UNIVERSITE CHEIKH ