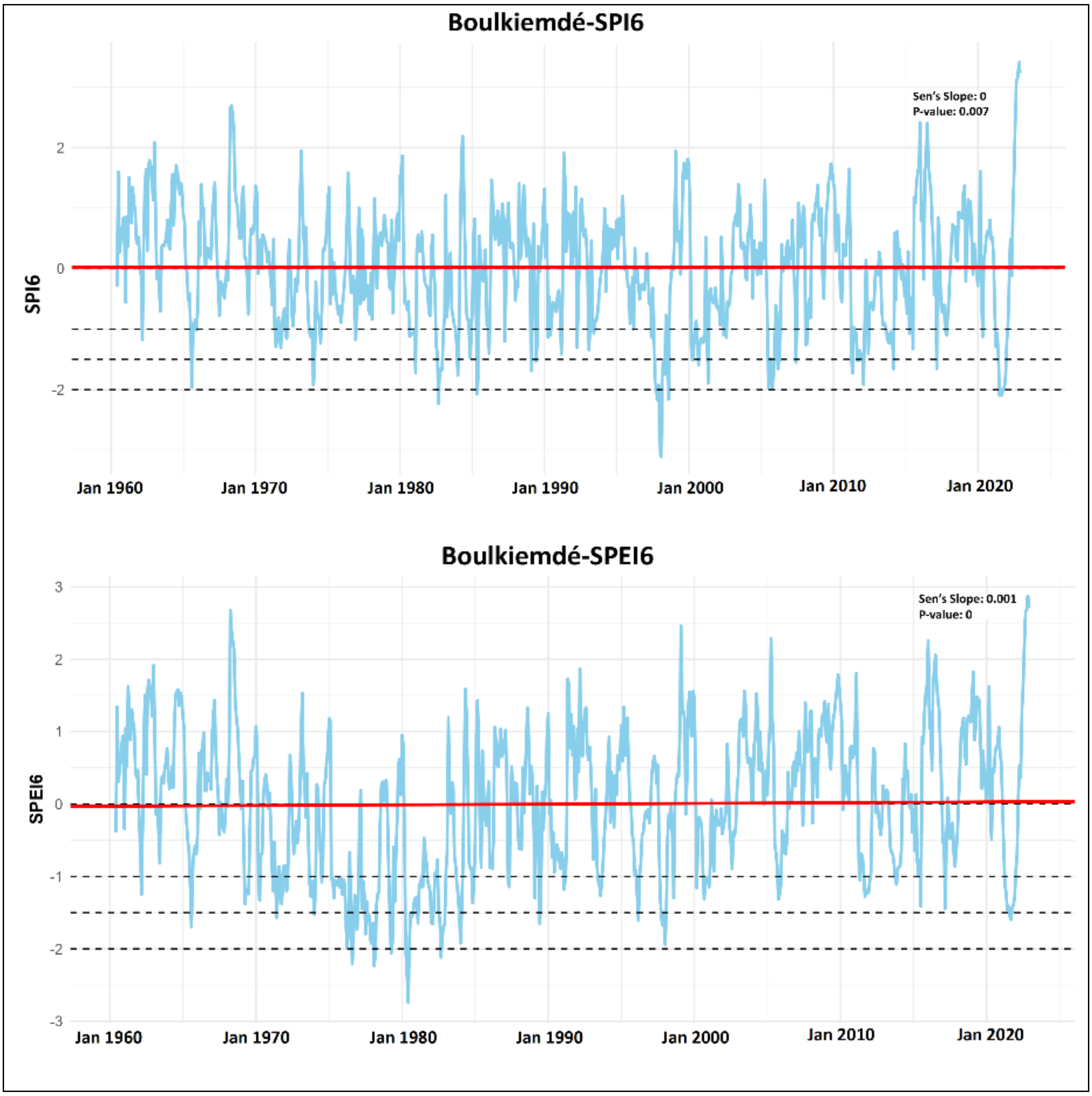


Figure 6.4: Trends in SPI6 and SPEI6 in the provinces of Boulkiemdé
Source: Author's Construct

SPI6 and SPEI6 reveal pronounced alternations between dry and wet periods in the medium term, consistent with historical droughts in the 1970s, 1980s, and 2000s. In Comoé, SPI6 shows no significant trend (Sen's slope = 0, p-value = 0.309), indicating stable precipitation patterns over time. SPEI6, however, shows a statistically significant negative trend (Sen's slope = -0.001, p-value = 0), suggesting a gradual decline in water availability, likely driven by increasing evapotranspiration. These observations align with those of Dardel et al. (2014), who documented intensifying droughts in Sudanian zones, often amplified by anthropogenic pressures.

In Boulkiemdé, both SPI6 and SPEI6 exhibit statistically significant trends (SPI6: Sen's slope = 0, p-value = 0.007; SPEI6: Sen's slope = +0.001, p-value = 0). This apparent resilience reflects the region's capacity to adapt to irregular precipitation, supporting the conclusions of Diasso & Abiodun (2017), who highlighted the potential for increased variability to foster hydrological recovery in some cases. These findings also align with Zhao and Dai (2015), who demonstrated that certain Sudano-Sahelian zones benefit from localised precipitation, compensating for medium-term deficits.

6.2.3 Hydrological Droughts (SPI12 and SPEI12)

Hydrological droughts, measured through SPI12 and SPEI12 (long-term), refer to significant reductions in the availability of all forms of water in the terrestrial phase of the hydrological cycle, including surface water, snowmelt, spring runoff, and groundwater Goyal et al. (2017). Figure 6.5 and 6.6 illustrate the trend of SPI12 and SPEI12 in both provinces.

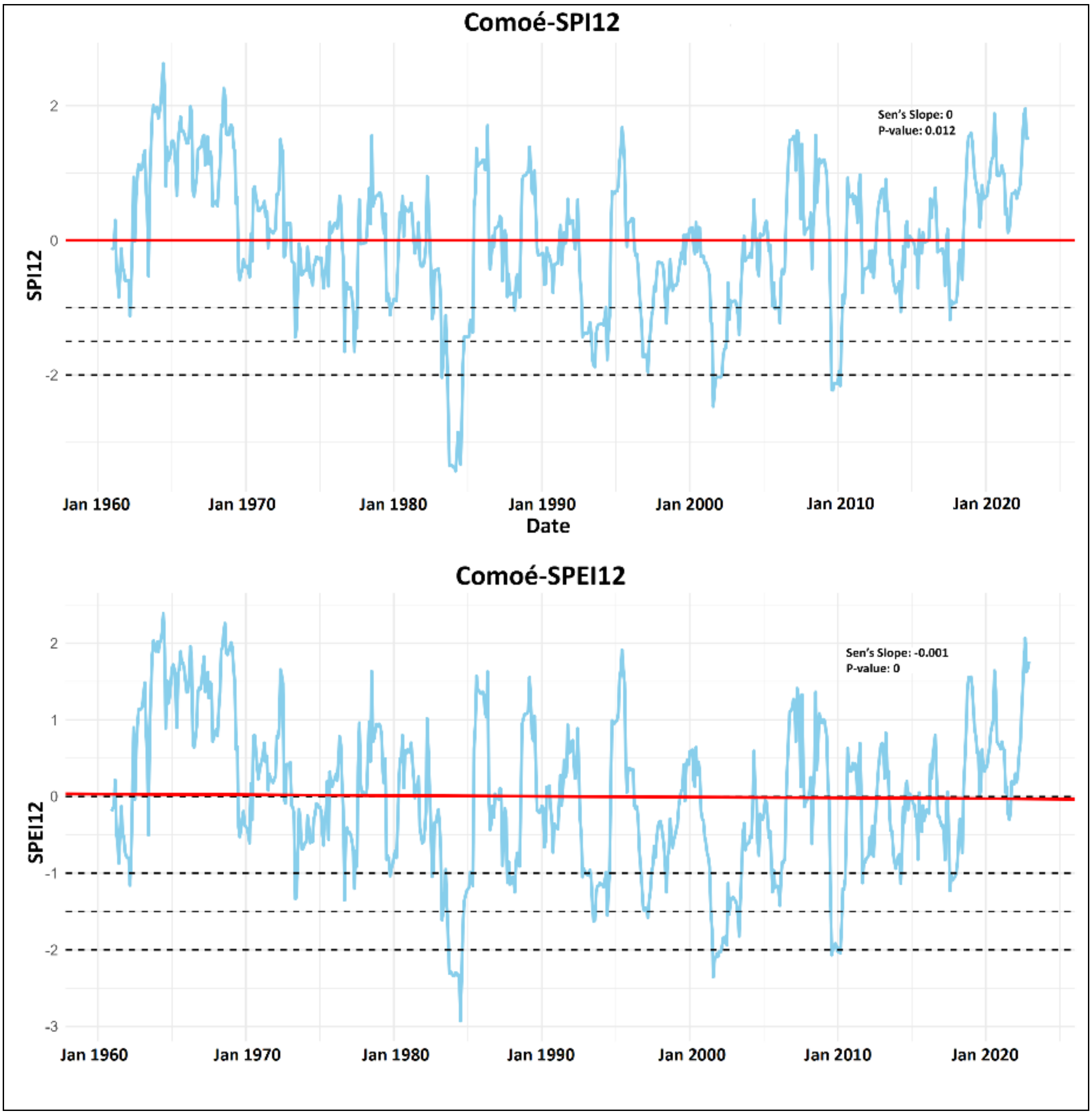


Figure 6.5: Trends in SPI12 and SPEI12 in the provinces of Comoé
Source: Author's Construct

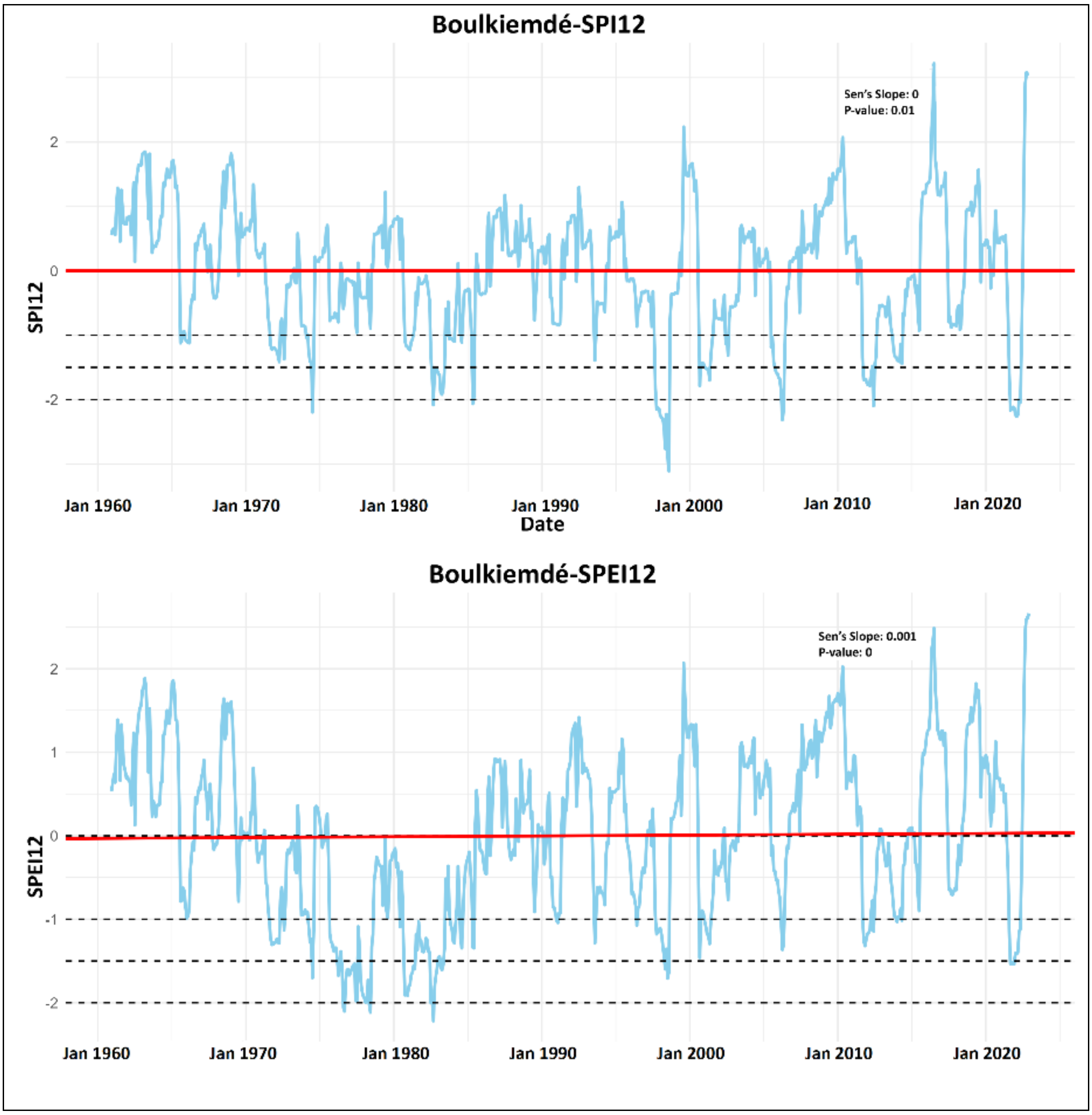


Figure 6.6: Trends in SPI12 and SPEI12 in the provinces of Boulkiemdé
Source: Author's Construct

SPI12 and SPEI12 display regular oscillations around zero, reflecting alternating prolonged periods of drought and wet conditions. In the Comoé region, SPI12 shows no clear trend (Sen's slope ≈ 0, p-value = 0.012), while SPEI12 indicates significant long-term hydrological degradation (Sen's slope = -0.001, p-value < 0.001. This degradation is in SPEI12, highlight the increasing influence of evapotranspiration on long-term moisture anomalies. These findings are consistent with Nicholson et al. (2018), who documented worsening long-term droughts in the Sudanian zones of West Africa, driven by both climatic variability and anthropogenic pressures.

In Boulkiemdé, both indices reveal statistically significant trends (SPI12: Sen's slope = 0, p-value = 0.01; SPEI12: Sen's slope = +0.001, p-value = 0). This dynamic may be attributed to the localised intensification of seasonal rainfall in the Sudano-Sahelian zone, characterised by increased climatic variability and opportunities for hydrological recovery, as Zhao and Dai (2015) suggested. These results confirm greater resilience in this province, where irregular rainfall supports relative stability even under climate change impacts.

6.2.4 Comparing SPI and SPEI

The differences between SPI and SPEI underscore the importance of incorporating evapotranspiration into climate trend analyses. SPEI which accounts for rising temperatures is particularly relevant in the context of global warming (Cook et al., 2014). These observations align with Huang et al. (2016) who demonstrated that increasing temperatures often exacerbate drought intensification in arid and semi-arid regions. In Sudanian zones such as Comoé, the findings are consistent with Dardel et al. (2014), who identified intensifying prolonged droughts exacerbated by anthropogenic pressures and rising temperatures. The greater sensitivity of SPEI compared to SPI in this region highlights increased vulnerability to climate change impacts. In Sudano-Sahelian zones such as Boulkiemdé, trends revealed by SPI and SPEI corroborate observations by Nicholson et al. (2018) who noted that increased climatic variability can sometimes support localised hydrological recovery. The slight positive trends in SPEI within this region suggest that temperature impacts are less pronounced than in Sudanian zones, possibly due to more intense and localised precipitation events.

6.3 Drought Intensity Based on SPI and SPEI in Comoé and Boulkiemdé

Drought intensity was assessed according to the thresholds proposed by McKee et al. (1993) and Mehr et al. (2020). The same threshold values were used for both indices. These thresholds are shown in Table 6.1.

Table 6.1: Thresholds used to classify drought intensity

Values (threshold)	Classification (Intensity)
0 <SPI/SPEI<−1.49	Mild drought
−1.49<SPI/SPEI<−1.0)	Moderate drought
−1.50<SPI/SPEI<−2.0	Severe drought
SPI/SPEI>−2	Extreme drought

Source: McKee et al. (1993) and Mehr et al. (2020)

The evaluation of the SPI (Standardised Precipitation Index) and SPEI (Standardised Precipitation-Evapotranspiration Index) at different time scales (3, 6 and 12 months) in the provinces of Comoé (Sudanese zone) and Boulkiemdé (Sudano-Sahelian zone) reveals significant variations in drought intensity due to specific climatic conditions.

6.3.1 Intensity of Meteorological Droughts (SPI3 and SPEI3)

The first temporal assessment scale is the meteorological drought intensity measure, i.e. short-term drought. In this section, it is assessed using the SPI3 and SPEI3 as shown by Figure 6.7.

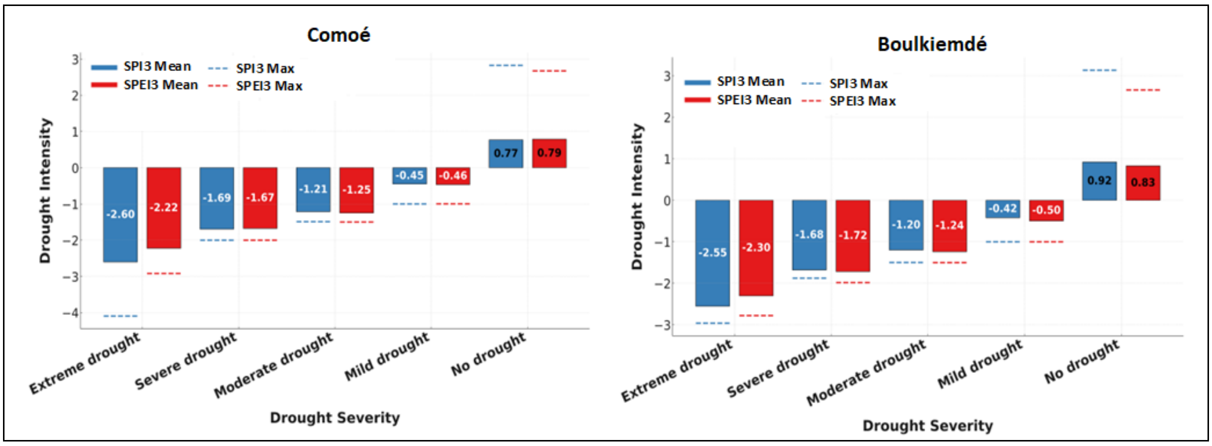


Figure 6.7: Intensity of meteorological drought in the provinces of Comoé and Boulkiemdé.
Source: Author's Construct

Extreme droughts in Comoé have an average intensity of -2.6 and a maximum intensity of -4.1 for SPI3, compared to an average of -2.2 and a maximum intensity of -2.92 for SPEI3. This difference is due to the fact that SPI3 only measures precipitation anomalies, whereas SPEI3 also takes into account evapotranspiration which moderates perceived water deficits. Moderate droughts have a maximum intensity of -1.49 for SPI3, comparable to that measured by SPEI3 (-1.50). Mild droughts have a maximum intensity of -0.99 for SPI3, similar to SPEI3 (-0.98).

These results are consistent with the observations of Sanogo et al. (2015), who highlighted the importance of integrating evapotranspiration to assess droughts in tropical humid zones. Furthermore, Panthou et al. (2018) emphasised that climate oscillations, such as the El Niño-Southern Oscillation (ENSO), strongly influence drought intensities measured by SPI in West Africa.

In Boulkiemdé, extreme droughts reach a maximum intensity of -2.96 for SPI3 and -2.3 for SPEI3, reflecting the moderating effect of temperatures and evapotranspiration included in SPEI. Moderate droughts reach a maximum intensity of -1.23 for SPI3 and -1.24 for SPEI3 while mild droughts have a maximum intensity of -0.99 for SPI3 and -0.98 for SPEI3.

These observations are consistent with the findings of Ogolo et al. (2024) and Ceccherini et al. (2017) who showed that high temperatures amplify extreme and moderate droughts in the Sudano-Sahelian zone.

6.3.2 Intensity of Agricultural Droughts (SPI6 and SPEI6)

The second temporal scale measures the intensity of agricultural drought, i.e. drought in the medium term. In this section, it is assessed using the SPI6. Figure 6.8 summarises the results.

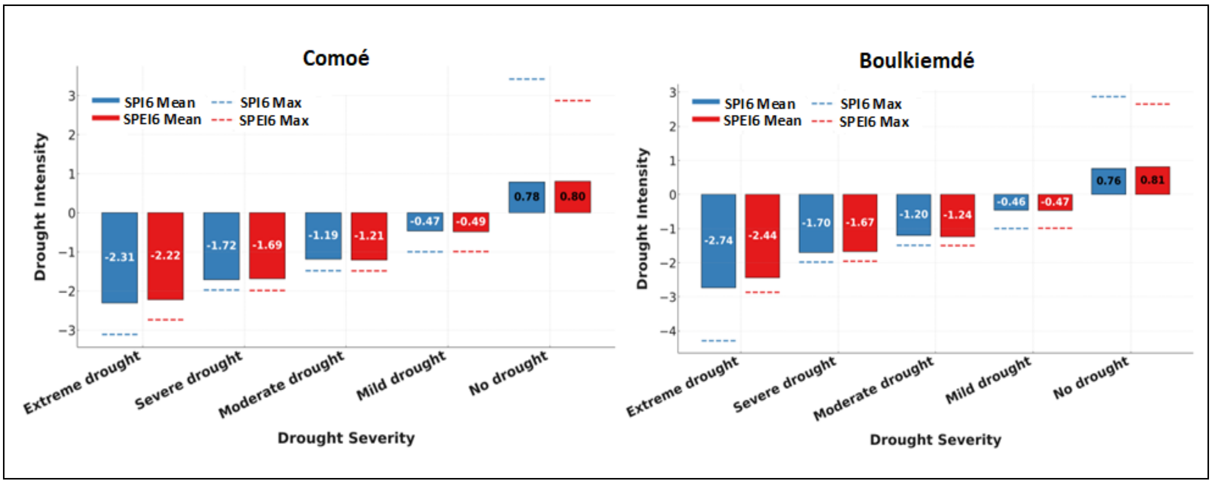


Figure 6.8: Intensity of agricultural drought in the provinces of Comoé and Boulkiemdé.

Source: Author’s Construct

Extreme droughts reach a maximum intensity of -4.29 for SPI6 compared to -2.87 for SPEI6. This reflects the ability of SPI6 to capture more intense rainfall deficits, while SPEI6 moderates these results by including water losses due to evapotranspiration. Moderate droughts show similar maximum intensities for both indices (-1.49 for SPI6 and -1.50 for SPEI6). Although less intense, mild droughts have maximum values of -0.99 for SPI6 and -0.98 for SPEI6.

These results are in line with studies by Ndehedehe et al. (2016) and Spinoni et al. (2019) who showed that SPEI is particularly suitable for capturing moderate and mild droughts that are exacerbated by rising temperatures.

In Boulkiemdé, extreme droughts reach a maximum intensity of -3.12 for SPI6 and -2.74 for SPEI6, highlighting a significant attenuation due to the inclusion of temperatures in SPEI. Moderate droughts show similar maximum intensities for both indices (-1.23 for SPI6 and -1.24 for SPEI6), whereas mild droughts have maximum intensities of -0.99 for SPI6 and -0.98 for SPEI6.

These results confirm the conclusions of Panthou et al. (2018) and Ceccherini et al. (2017), and highlight the importance of taking temperature into account when assessing the impact of droughts in semi-arid zones.

6.3.3 Intensity of Hydrological Droughts (SPI12 and SPEI12)

The last temporal assessment scale in this study is the measure of hydrological drought intensity, i.e. long-term drought. In this case, it is assessed using the SPI12. Figure 6.9 summarises the results.

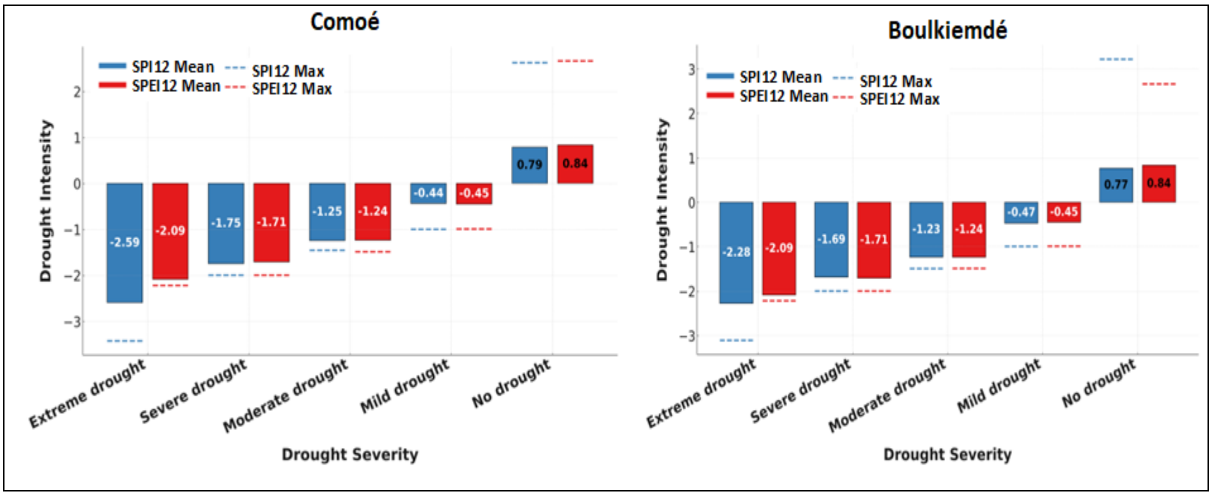


Figure 6.9: Intensity of hydrological drought in the provinces of Comoé and Boulkiemdé.
Source: Author's Construct

On an annual scale, extreme droughts reach a maximum intensity of -3.43 for SPI12 compared to -2.93 for SPEI12. Moderate droughts show maximum intensities of -1.49 for SPI12 and -1.50 for SPEI12, while mild droughts reach -0.99 for SPI12 and -0.98 for SPEI12. The moderating effect of evapotranspiration on drought intensity is particularly evident at this scale.

These results corroborate the observations of Nauditt et al. (2022), who showed that tropical humid regions are mainly affected by prolonged moderate droughts due to cumulative water deficits.

In Boulkiemdé, extreme droughts reach a maximum intensity of -3.11 for SPI12 and -2.93 for SPEI12. Moderate droughts show similar maximum intensities (-1.23 for SPI12 and -1.24 for SPEI12). Mild droughts have maximum intensities of -0.99 for SPI12 and -0.98 for SPEI12.

These observations are consistent with the findings of Sayat et al. (2025) and Venturi et al. (2025), who showed that the integration of temperature into SPEI is essential to capture prolonged droughts in semiarid regions.

6.3.4 Comparison between SPI and SPEI

In both provinces, the SPI generally measures higher drought intensities, especially for extreme events. This is due to SPI's exclusive reliance on precipitation anomalies, which amplify water deficits. Conversely, SPEI, by integrating evapotranspiration, moderates intensities but detects a greater number of mild and moderate droughts, particularly in areas where high temperatures exacerbate water losses. In Comoé, a wetter region, SPI tends to overestimate extreme water deficits, while SPEI is more relevant for capturing mild and moderate droughts. In Boulkiemdé, prolonged and severe droughts captured by SPEI highlight the need for temperature integration to understand the real impacts in Sudano-Sahelian zones.

6.4 SPI and SPEI-based Drought Frequency and Distribution in Comoé and Boulkiemdé Provinces

The analysis of the frequency of meteorological, agricultural and hydrological droughts in the provinces of Comoé and Boulkiemdé, based on the SPI and the SPEI, reveals significant differences in the frequency and distribution of droughts linked to the climatic specificities of each region. The SPI and SPEI provide complementary insights into drought dynamics by including or excluding evapotranspiration in the calculations.

6.4.1 Frequency and Intensity Distribution of Meteorological Droughts

Meteorological drought, as measured by the SPI-3 index over 63 years (756 months), affected Comoé for 319 months, equivalent to a frequency of 5.06 drought months per year, while Boulkiemdé experienced 316 drought months, or 5.05 per year. Although the difference is slight, it is notable that Boulkiemdé, located in the drier Sudano-Sahelian zone, was marginally less exposed to meteorological drought than Comoé in the Sudanian zone. This counterintuitive pattern suggests the influence of localized climatic and environmental factors, such as intra-seasonal rainfall distribution, soil water retention, and land use patterns, which may mitigate drought exposure beyond zonal climate classifications.

When the SPEI3 index is applied, integrating both precipitation and potential evapotranspiration (PET), the pattern shifts significantly. Boulkiemdé now records 380 drought months (6.03 per year), compared to 369 months (5.86 per year) in Comoé. This marks a reversal of the SPI-based profile and highlights the increasing role of temperature-driven atmospheric demand in intensifying short-term water stress, particularly in the thermally vulnerable Sudano-Sahelian zone. The shift is consistent with observations by Alvar-Beltrán et al. (2020), who reported that farmers in central Burkina Faso are experiencing more frequent dry spells and increasing temperatures, especially during critical agricultural periods. Table 6.2 shows the number of drought and non-drought months during the 756 months of observation and the corresponding drought frequency per year.

Table 6.2: Number of Drought and Non-Drought Months and Drought Frequency in Comoé and Boulkiemdé Provinces Based on the SPI3 and SPEI3

Province	Drought index	Number of drought months	Number of free-drought months	Drought Frequency (months/year)
Comoé	SPI3	319	437	5.06
	SPEI3	369	387	5.86
Boulkiemdé	SPI3	316	440	5.05
	SPEI3	380	376	6.03

Source: Author’s computation

The breakdown of drought intensity adds further insight. Under SPI3, mild droughts dominate in both provinces, comprising 60.5% of drought months in Comoé and 61.2% in Boulkiemdé. Moderate droughts account for 23.1% and 22.9%, respectively. Severe and extreme droughts make up 11.9% and 4.5% in Comoé, and 12.3% and 3.6% in Boulkiemdé.

Under SPEI3, mild droughts increase in both provinces, 64.2% in Comoé and 67.6% in Boulkiemdé, while moderate droughts slightly decline. Notably, severe droughts rose in Boulkiemdé to 9.2%, suggesting an increase in drought persistence rather than extremity. Extreme droughts decrease slightly in both regions, reflecting a redistribution of severity categories due to enhanced evapotranspiration, consistent with findings by Bontogho et al. (2022), who observed similar patterns in eastern Burkina Faso.

These results underscore that temperature-driven evapotranspiration is increasingly shaping drought dynamics, particularly in short-term, meteorologically defined droughts. The stronger response in Boulkiemdé under SPEI-3 confirms that warming temperatures, not rainfall decline, are now a primary driver of drought frequency in semi-arid environments. This trend is further supported by Sanou et al. (2023), who found that rising temperatures are significantly altering soil moisture retention and shortening growing seasons, even in areas with relatively stable rainfall.

This shift reflects a broader recognition in the literature of the limitations of rainfall-only indices. Vicente-Serrano et al. (2010) demonstrated that SPEI is more sensitive to temperature anomalies, making it better suited for detecting drought under warming conditions. Tefera et al. (2025) similarly found that in West Africa, SPI often underrepresents drought risk where soil moisture variability is increasingly driven by evaporative stress. Supporting this, Nunno et al. (2025) showed that several Sahelian zones are experiencing more frequent droughts despite steady or increasing rainfall, reinforcing the role of temperature. In addition, Diedhiou et al. (2018) emphasised that drought vulnerability varies spatially based on land cover, vegetation, and climatic exposure, factors that may explain Comoé's consistent drought signal despite its more humid climate. Agutu et al. (2017) further validated the importance of integrating atmospheric demand into drought monitoring, using satellite-based evapotranspiration data to capture crop stress in sub-Saharan Africa more accurately. Figure 6.10 shows the distribution of meteorological drought intensities in the provinces of Comoé and Boulkiemdé, based on SPI3 and SPEI3 values.

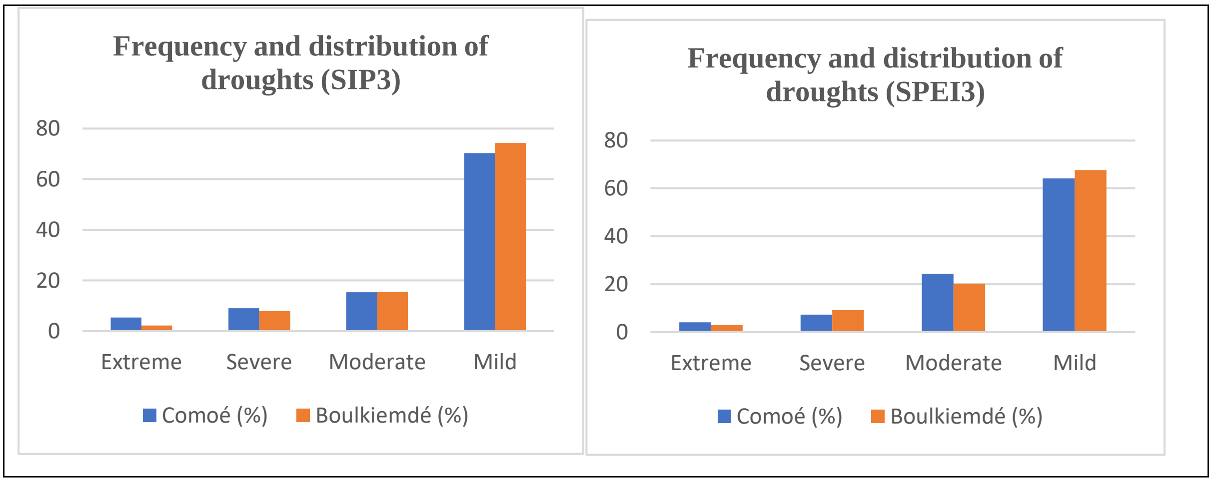


Figure 6.10: Meteorological droughts frequency and distribution in Comoé and Boulkiemdé.
Source: Author's Construct

6.4.2 Frequency and Intensity Distribution of Agricultural Droughts

Over the 63-year observation period (756 months), the SPI6 index reveals that both Comoé and Boulkiemdé provinces experienced 363 drought months, representing a frequency of 5.76 months of drought per year and 393 drought-free months. This symmetry suggests a comparable level of medium-term agricultural water deficit between the two provinces when only precipitation is considered, indicating similar exposure to meteorological variability.

However, this pattern shifts when SPEI6, which integrates potential evapotranspiration, is applied. In Comoé, drought months increase to 379 (6.02 per year), while drought-free months drop to 377, reflecting a moderate but notable intensification of drought conditions. This increase points to heightened agricultural vulnerability in the Sudanian zone, where rising atmospheric demand may be surpassing the buffering capacity of rainfall inputs.

In contrast, Boulkiemdé records 364 drought months under SPEI6 (5.78 per year) and 392 drought-free months, reflecting a slight improvement over its SPI6 profile. This relative resilience may result from localised adaptation strategies, such as drought-resistant crops or changes in farming practices, as well as agroecological characteristics that mitigate the impacts of heat stress more effectively in the Sudano-Sahelian zone.

These dynamics align with findings by Bontogho et al. (2022), who reported that while annual rainfall has remained relatively stable in Burkina Faso, significant increases in temperature, especially during the growing season, have intensified water stress through elevated evapotranspiration. Their analysis showed that despite receiving more rain, Sudanian areas are experiencing greater agricultural vulnerability due to these thermal pressures.

The stronger sensitivity of Comoé to SPEI-based droughts also aligns with observations by Bouabdelli et al. (2022), whose regional study found that SPEI more accurately captures drought severity than SPI, particularly in humid zones. Their findings indicate that rising temperatures in such areas shorten growing seasons and reduce soil moisture retention, leading to increased crop failure even when precipitation appears adequate. The Table 6.3 summarizes the drought frequencies and total counts of drought months.

Table 6.3: Number of Drought and Non-Drought Months and Drought Frequency in Comoé and Boulkiemdé Provinces Based on the SPI6 and SPEI6

Province	Drought index	Number of drought months	Number of free-drought months	Drought Frequency (months/year)
Comoé	SPI6	363	393	5.76
	SPEI6	379	377	6.02
Boulkiemdé	SPI6	363	393	5.76
	SPEI6	364	392	5.78

Source: Author's computation

The breakdown of drought frequency by intensity further highlights key contrasts. Under SPI-6, mild droughts dominate in both regions, accounting for 62.4% of drought months in Comoé and 60.2% in Boulkiemdé. Moderate droughts represent 21.5% and 23.8%, respectively, while severe and extreme events are relatively infrequent, 11.8% and 4.3% in Comoé, compared to 12.0% and 4.0% in Boulkiemdé.

Under SPEI-6, the distribution shifts. In Comoé, mild droughts increase to 69.4%, while moderate and severe droughts decrease to 19.3% and 6.9%, respectively. Extreme droughts rise slightly to 4.5%. In Boulkiemdé, mild droughts decline to 59.6%, but moderate and severe droughts increase to 28.0% and 10.2%, while extreme droughts remain stable at around 2.2%. These changes suggest that while Comoé sees more frequent but less intense droughts, Boulkiemdé faces fewer droughts overall, but when they occur, they tend to be more persistent and agriculturally disruptive.

This pattern is consistent with the findings of Ceccherini et al. (2017), who demonstrated that prolonged heatwaves significantly exacerbate agricultural drought impacts in the Sahel-Sudanian transition zone. Their research emphasized that increased evaporative demand, driven by higher temperatures, leads to deeper and more persistent soil moisture deficits, even in regions with relatively high rainfall.

These results underscore the increasing influence of temperature on agricultural drought patterns in Burkina Faso. They highlight the limitations of relying solely on precipitation-based indices like SPI and reinforce the need for integrated drought monitoring systems that include evapotranspiration, temperature, and soil moisture, key components for capturing crop-relevant drought stress. As climate change continues to drive increased evapotranspiration across the province, using indices like SPEI becomes essential for identifying areas of emerging risk and guiding adaptation strategies in both Sudanian and

Sudano-Sahelian zones. Figure 6.11 shows the distribution of meteorological drought frequency by intensities in the provinces of Comoé and Boulkiemdé, based on SPI6 and SPEI6 values.

Figure 6.11 shows the distribution of meteorological drought frequency by intensities in the provinces of Comoé and Boulkiemdé, based on SPI6 and SPEI6 values.

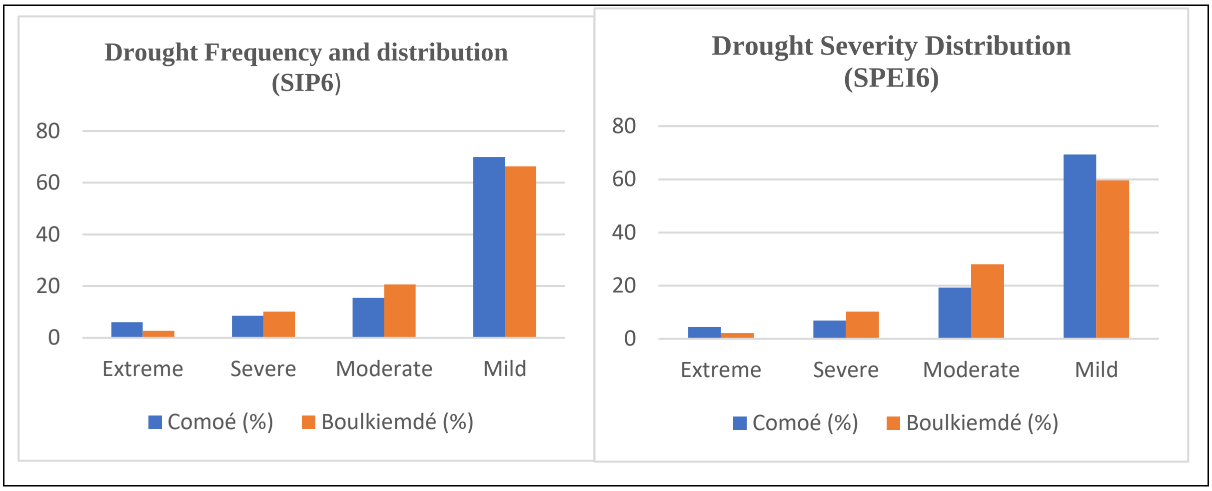


Figure 6.11: Agricultural droughts frequency and distribution in Comoé and Boulkiemdé. Source: Author's Construct

6.4.3 Frequency and Intensity Distribution of Hydrological Droughts

Hydrological drought, as indicated by the SPI12 index over a 63-year observation period (756 months), affected Comoé for 372 months, equivalent to an average of 5.90 drought months per year, while Boulkiemdé experienced 355 drought months, or 5.63 per year. Despite its location in the drier Sudano-Sahelian zone, Boulkiemdé experienced fewer long-term hydrological droughts than Comoé. This seemingly paradoxical result may reflect differences in runoff efficiency, aquifer recharge, and land cover, which influence water availability beyond climatic classification alone.

When using SPEI12, which incorporates both precipitation and potential evapotranspiration, the pattern shifts slightly. Comoé records 382 drought months (6.06 per year), while Boulkiemdé records 379 drought months (6.02 per year), showing a convergence in drought frequency. This convergence in drought frequency under SPEI12 suggests that temperature-driven atmospheric demand is amplifying long-term hydrological stress in both provinces, with a slightly stronger impact in the already heat-prone Sudano-Sahelian region.

These findings align with Sawadogo et al. (2024), who project that rising temperatures and increased evapotranspiration will offset potential gains in rainfall, intensifying water stress across Burkina Faso, even in regions with relatively stable precipitation. Similarly, Sougué et al., (2023) stress that hydrological impacts in the region are increasingly shaped by non-rainfall factors, including land use and warming trends. Table 6.4 shows the number of drought and non-drought months during the 756 months of observation.

Table 6.4: Number of Drought and Non-Drought Months and Drought Frequency in Comoé and Boulkiemdé Provinces Based on the SPI12 and SPEI12

Province	Drought index	Number of drought months	Number of free-drought months	Drought Frequency (months/year)
Comoé	SPI12	372	382	5.90
	SPEI12	382	374	6.06
Boulkiemdé	SPI12	355	401	5.63
	SPEI12	379	377	6.02

Source: Author's computation

A breakdown of drought frequency by intensity under SPI12 shows that mild droughts are predominant in both provinces, 63.2% in Comoé and 62.1% in Boulkiemdé. Moderate droughts follow at 20.4% and 22.6%, while severe droughts account for 11.5% and 12.3%, and extreme droughts for 4.9% and 3.0%, respectively. In contrast, SPEI12 reveals more nuanced distributions. In Comoé, mild droughts increase to 69.4%, while moderate and severe events drop to 19.1% and 6.0%, and extreme droughts slightly rise to 5.5%. In Boulkiemdé, mild droughts fall to 63.1%, moderate droughts increase to 23.8%, severe droughts remain at 11.6%, and extreme droughts decrease to 1.6%.

These shifts reflect patterns identified by Zhang et al. (2019), who found that incorporating evapotranspiration into drought indices redistributes severity, reducing extremes while increasing the persistence of moderate and severe droughts. This effect is particularly pronounced in semi-arid regions, where high temperatures sustain hydrological deficits even without rainfall decline. Additionally, Tefera et al. (2025) demonstrated that SPEI is more sensitive to warming trends than SPI, better capturing the compounding effects of temperature and rainfall variability on hydrological systems. Their West Africa-wide analysis showed that in Sudano-Sahelian zones, hydrological droughts are increasingly decoupled from rainfall and more closely linked to evaporative stress.

These findings underscore the importance of using temperature-sensitive indices like SPEI in long-term drought assessment. While SPI12 may underreport water stress in warming climates, SPEI12 reveals how elevated temperatures are intensifying baseline water deficits. The contrast between Comoé's increased drought frequency under SPEI12 and Boulkiemdé's stable but more moderate drought profile highlights the complex interplay between precipitation, evapotranspiration, and landscape-level hydrological processes, as highlighted by Zhang et al. (2019).

Overall, the results confirm that incorporating evapotranspiration into drought analysis enhances the detection of moderate and severe hydrological stress, particularly in semi-arid environments. As Bouabdelli et al. (2022) point out, failing to account for temperature in hydrological assessments can mask systemic drought vulnerability, leading to underpreparedness in water resource management. These findings strengthen the case for integrated drought monitoring frameworks that combine rainfall, temperature, and evapotranspiration to support more targeted adaptation strategies across diverse ecological zones in Burkina Faso. Figure 6.12 shows the distribution of meteorological drought frequency by intensities in the provinces of Comoé and Boulkiemdé, based on SPI12 and SPEI12 values.

Figure 6.12 shows the distribution of hydrological drought frequency by intensities in the provinces of Comoé and Boulkiemdé, based on SPI12 and SPEI12 values.

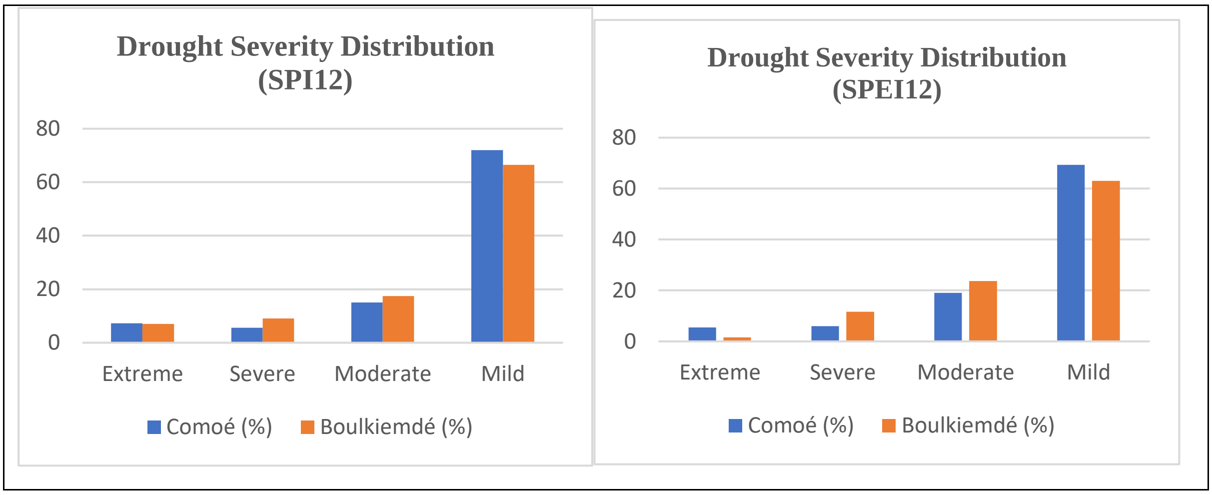


Figure 6.12: Agricultural droughts frequency and distribution in the provinces of Comoé and Boulkiemdé.
Source: Author's Construct

6.4.4 Comparative Analysis of SPI and SPEI Droughts Frequencies

Regarding the extreme droughts, the SPEI generally indicates slightly lower proportions of extreme droughts compared to the SPI, except for SPI12 in both Comoé and Boulkiemdé.

In the Comoé province, the proportion of extreme droughts decreases from 5.33% (SPI3) to 4.07% (SPEI3). This reduction likely reflects the mitigating effect of evapotranspiration, which offsets some rainfall deficits. For the Boulkiemdé province, the extreme droughts measured by SPEI are significantly lower for long-term indices (SPEI12: 1.58% compared to SPI12: 7.04%), suggesting improved water management or less pronounced deficits over extended periods.

The SPEI highlights contrasting trends in severe droughts regarding. In the Boulkiemdé, severe droughts increase under SPEI, rising from 9.01% (SPI12) to 11.61% (SPEI12). This suggests that evapotranspiration exacerbates water deficits in this semi-arid region, where water availability is already limited. Severe droughts decrease slightly under SPEI, from 9.09% (SPI3) to 7.32% (SPEI3) in Comoé province, reflecting a reduced impact of evapotranspiration in this region with more favourable hydrological conditions.

The proportion of moderate droughts consistently increases with the SPEI, particularly in Boulkiemdé. For example, moderate droughts rise from 20.66% (SPI6) to 28.02% (SPEI6). This trend is attributed to heightened evapotranspiration in the Sudano-Sahelian zone which amplifies water deficits, making moderate droughts more pronounced. The SPEI reduces the proportion of mild droughts across all categories, as the integration of evapotranspiration accentuates deficits. In the Boulkiemdé, the droughts decrease from 66.48% (SPI12) to 63.06% (SPEI12), indicating increased water stress due to higher temperatures and evaporative demand.

The SPEI, which incorporates evapotranspiration, highlights the critical role of atmospheric demand in shaping water deficits. This is particularly evident in regions like Boulkiemdé, where semi-arid conditions amplify the impact of evapotranspiration. The province of Comoé shows resilience to moderate and severe droughts but faces a slight rise in extreme droughts under SPEI, likely due to more favourable climatic conditions and reduced evapotranspiration impacts. The Boulkiemdé shows heightened vulnerability to severe and moderate droughts under SPEI, reflecting greater susceptibility to water deficits exacerbated by evapotranspiration. The SPEI also shifts drought classifications, reducing the prevalence of mild droughts while increasing moderate and severe droughts. This trend underscores the importance of considering both rainfall deficits and atmospheric demand when assessing drought impacts.

The comparative analysis of SPI and SPEI highlights the need for tailored drought mitigation strategies. In regions like Boulkiemdé, where evapotranspiration significantly exacerbates water stress, measures such as improved irrigation efficiency, water conservation techniques, and agroforestry could mitigate impacts. In Comoé, efforts should focus on managing extreme droughts and maintaining resilience to severe droughts, leveraging favourable climatic conditions to sustain agricultural productivity and water availability.

6.5 SPI and SPEI-based Drought Duration in Comoé and Boulkiemdé Provinces

6.5.1 Meteorological Droughts Duration

In the Comoé region of the Sudanese climate, meteorological droughts assessed by SPI3 are relatively short. Moderate droughts last an average of 3.76 months, while severe droughts last 6.12 months, with a maximum of 10 months. Conversely, SPEI3 indicates longer durations for all classifications, with moderate droughts lasting an average of 5.65 months and severe droughts lasting 14.33 months, with a maximum of 32 months. This significant difference between SPI3 and SPEI3 highlights the impact of temperature-induced evapotranspiration which prolongs droughts even in humid climates such as Comoé. These findings are in line with research by Bontogho et al. (2022), who showed that in Burkina Faso, indices that include evapotranspiration, such as SPEI, provide a more comprehensive picture of drought dynamics. Their study showed that temperature variability plays a critical role in extending the duration of droughts, especially in humid regions where rainfall alone is insufficient to mitigate hydrological stress. Similarly, Araujo Bonjean et al. (2023) noted that climate variability and evapotranspiration are pivotal in determining drought persistence in West Africa, supporting the observed discrepancies between SPI3 and SPEI3 in Comoé.

In Boulkiemdé, a semi-arid Sudano-Sahelian zone, SPI3 shows slightly longer durations of climatic drought as compared to Comoé. Mild droughts last on average 4.76 months, while extreme droughts last about 6.43 months, both with a maximum duration of 10 months. However, the SPEI3 indicates significantly longer durations, with severe droughts lasting on average 15.36 months and reaching a maximum of 26 months. This discrepancy highlights the cumulative effects of temperature-induced evapotranspiration in prolonged drought conditions. These findings are in line with the observations of Noureldeen et al. (2020), who reported that evapotranspiration significantly prolongs drought duration in semi-arid Sahelian regions when assessed using SPEI rather than SPI. Figure 6.13 shows the average and maximum duration of droughts as a function of their severity, calculated based on the SPI3 and SPEI3 in the provinces of Comoé and Boukiemdé.

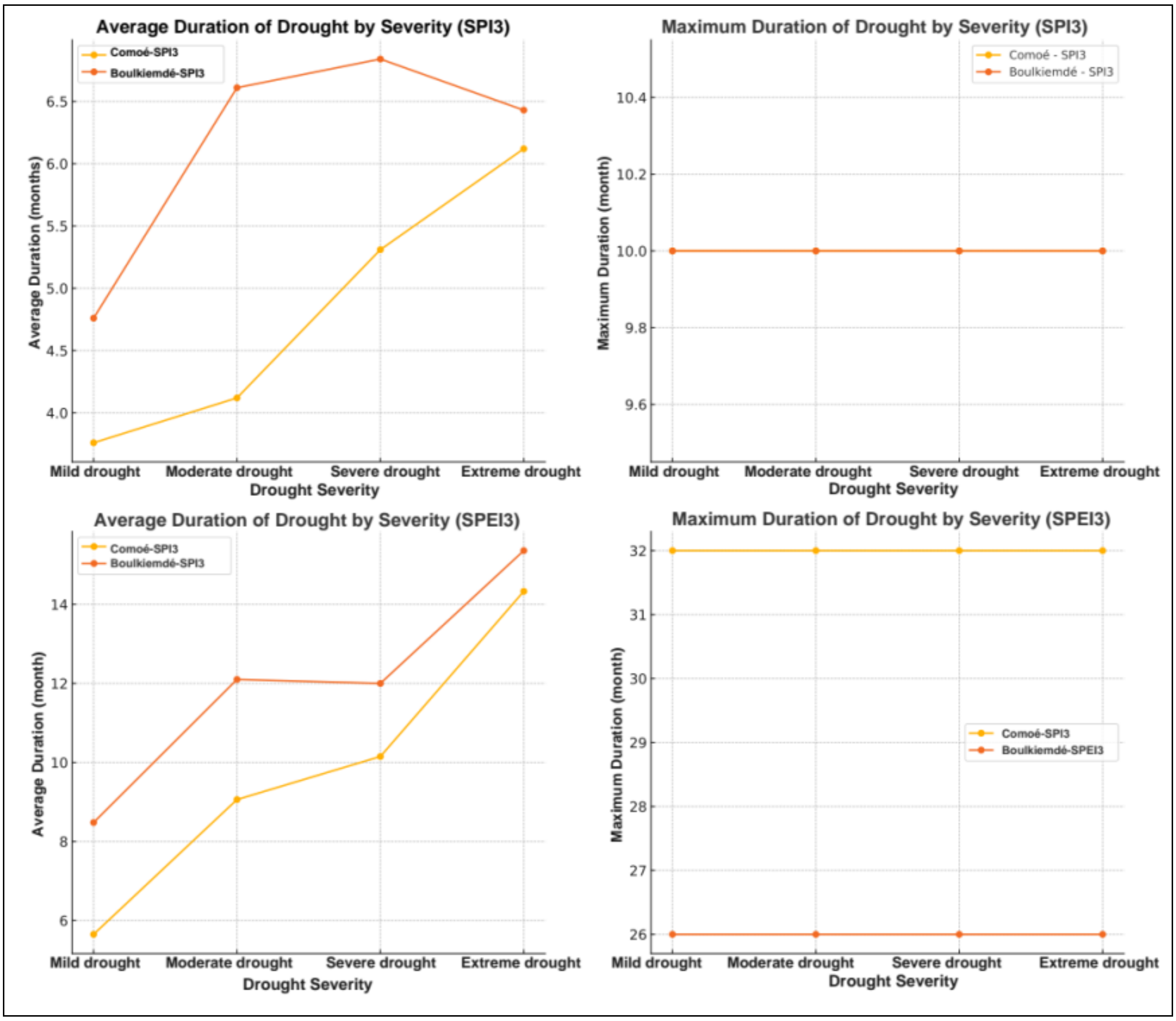


Figure 6.13: Drought duration by severity calculated from SPI 3 and SPEI 3
Source: Author's Construct

The plots for SPI3 and SPEI3 provide a detailed comparison of drought duration by severity in the provinces of Comoé and Boulkiemdé. For SPI3, the first plot (a) shows the average duration of droughts for each severity level (mild, moderate, severe and extreme). Boulkiemdé shows longer average durations than Comoé for moderate and severe droughts. The second plot (b) highlights the maximum duration of droughts which remains constant at 10 months across all severity levels for both provinces. For SPEI3, the third plot (c) shows the average duration of droughts, with Boulkiemdé having longer durations than Comoé for all severities. This trend is particularly pronounced for extreme droughts. The fourth (d) graph shows the maximum duration of droughts, where Comoé has a longer duration of 32 months compared to 26 months in Boulkiemdé. These visualisations underline the different drought characteristics in the two provinces, with Boulkiemdé generally experiencing longer average drought durations and Comoé showing more prolonged maximum droughts under certain conditions.

6.5.2 Agricultural Droughts Duration

In Comoé, agricultural drought measured utilizing SPI6 demonstrates comparatively brief durations, with severe aridity enduring an average of 5.31 months and extreme aridity continuing for 6.12 months, both with a maximum of 10 months. SPEI6, however, discloses markedly longer durations, with severe aridity averaging 10.15 months and extreme aridity extending to 14.33 months on average, with a maximum of 32 months. The incorporation of evapotranspiration in SPEI underscores the compounded influence of temperature-induced water losses on agrarian systems, particularly during the cultivation season. Dardel et al., (2014) discerned analogous patterns in Sudanian zones, where elevated temperatures and erratic precipitation patterns intensify soil moisture deficits, resulting in prolonged agricultural aridity. Their investigation illustrated that SPEI offers a more precise representation of aridity dynamics in comparison to SPI. Similarly, Faye et al. (2022) found that SPEI offered a more accurate representation of agricultural aridity than SPI. The extended drought durations observed with SPEI were attributed to the increasing influence of evapotranspiration, which has become a dominant factor in determining water deficits in the semi-arid climate of West Africa. These findings support the results observed in Comoé, where SPEI revealed longer durations of agricultural droughts compared to SPI.

In Boulkiemdé, SPI6 findings indicate extended durations for agricultural drought relative to Comoé, with severe drought lasting an average of 6.84 months and extreme aridity persisting for 6.43 months, both with a maximum of 10 months. SPEI6 unveils even greater durations, with severe aridity averaging 12.00 months and extreme aridity continuing for 15.36 months on average, with a maximum of 26 months. The prolonged durations reflect the impact of semi-arid conditions and evapotranspiration on agricultural aridity persistence.

These observations are congruent with conclusions drawn by Diasso and Abiodun (2017), who demonstrated that semi-arid zones undergo extended agricultural aridity due to elevated evapotranspiration rates. For Sayat et al. (2025), the SPI frequently minimises drought durations in these regions since it fails to consider the water losses induced by temperature.

Ceccherini et al. (2017) underscored that rising temperatures in the Sudano-Sahelian region exacerbate soil moisture deficits, rendering SPEI an essential instrument for comprehending agricultural aridity. Figure 6.14 shows the average and maximum duration of droughts as a function of their severity, calculated on the basis of the SPI6 and SPEI6 in the provinces of Comoé and Boukiemdé.

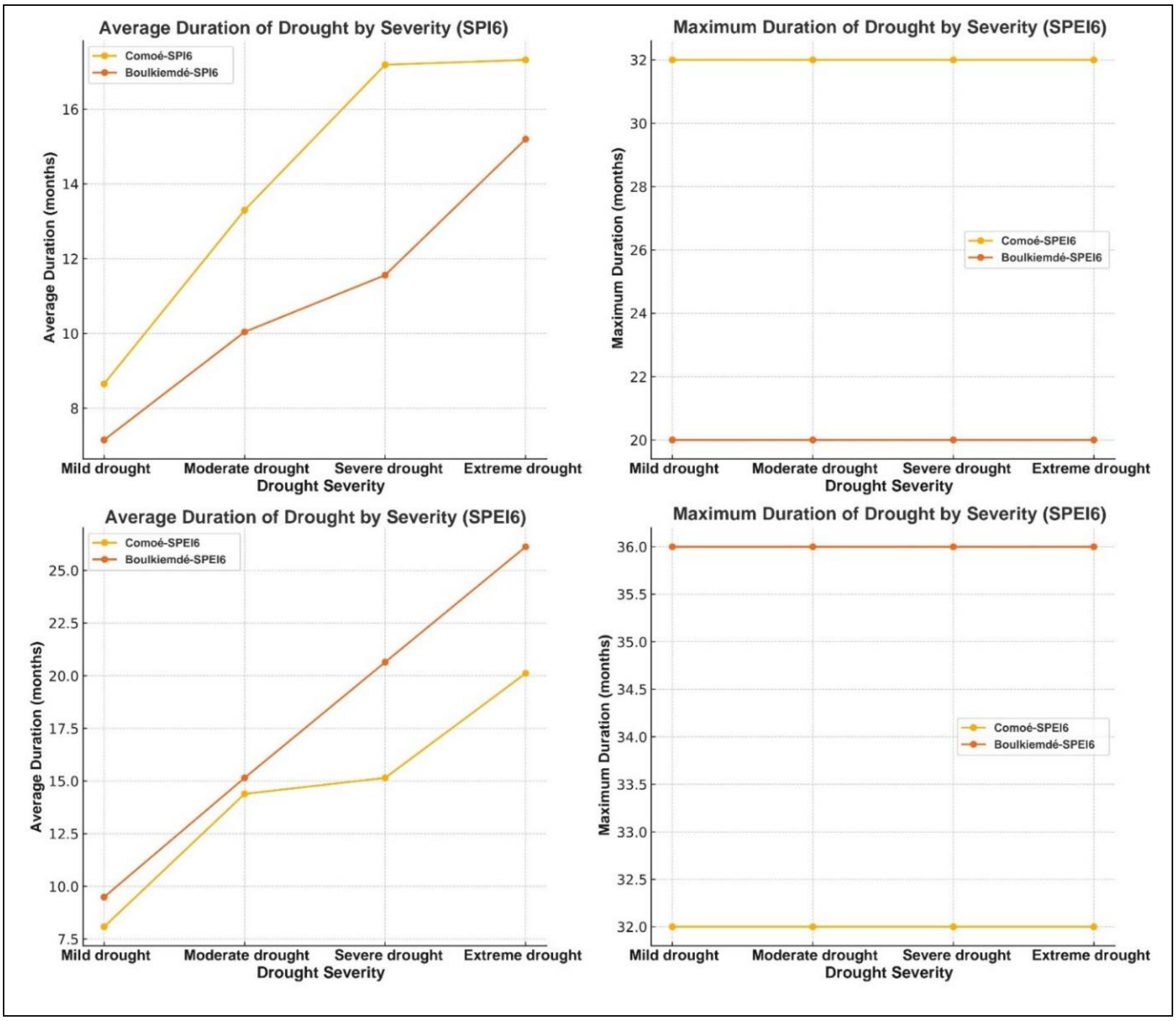


Figure 6.14: Drought duration by severity calculated from SPI6 and SPEI6
Source: Author's Construct

The plots for SPI6 and SPEI6 provide a detailed comparison of drought duration by severity in Comoé and Boulkiemdé provinces. For SPI6, the first plot shows the average duration of droughts across severity levels, including mild, moderate, severe and extreme droughts, in both provinces. While the average durations are similar, the maximum duration of droughts, shown in the second plot, shows that Comoé consistently reaches a maximum of 32 months, while Boulkiemdé experiences shorter maximum durations of 20 months. For SPEI6, the third plot highlights the average duration of droughts, showing longer durations in Boulkiemdé compared to Comoé, especially for severe and extreme droughts. The fourth plot shows the maximum duration of droughts, with Boulkiemdé reaching a maximum of 36 months, exceeding the maximum of 32 months recorded in Comoé. These plots provide a clearer and more nuanced understanding of drought dynamics in the two provinces, showing the differences in both severity and duration depending on the indicator used.

6.5.3 Hydrological Droughts Duration

In Comoé, SPI12 reveals hydrological droughts lasting up to 35 months for extreme events, with severe droughts averaging 31.67 months. SPEI12 shows even longer durations, with extreme droughts averaging 34.81 months and reaching a maximum of 43 months. These results highlight the importance of cumulative water deficits and the influence of evapotranspiration in prolonging drought duration. As observed by Zhang et al. (2019), similar patterns were found in tropical areas where prolonged droughts are significantly exacerbated by cumulative rainfall deficits and increasing evapotranspiration. Makougoum et al. (2020) further demonstrated that SPEI provides a more holistic understanding of hydrological drought dynamics in humid regions compared to SPI.

In Boulkiemdé, SPI12 implies that extreme hydrological droughts last up to 47 months, with severe droughts lasting an average of 34.75 months. SPEI12, on the other hand, shows much longer durations, with extreme droughts lasting an average of 119 months. These longer durations highlight the compounding effects of cumulative precipitation deficits and temperature-induced evapotranspiration in the semi-arid Sudano-Sahelian zone. In their 2020 analysis, Hassan et al. found that SPEI is adept at detecting persistent hydrological droughts in places where evapotranspiration amplifies water scarcity. As highlighted by Nicholson et al. (2018), the combination of rising temperatures and climate variability is exacerbating prolonged droughts, establishing SPEI as an essential tool for in-depth analysis in semi-arid landscapes. In addition, Faye, (2022) further emphasised that SPEI is particularly advantageous for capturing prolonged climatic droughts in West Africa, where temperature increases exacerbate hydrological stresses. Figure 6.15 illustrates the average and maximum duration of droughts as a function of their severity, calculated on the basis of SPI12 and SPEI12 in the provinces of Comoé and Boulkiemdé.

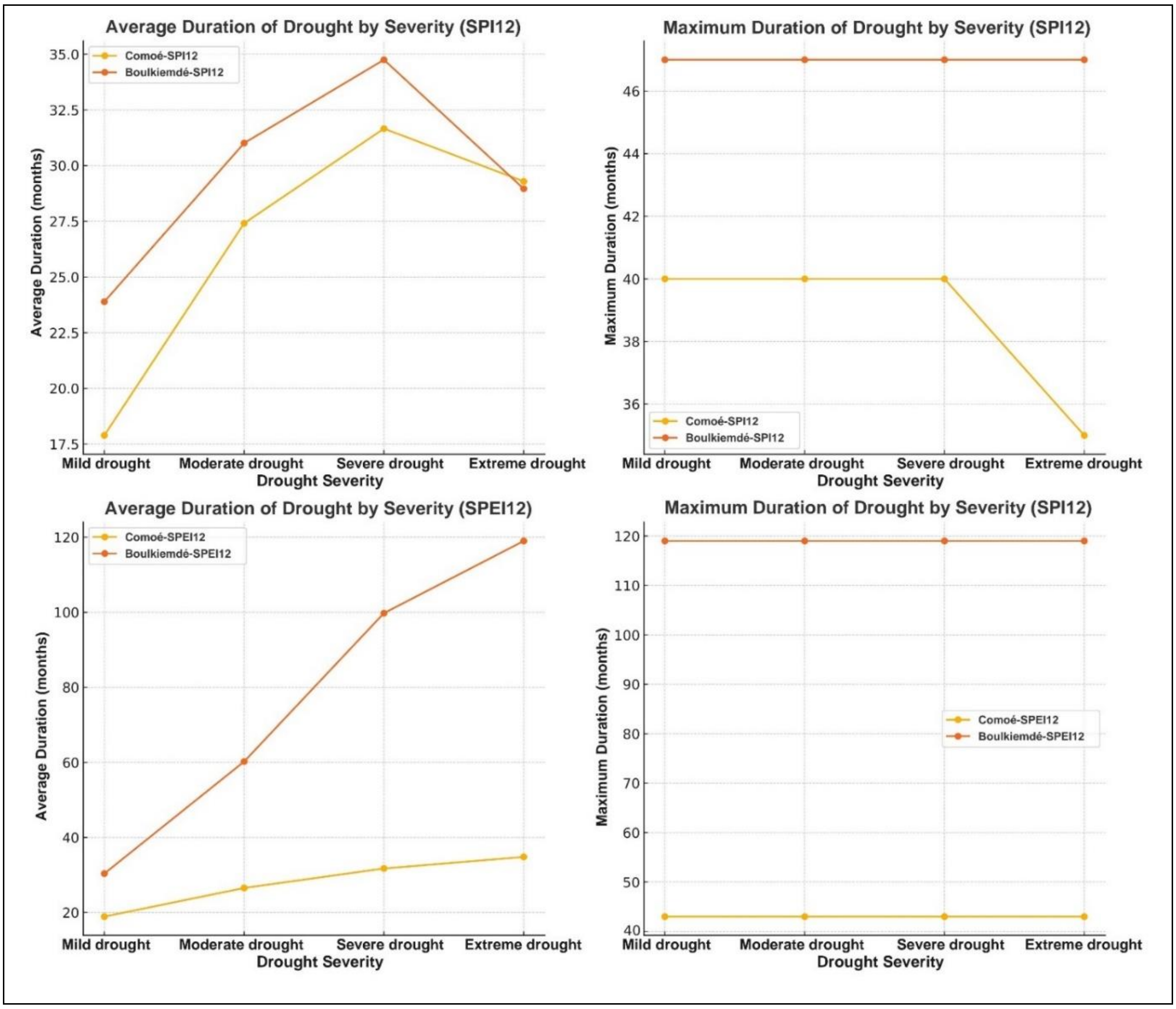


Figure 6.15: Drought duration by severity calculated from SPI12 and SPEI12
Source: Author’s Construct

The plots for SPI12 and SPEI12 provide a comparative analysis of drought duration by severity in the provinces of Comoé and Boulkiemdé. For SPI12, the first plot highlights the average duration of droughts for each severity level - mild, moderate, severe and extreme. Boulkiemdé has longer average durations than Comoé for all severity levels. The second graph illustrates the maximum duration of droughts, with Boulkiemdé consistently having longer maximum durations than Comoé. For SPEI12, the third plot shows the average duration of droughts, revealing significant differences between the two provinces. Boulkiemdé experiences much longer durations than Comoé, especially for severe and extreme droughts. The fourth plot shows the maximum duration of droughts, with Boulkiemdé having a significantly higher maximum duration (119 months) than Comoé (43 months). These plots provide a comprehensive comparison of drought dynamics at the hydrological scale, highlighting the longer and more severe droughts in Boulkiemdé compared to Comoé.

6.6 Analysis of drought return levels using combined indices for Comoé and Boulkiemdé

The analysis of return levels of combined indices (SPI-SPEI) for the provinces of Comoé (Sudanese zone) and Boulkiemdé (Sudano-Sahelian zone) reveals contrasting drought dynamics. These return values, calculated for return periods of 2, 5, 10, 20, 50 and 100 years, allow the intensity of drought events to be assessed in relation to their rarity. The results for each province are compared with similar studies carried out in Burkina Faso and other regions of West Africa.

6.6.1 Return levels for Comoé

Figure 6.16 shows the relationship between drought intensity (measured by the combined index) and return period (in years) in the Come province. It relates the combined drought index levels to return periods of 2, 5, 10, 20, 50 and 100 years.

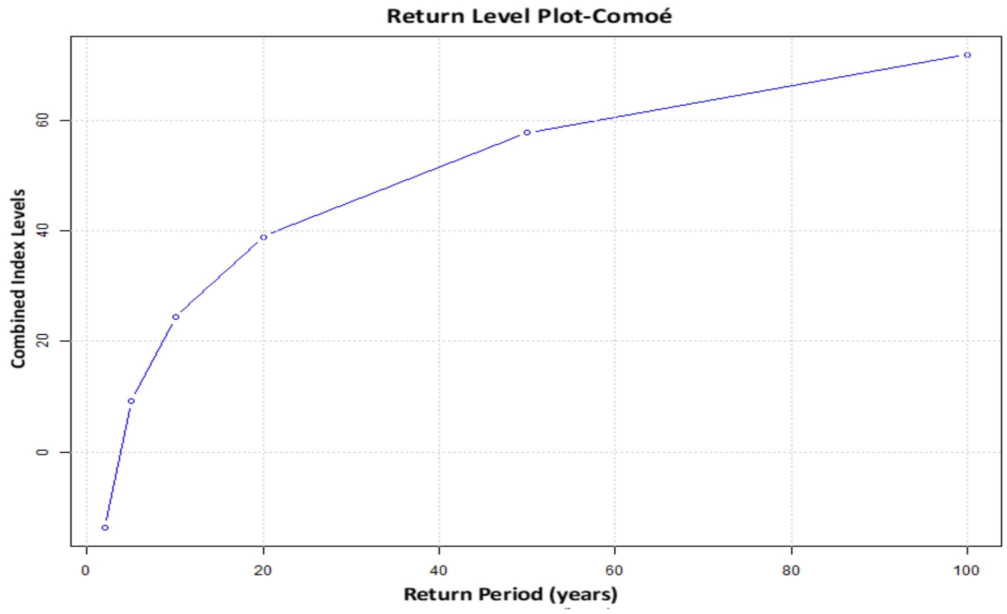


Figure 6.16: Return levels graph for the province of Comoé
Source: Author's Construct

In Comoé, return levels show a significant increase in drought intensity with longer return periods. For a 2-year return period, the combined index is negative (-14.25), indicating that frequent droughts in this region are moderate or that excess rainfall compensates for water deficits. These results are consistent with the findings of Bontogho et al. (2022), who showed that in the Massili basin of Burkina Faso, while periodic droughts occur, sufficient rainfall can mitigate the intensity of short-term deficits. From a return period of 5 years, the index becomes positive (6.84) and continues to increase, reaching 20.81 and 34.21 for return periods of 10 and 20 years, respectively. These values reflect the increasing intensity of moderate and severe droughts as their frequency decreases. The observations of Araujo Bonjean et al. (2023) support this trend, showing that in West African regions, medium-term droughts are often the result of combined rainfall deficits and increased evapotranspiration rates. For longer return periods (50 and 100 years), the return values reach 51.55 and 64.55, indicating rare but very intense extreme droughts. These results are consistent with regional analyses by Sy et al. (2021) which demonstrated that in West Africa, prolonged drought events are amplified by extreme climatic anomalies, including heat waves and interannual rainfall variability.

6.6.2 Return Levels for Boulkiemdé

Figure 6.17 shows the relationship between drought intensity (measured by the combined index) and return period (in years) in the Boulkiemdé province.

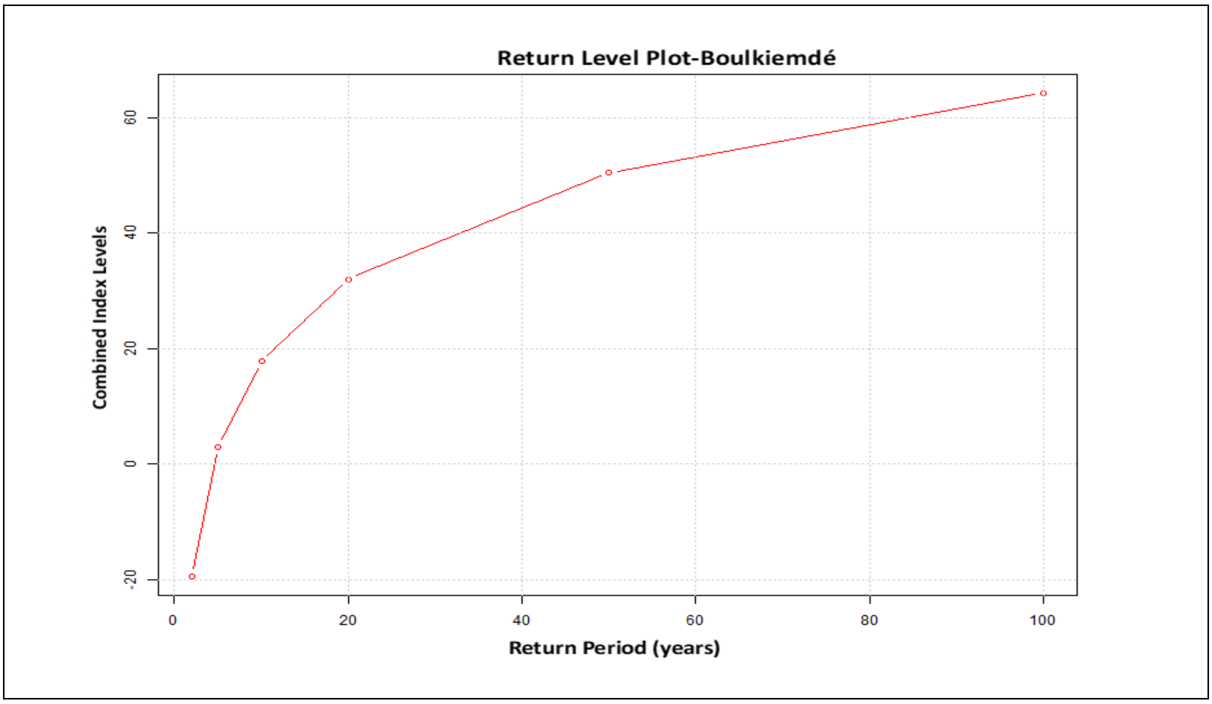


Figure 6.17: Return levels graph for the province of Boulkiemdé
Source: Author's Construct

In Boulkiemdé, return levels follow a similar pattern, but with less intensity than in Comoé. For a 2-year return period, the combined index is also negative (-20.22), reflecting mild droughts or occasional rainfall excesses over short periods. This result is consistent with the observations of Abaje et al. (2013), who showed that the Sudano-Sahelian regions are characterised by irregular rainfall patterns and water deficits only become significant for less frequent events. For medium return periods of 5 to 20 years, the return levels increase from -0.09 to 13.23 and 26.00. This indicates that moderate droughts are more frequent in this region and their intensity increases with longer return periods. These findings are consistent with the work of Tefera et al. (2025), who reported that droughts in the Sahel often manifest as moderate but recurrent water deficits due to high rainfall variability. For longer return periods of 50 and 100 years, the return levels reach 42.55 and 54.95, respectively, indicating extreme droughts that are less intense than those in Comoé. This reflects the semi-arid conditions of Boulkiemdé, where droughts are more frequent but rarely catastrophic. These observations confirm the conclusions of Nicholson, (2013), who noted that in Sudano-Sahelian regions, extreme droughts are often mitigated by low soil water retention and vegetation adapted to water deficits.

6.6.3 Comparison between Comoé and Boulkiemdé

Figure 6.18 compares the return levels plots for Comoé and Boulkiemdé. It shows at a glance the differences and similarities between the two provinces.

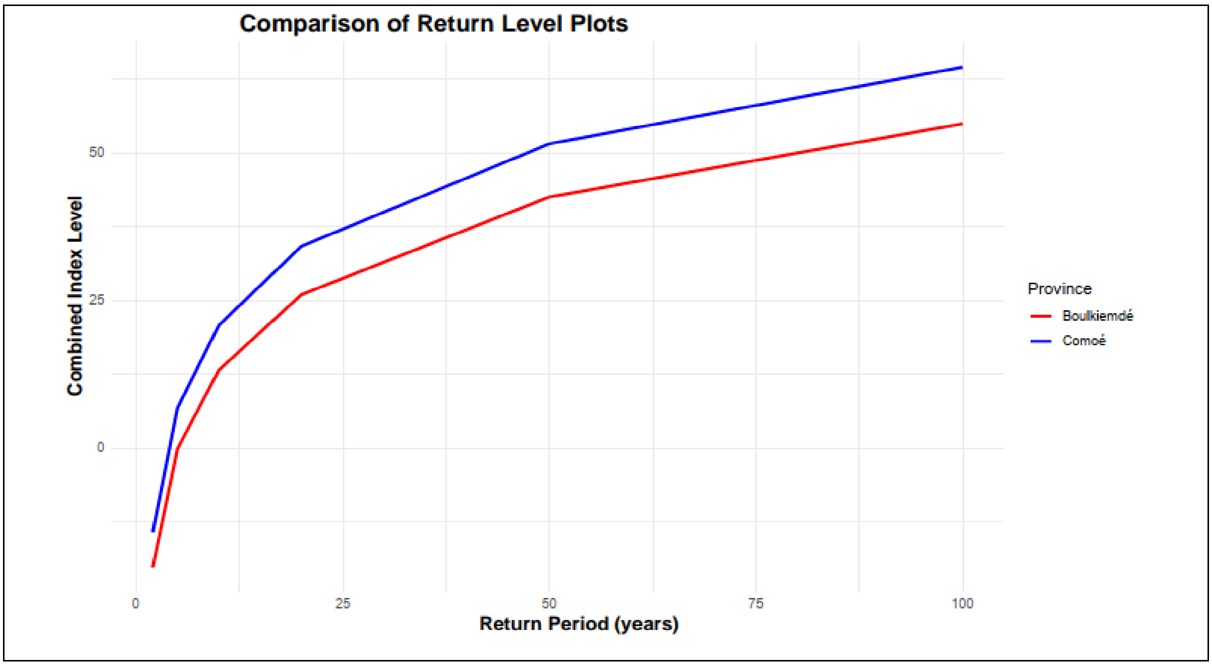


Figure 6.18: Comparative graph of return levels in Comoé and Boulkiemdé

Source: Author’s Construct

The return levels show significant differences between Comoé and Boulkiemdé. For short return periods (2 to 5 years), the values are negative for both provinces, but those for Boulkiemdé are lower, reflecting the more frequent and milder droughts in this semi-arid region. Starting from medium return periods (10 to 20 years), the return levels become positive for both provinces, but the values increase more rapidly in Comoé. This indicates that prolonged droughts are more severe in the Sudanese region than in Boulkiemdé. For long return periods (50 to 100 years), the return levels peak at 64.55 in Comoé and 54.95 in Boulkiemdé. These differences reflect specific climatic dynamics. Comoé, with higher annual rainfall, accumulates prolonged water deficits during rare events, whereas Boulkiemdé, with lower rainfall, experiences more frequent but less intense droughts. Those results for both provinces are consistent with studies conducted in West Africa. For example, Tefera et al. (2025) showed that extreme droughts are rare but intense in the Sudanese zone, while they are more frequent but moderate in the Sudano-Sahelian zone. Similarly, Marcotullio et al. (2021) highlighted that droughts in tropical humid zones are exacerbated by prolonged heat waves, which explains the higher return levels for long periods in Comoé.

The return levels of the combined indices reveal contrasting drought dynamics between Comoé and Boulkiemdé. In Comoé, droughts are less frequent but more intense, whereas in Boulkiemdé they are more frequent but more moderate.

6.7 Migration Dynamics in the Provinces of Comoé and Boulkiemdé

Migration dynamics in the provinces of Comoé and Boulkiemdé show distinct and contrasting trends in terms of inflows, outflows and net migration. Analysed over the years 1985, 1996, 2006 and 2019, these data reflect the socio-economic and environmental contexts specific to each province.

6.7.1 Migration Dynamics in the Province of Comoé

The Comoé province was characterised by consistently positive net migration throughout the period under study. In 1985, net migration amounted to 16,513, with 27,566 arrivals and only 11,053 departures. This situation highlights a relatively stable and attractive province, probably due to the favourable climatic conditions associated with its location in the Sudanese zone. These findings are in line with the work of Henry et al. (2004), who showed that the Sudanese regions of Burkina Faso attract more people due to higher rainfall and agricultural resources compared to more arid areas.

In 1996, net migration increased to 24,621, driven by a rise in inflows to 41,294, while outflows remained low at 16,673. This can be explained by the fact that the former cotton-growing area, which was mainly located in the Mouhoun and Houet regions, became saturated in the 1990s, and migrants were confronted with land tenure insecurity (Claims/Issp, 2005; Nana, 2018). This area is gradually losing migrants to the new pioneer front, in particular the Comoé provinces, which began to record large inflows of internal migrants in the 1990s (Nana, 2018; Ouedraogo et al., 2010).

The year 2006 marks a notable peak, with net migration reaching 69,012, supported by exceptionally high inflows of 93,523 and limited outflows of 24,511. The sharp increase in inflows can be explained by two major events (Nana, 2018; Zongo, 2009).The first is the inter-community conflict that broke out in the Ivorian town of Tabou in 1999, which led to the repatriation of thousands of migrants from Burkina Faso. In addition, the outbreak of the politico-military crisis (the rebellion) in Côte d'Ivoire led to the mass departure of migrants from that country. These migrants, mainly from the 'Mossi plateau', have mostly returned to settle in the province of Comoé, which has more favourable climatic conditions and is less densely populated than their places of origin.

In 2019, inflows fell slightly to 86,703 but net migration remained positive at 43,511. This slight decline may reflect increased competition from urban areas, which are attracting a growing share of the national migrant population. Schoumaker and Dabiré (2014) confirm this trend, noting that increasing urbanisation in regions such as Bobo-Dioulasso has contributed to attracting some of the migration flows.

The province of Comoé consistently displayed positive net migration in the years analysed (1985, 1996, 2006 and 2019). In 1985, Comoé recorded a net migration of 16 513, with inflows of 27 566 and outflows of 11 053. The province's location in the Sudan zone, which benefits from higher annual rainfall and favourable agricultural conditions, probably contributed to its attractiveness. Research by Nébié and West, (2019) highlights that provinces in the Sudanian zone, characterised by relatively stable climatic conditions and better agricultural potential, are consistently more attractive for migration. These findings are also consistent with Sanfo et al. (2017), who found that productive agricultural zones in Burkina Faso tend to attract rural populations fleeing drier regions.

In 1996, net migration increased to 24,621, driven by a rise in inflows to 41,294, while outflows remained low at 16 673. In 1996, net migration increased to 24 621 people, as a result of an increase in inflows to 41 294 people, while outflows remained low at 16,673 people. This can be explained by the fact that the former cotton-growing area, which was mainly located in the Mouhoun and Houet regions, became saturated in the 1990s, and migrants were confronted with land tenure insecurity (Claims/Issp, 2005; Nana, 2018). This area is gradually losing migrants to the new pioneer front, in particular the Comoé provinces, which began to record large inflows of internal migrants in the 1990s (Nana, 2018; Ouedraogo et al., 2010).

The year 2006 marks a notable peak, with net migration reaching 69,012, supported by exceptionally high inflows of 93,523 and limited outflows of 24,511. The sharp increase in inflows can be explained by two major events (Nana, 2018; Zongo, 2009).The first is the inter-community conflict that broke out in the Ivorian town of Tabou in 1999, which led to the repatriation of thousands of migrants from Burkina Faso. In addition, the outbreak of the politico-military crisis (the rebellion) in Côte d'Ivoire led to the mass departure of migrants from that country. These migrants, mainly from the 'Mossi plateau', have mostly returned to settle in the province of Comoé, which has more favourable climatic conditions and is less densely populated than their places of origin.

In 2019, while inflows to Comoé decreased slightly to 86,703, the province maintained a positive net migration of 43,511. This slight decline in attractiveness may reflect increased competition from urban areas such as Bobo-Dioulasso which have experienced rapid industrialization and urbanization. A study by Guipo, (2019) corroborates this trend, indicating that since the 1990s, migratory movements have frequently been directed toward major urban centers like Ouagadougou and Bobo-Dioulasso, as well as secondary cities in regions with high natural potential, such as the cotton-growing areas of the West and South.

6.7.2 Migration Dynamics in the Province of Boulkiemdé

In contrast to Comoé, Boulkiemdé experienced negative net migration throughout the period analysed. In 1985, the inflow was 22,927, but the outflow reached 80,742, resulting in a net migration of -57,805. This pattern reflects the more difficult socio-economic and environmental conditions of the Sudano-Sahelian zone of Burkina Faso. The great droughts of the 1970s and 1980s contributed to the mass exodus of people from these areas where the climatic conditions were the worst (Niva et al., 2021; Nébié & West, 2019). These findings are consistent with Henry et al. (2004), who documented significant population losses from arid and semi-arid zones to more favourable areas. In 1996, immigration increased slightly to 27,108, while emigration increased to 83,742, resulting in a negative net migration of -56,634. This stagnation may be due to persistent challenges such as limited economic opportunities and increased rainfall variability.

In 2006, the province recorded its highest migration loss, with a net migration of -76,389. Inflows reached 31,636, but outflows rose to 108,025. This significant loss is probably due to environmental factors, in particular, the frequent droughts in the Sudano-Sahelian zones, which drive the population towards more fertile agricultural areas in the west (B. Sawadogo, 2022). Teye and Nikoi, (2022) showed that climatic shocks, especially droughts, are a major driver of migration in semi-arid regions of West Africa.

In 2019, the province of Boulkiemdé recorded a peak in inflows of 73,644 individuals, but outflows were higher at 130,420 individuals, resulting in a net migration of -56,776. This is not consistent with the increase in humidity conditions noted in the analysis of drought trends (SPEI) in the province and confirmed by Sanou et al. (2023) in the Sudano-Sahelian zone. This migration trend highlights the persistence of structural challenges, in particular high demographic pressure, land scarcity and limited economic resources (Zoma, Compaoré, et al., 2024).

6.7.3 Comparison between Comoé and Boulkiemdé

Figure 6.19 clearly illustrates the temporal dynamics of inflows, outflows and net migration in Boulkiemdé and Comoé for the years 1985, 1996, 2006 and 2019.

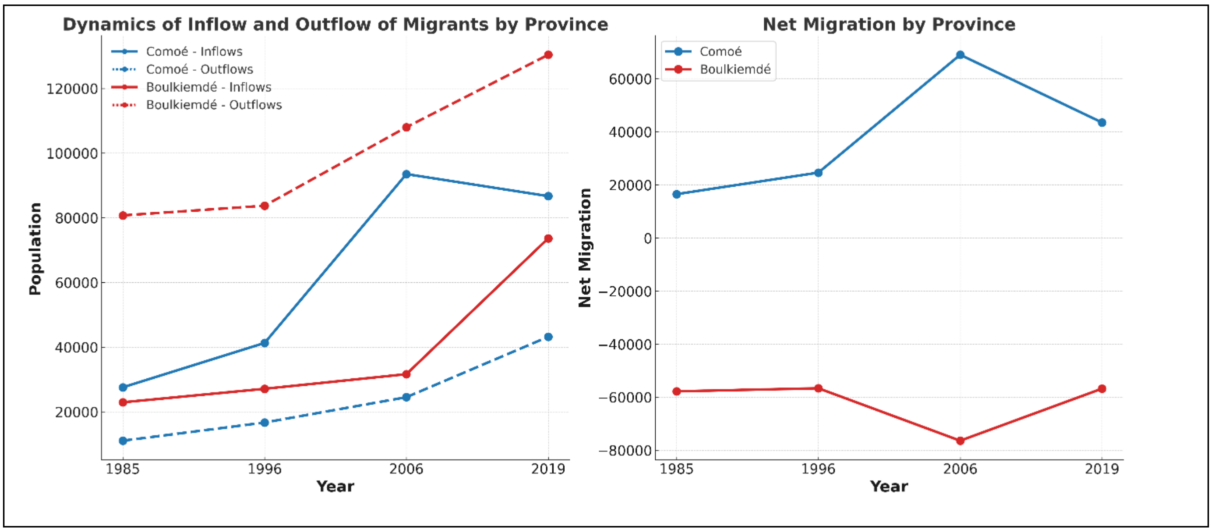


Figure 6.19: Temporal Dynamics of Migration in Comoé and Boulkiemdé
Source: Author's Construct

The province of Comoé has consistently recorded higher inflows than outflows, reflecting its continued attractiveness. In 2006, inflows peaked at 93,523, probably due to favourable economic and agricultural conditions. Although inflows declined slightly in 2019 (86,703), net migration remained positive at 43,511, confirming that the province continues to attract significant numbers of migrants. Net migration peaked in 2006 (69,012), reflecting a period of increased attractiveness. These findings are consistent with studies of migration in West Africa which show that Sudanese regions with better climatic and economic conditions attract more migrants (Nébié & West, 2019; Sanfo et al., 2017). In contrast, the province of Boulkiemdé consistently shows lower inflows relative to outflows, resulting in a persistent negative net migration. In 2019, inflows increased significantly to 73,644, while outflows peaked at 130,420, reflecting continued population loss. This trend is attributed to socio-economic and environmental constraints, such as limited resources and adverse climatic conditions, as similarly observed by Schürmann et al. (2022) in other semi-arid and arid zones in Burkina Faso. Net migration reached a notable low in 2006 (-76,389) and improved slightly by 2019 (-56,776), possibly due to population maintenance efforts.

Migration dynamics in the provinces of Comoé and Boulkiemdé reflect divergent socio-economic and environmental contexts. Comoé stands out for its ability to attract and retain its population, largely due to favourable climatic conditions and growing economic opportunities. Conversely, Boulkiemdé experiences persistent population loss due to structural and environmental challenges. These findings are consistent with observed migration trends in Burkina Faso and West Africa where Sudanian regions attract more migrants while Sudano-Sahelian regions continue to lose their population (Schürmann et al., 2022;Teye & Nikoi, 2022).

6.8 Linking Migration and Drought in Comoé and Boulkiemdé Provinces

The Comoé in the Sudanian zone and the Boulkiemdé in the Sudanian-Sahelian zone provide contrasting contexts in which to explore possible links between drought conditions, as measured by the SPI and SPEI indices, and the dynamics of migration. The Pearson correlation matrix is used to quantify the links between these climatic indices and migratory flows - specifically inflows, outflows and net migration. A province-by-province analysis highlights the unique characteristics of migratory dynamics in each province, while also exploring similarities and differences in how climatic conditions affect these flows.

6.8.1 Migration and Drought Dynamics in the Province of Comoé

Table 6.5, showed Pearson correlation matrix between SPI/SPEI and migration variables in Comoé.

In 1985, the province of Comoé experienced slightly humid climatic conditions, characterised by positive SPI and SPEI indices, except for SPI and SPEI 24. The Pearson correlation between the SPEI6 and inflows was 0.81, and the correlation with net migration was similarly high at 0.8. These values underline the strong influence of medium-term wet conditions on migration dynamics in the province. During this period, inflows represented 15.44% of the population while outflows were 6.19%, resulting in a positive net migration rate of 9.25%. These findings are consistent with Hassan and Tularam, (2018), who showed that favourable climatic conditions promote rural retention and even attract migrants to agriculturally productive regions in Burkina Faso and Senegal.

By 2006, the province had become slightly more humid. Inflows increased significantly to 22.95%, while outflows decreased slightly to 9.01%, resulting in a net migration rate of 16.93%. The correlations showed a very strong relationship between SPI6 and net migration, with a correlation value of 0.88, highlighting the positive impact of medium-term wet conditions on migration attractiveness. These findings are in line with Van der Land et al. (2018) who noted that improved precipitation seasons facilitate internal migration in West Africa, especially in areas with stable agricultural conditions.

In 2019, despite favourable climatic conditions as indicated by positive SPI and SPEI indices, migration flows declined compared to 2006. Inflows represented only 13.70% of the population, while outflows increased slightly to 6.83%, resulting in a lower net migration rate of 6.88%. Nevertheless, correlations showed a strong relationship between climate indices and migration flows, with the SPI12 showing a positive correlation of 0.87 with net migration. These results suggest that although climatic conditions were favourable, other factors such as land saturation and declining economic opportunities played a key role in limiting migration to the province. This is in line with the conclusions of Piguet et al. (2011), who highlighted the predominant influence of socio-economic factors in climate-related migration.

Table 6.5: Pearson correlation matrix between SPI/SPEI and migration variables in Comoé

Year	1985			1996			2006			2019		
Variable	**Inflows**	**Outflows**	**Net Migration**	**Inflows**	**Outflows**	**Net Migration**	**Inflows**	**Outflows**	**Net Migration**	**Inflows**	**Outflows**	**Net Migration**
SPI3 Comoé	0.63	-0.48	0.71	-0.49	0.41	-0.56	0.77	-0.62	0.84	0.58	-0.44	0.65
SPI6 Comoé	0.75	-0.42	0.78	-0.63	0.38	-0.67	0.82	-0.67	0.88	0.49	-0.37	0.57
SPI12 Comoé	0.02	-0.37	0.29	-0.68	0.32	-0.72	0.29	-0.41	0.55	0.81	-0.63	0.87
SPEI3 Comoé	0.68	-0.51	0.77	-0.52	0.42	-0.61	0.53	-0.48	0.69	0.23	-0.17	0.35
SPEI6 Comoé	0.81	-0.43	0.8	-0.51	0.35	-0.59	0.61	-0.49	0.74	0.33	-0.19	0.41
SPEI12 Comoé	0.33	-0.28	0.58	-0.47	0.31	-0.53	0.15	-0.22	0.32	0.72	-0.56	0.83

$|r|<0.3$: Low correlation; **$0.3\leq|r|<0.7$:** Moderate correlation, **$|r|\geq0.7$**: Strong correlation

Source: Authors computation

6.8.2 Migration and Drought Dynamics in the Province of Boulkiemdé

Table 6.6 showed the Pearson correlation matrix between SPI/SPEI and migration variables in Boulkiemdé.

In 1985, negative SPI and SPEI indices indicated prolonged droughts, resulting in high emigration of 22.11% of the population and limited immigration of 6.28%, leading to a highly negative net migration rate of -15.83%. Pearson correlations revealed a strong relationship between prolonged droughts and migration flows, with SPI12 showing a highly negative correlation of -0.912 with net migration. SPI3 also showed a moderate negative correlation of -0.612 with inflows and a strong positive correlation of 0.743 with outflows. These results are in line with Bruning & Piguet, (2018), who showed that droughts exacerbate outflows in vulnerable agricultural regions.

In 1996, although climatic conditions remained dry, slight improvements were observed. Outflows decreased to 19.88% while inflows increased slightly to 6.43%, resulting in a less negative net migration rate of -13.44%. The SPI12 continued to show a strong negative correlation with inflows (-0.837) and a moderate positive correlation with outflows (0.629). These findings are consistent with Van der Land et al. (2018), who found that environmental conditions affect migration, but are moderated by economic and social factors. Azumah and Ahmed (2023) similarly, found that in addition to climate factors, the migration decision of maize farmers in Ghana is influenced by socio-economic factors such as household size, farming experience, access to credit, training in climate-smart farming, access to extension services and information provided by extension agents.

In 2006, the intensification of prolonged droughts exacerbated migration dynamics. Outflows increased to 21.69%, while inflows decreased slightly to 6.35%, resulting in a net migration rate of -15.34%. The SPI12 again showed a strong negative correlation of -0.912 with net migration confirming the negative impact of prolonged droughts on migration. The SPI3 also showed a moderate negative correlation with inflows (-0.612) and a strong positive correlation with outflows (0.743), reflecting the significant impact of adverse climatic conditions on migration flows.

By 2019, significant improvements in rainfall, indicated by positive SPI and SPEI indices, led to an increase in inflows of 10.69% and a decrease in outflows of 18.92%. This reduced the negative net migration rate to -8.24%. The SPI12 showed a very strong positive correlation with net migration (0.974) and a strong negative correlation with outflows (-0.862), suggesting that prolonged periods of wetness favoured increased inflows and reduced outflows. These findings are consistent with Diallo (2024a), who observed that improved precipitation stabilises migration flows in regions affected by climate variability in Senegal.

Table 6.6: Pearson correlation matrix between SPI/SPEI and migration variables in Boulkiemdé

Year	**1985**			**1996**			**2006**			**2019**		
Variable	**Inflows**	**Outflows**	**Net Migration**	**Inflows**	**Outflows**	**Net Migration**	**Inflows**	**Outflows**	**Net Migration**	**Inflows**	**Outflows**	**Net Migration**
SPI3 Boulk.	-0.612	0.743	-0.889	0.345	-0.471	0.558	0.611	-0.719	0.842	0.611	-0.719	0.842
SPI6 Boulk.	-0.531	0.648	-0.805	0.218	-0.318	0.419	0.715	-0.805	0.891	0.715	-0.805	0.891
SPI12 Boulk.	-0.837	0.629	-0.912	0.104	-0.205	0.291	0.928	-0.862	0.974	0.928	-0.862	0.974
SPEI3 Boulk.	-0.047	0.283	-0.355	-0.278	0.341	-0.473	0.354	-0.405	0.489	0.354	-0.405	0.489
SPEI6 Boulk.	0.221	-0.195	0.109	-0.381	0.508	-0.641	-0.189	0.232	-0.289	-0.189	0.232	-0.289
SPEI12 Boulk.	-0.341	0.524	-0.602	-0.469	0.612	-0.769	-0.356	0.495	-0.623	-0.356	0.495	-0.623

6.8.3 Comparative analysis between Comoé and Boulkiemdé

Comparing the provinces of Comoé and Boulkiemdé, it is clear that climatic conditions as measured by the SPI and SPEI indices have a significant impact on migration dynamics. However, the impact of droughts is more pronounced in Boulkiemdé, where they consistently lead to negative net migration rates while in Comoé wet periods generally support positive migration dynamics. This difference can be attributed to factors such as the level of socio-economic development, the availability of arable land and economic opportunities which determine how populations respond to climatic conditions. These observations are consistent with the findings of Fernández et al. (2024), which emphasises that while climate is a key driver of migration, its effects need to be examined within a broader framework of socio-economic and structural dynamics.

6.9 Summary

This study analyses drought dynamics and migration trends in the provinces of Comoé and Boulkiemdé using SPI and SPEI indices. The results highlight significant climatic differences between the two regions. Comoé (Sudanian zone) experiences less frequent but intense droughts, with extreme meteorological droughts reaching an SPI3 of -4.1 and hydrological droughts lasting up to 43 months (SPEI12). In contrast, Boulkiemdé (Sudano-Sahelian zone) faces prolonged and severe droughts, with extreme hydrological droughts persisting for up to 119 months (SPEI12). The inclusion of evapotranspiration in SPEI further emphasizes the growing impact of rising temperatures, particularly in Comoé, where a statistically significant negative trend in SPEI12 suggests increasing hydrological degradation. Drought severity varies across timescales. Long-term droughts are more intense in Comoé, as reflected in SPI12 and SPEI12 values. However, Boulkiemdé exhibits occasional hydrological recovery, shown by slight positive trends in SPEI6. Despite these fluctuations, both regions face intensifying agricultural and hydrological droughts, reinforcing the pressing need for effective water resource management. The findings confirm a strong relationship between drought conditions and migration patterns. Comoé attracts more migrants, benefiting from relatively favourable climatic and socio-economic conditions. Migration peaked in 2006, with a net migration gain of 69,012, driven by high inflows (93,523) and low outflows (24,511). Conversely, Boulkiemdé experiences significant population departure, due to prolonged drought and economic constraints. In 2006, net migration reached a low of -76,389, with outflows as high as 108,025. Correlation analysis further supports these trends. In Comoé, periods of increased precipitation correspond to higher migration inflows with SPEI6 showing a strong positive correlation (r = 0.81) with net migration. Conversely, in Boulkiemdé, drought conditions are associated with substantial outmigration, as reflected in a strong negative correlation between SPI12 and net migration (r = -0.912). The observed correlations suggest that climate variability is associated with migration flows, indicating the potential influence of drought conditions on migration patterns.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This study assesses the impacts of climate change on internal migration in Burkina Faso, a climate-vulnerable country heavily reliant on rainfed agriculture. It addresses critical gaps in understanding rural-to-rural migration under localized climate stress. Using a mixed-methods approach, combining participatory workshops and econometric analysis, the study identifies socio-economic and environmental drivers of migration and evaluates impacts on household welfare. Drought conditions were analysed using SPI and SPEI indices, with Pearson correlation applied to assess their relationship with migration flows. The study focuses on three key objectives: analysing internal migration dynamics from the perspective of local stakeholders, examining drivers and impacts of climate-induced internal migration on welfare, and assessing the relationship between drought dynamics and migration trends in selected provinces. Specifically, the study pursues three objectives: (1) to develop migration scenarios from the perspective of local stakeholders on the factors shaping future migration trends; (2) to analyse the determinants and impact of internal migration on household welfare of destination migrants; and (3) to assess the relationship between drought and internal migration.

The analysis of internal migration by local stakeholders showed that it is influenced primarily by environmental factors, with spatial specificities. In the provinces of departure, Boulkiemdé and Oubritenga, migration is primarily driven by economic hardship and environmental degradation. The interplay of these two factors is the main catalyst for out-migration. Conversely, in the destination provinces, Comoé and Ziro, migration is largely influenced by environmental factors, due to the fact that most migrants are farmers, so they are particularly responsive to favorable climatic conditions. Future migration trends from Oubritenga are likely to be shaped by persistent drought and insufficient policy interventions, while in Boulkiemdé, land scarcity and a lack of access to quality education and vocational training will be key drivers of migration. In destination areas, future arrivals of internal migrants will likely be influenced by environmental and economic factors specific to each region. In Comoé province, adequate rainfall plays a key role in ensuring favourable agricultural conditions, while gold mining represents a major economic opportunity likely to attract new arrivals. Regarding Ziro province, future migration is expected to be primarily determined by the availability of arable land and adequate rainfall.

The Marginal Treatment Effect model results showed that climate-induced internal migration is primarily driven by environmental factors such as inadequate rainfall, soil degradation, and persistent droughts, which severely affect agricultural productivity. It confirms that internal migration is an important adaptation strategy for households in regions facing climate variability, particularly for those heavily reliant on agriculture. Migrants generally accumulate more assets than non-migrants, indicating that migration can be a means to secure better livelihoods and enhance household wealth. However, this opportunity is not accessible to all, as extreme environmental degradation in some areas limits people's ability to migrate, trapping them in poverty. The findings highlight the complex interplay between environmental stress, socio-economic factors, and migration decisions, and underscore the importance of understanding these dynamics for more effective policy interventions.

The analysis of drought dynamics using SPI and SPEI indices in Comoé and Boulkiemdé reveals significant regional disparities in climate trends and their impacts on migration. Surprisingly, SPEI indicates that Comoé, the wettest province, is experiencing a slight but significant trend towards drought, while Boulkiemdé, located in a drier area, is showing a slight but significant trend towards increased wetness. In both provinces, SPI generally measures higher drought intensities, especially for extreme events. SPEI, by integrating evapotranspiration, moderates these intensities but detects a greater number of mild and moderate droughts. In Comoé, periods of increased precipitation in 1985 correspond to higher inflows and positive net migration, with SPEI6 showing a strong positive correlation with inflows ($r = 0.81$) and net migration ($r = 0.80$). Conversely, in Boulkiemdé, drought conditions in 1985 coincide with significant outmigration, with strong negative correlations between SPI12 and outflows ($r = 0.83$) and net migration ($r = -0.91$). These findings highlight the critical role of climate variability in shaping migration patterns. While drought conditions influence migration trends, they do not act in isolation. In Comoé, despite a moderately negative correlation (-0.68) between SPEI12 and inflows in 1996, migration data showed an unexpected increase in inflows from 15.44% in 1985 to 17.11%. Similarly, in Boulkiemdé in 2019, although SPI12 exhibited a strong positive correlation (0.92) with inflows, inward migration declined from 22.94% in 2006 to 10.69%. These inconsistencies highlight the complex interplay between environmental constraints and socio-economic factors in shaping migration trends, reinforcing the need for a multi-dimensional approach to climate-induced migration analysis.

7.2 Recommendations

7.2.1 Recommendations for Policy

The analysis of migration drivers from the perspective of local stakeholders reveals that land scarcity largely due to land grabbing, inadequate education/vocational training, and insufficient rainfall are among the main factors currently driving, and likely to continue driving, internal migration. Econometric analysis further confirms that persistent droughts are a major determinant of internal migration patterns.

In light of these findings, policymakers should consider the following measures:

- Implement urgent actions to prevent land grabbing in areas such as Boulkiemdé by ensuring that local communities have secure access to and control over arable land.
- Design and implement vocational training programs aligned with local economic opportunities, particularly in high-emigration regions like Boulkiemdé and Oubritenga, to promote local retention and reduce migration pressures.
- Promote best practices in soil and water conservation (SWC) and soil defense and restoration (SDR) to enhance sustainable water use, combat land degradation, and improve agricultural productivity, especially in areas with high out-migration.
- Encourage the adoption of climate-resilient agricultural technologies, such as improved irrigation systems and drought-tolerant crop varieties, to stabilise agricultural yields and mitigate key migration drivers.
- Integrate migration into national climate adaptation strategies, ensuring a coordinated response to climate-induced displacement while supporting the resilience of vulnerable communities.

7.2.2 Limitations of the Study and Suggestions for Future Research

This study, while providing valuable insights into internal migration, presents some limitations that must be considered when interpreting the findings.

The analysis of migration from the perspective of local actors was conducted in four provinces of Burkina Faso. However, the results indicate that migration patterns and influencing factors vary significantly across different regions. This geographical limitation prevents the formulation of general conclusions at the national level and restricts the applicability of the findings for comprehensive migration management planning in the context of climate change.

The econometric analysis of migration's impact on welfare primarily focused on objective measures (total assets and remittances), excluding subjective indicators. As a result, the study partially evaluates the overall impact of migration on well-being, overlooking psychological and social dimensions that could provide a more comprehensive understanding of migrants' quality of life. Thus, the sociodemographic variables considered in this analysis are post-migratory, which does not allow for a comprehensive understanding of the sociodemographic determinants of internal migration.

The analysis of the relationship between drought and migration relied on a linear regression approach using Pearson correlation matrices. This methodological choice was driven by the limited availability of migration data. However, given the complexity of migration dynamics, this approach may not fully capture the intricate relationship between climate variability and population movements, potentially limiting the depth of the findings.

To address these limitations and enhance our understanding of internal migration, future research should focus on the following areas:

i. Comprehensive national-level studies should be conducted to analyse internal migration patterns and their driving factors from the perspective of local stakeholders. This approach would facilitate evidence-based local planning by integrating precise, context-specific data rather than relying on generalised information.
ii. Future research should incorporate both objective and subjective indicators of well-being to provide a holistic assessment of migration's impact on individuals and households. This could involve capturing migrants' perceptions of their quality of life, social integration, and overall life satisfaction, complementing quantitative analyses with qualitative insights.
iii. Future research should incorporate pre-migratory sociodemographic variables when analysing the drivers of internal migration, as this would enable a deeper understanding of the sociodemographic conditions that influence migration decisions.
iv. Future research should expand migration data collection to enable more advanced analytical approaches beyond linear regression, such as non-linear models better

suited to capturing the complexity of migration dynamics. A more comprehensive dataset would allow for more robust investigations into the relationship between migration and climate variables like drought.

7.2.3 Contribution to Knowledge

This research advances the study of internal migration, climate change adaptation, and migration policy by integrating diverse methods, stakeholder perspectives, and systematic empirical assessment. By incorporating insights from migrants, policymakers, and affected communities, it refines push-pull migration models and identifies key migration drivers through participatory workshops. This approach enhances the contextual accuracy of migration studies and informs policy development.

A major contribution of this study is its examination of climate-induced migration and its effects on household welfare. Using rigorous econometric methods, particularly the Marginal Treatment Effect (MTE) framework, it provides robust statistical insights into migration decision-making and its socioeconomic consequences. The findings challenge conventional assumptions by showing that while migration enhances household asset accumulation, it does not necessarily result in sustained financial support (remittances) for non-migrant households. These insights are crucial for policymakers and development organizations designing targeted interventions in climate-vulnerable regions.

Empirical analysis of climate migration patterns employs climate indices (SPI & SPEI), statistical correlation analysis, and regional assessment. A long-term evaluation of drought severity and migration flows in Burkina Faso reveals a moderate to strong statistical link between climate variability and internal migration, with regional disparities. Boulkiemdé (Sudano-Sahelian zone) experiences persistent outmigration due to prolonged droughts, while Comoé (Sudanian zone) attracts migrants due to more stable climatic and economic conditions.

Methodologically, this research advances climate migration studies by demonstrating that SPEI more effectively captures evapotranspiration effects on drought severity and migration in Burkina Faso compared to SPI. It also introduces return level analysis to estimate the probability of extreme drought events and their migration impacts, while correlation matrices between drought indices and migration variables offer new quantitative insights into climate-induced displacement in West Africa.

Beyond theoretical and methodological contributions, this study has practical policy implications. The findings highlight the need for climate-resilient agricultural practices, improved water management, and livelihood diversification to mitigate migration pressures. Additionally, they underscore the importance of migration support programs to facilitate the integration of climate migrants into host communities.

In summary, this study makes a significant contribution to migration studies, climate adaptation research, and development policy by integrating econometric modeling, climate science, and participatory research methods. It offers new theoretical insights, methodological advancements, and policy recommendations for addressing climate-induced migration in Burkina Faso and the broader Sahel region.

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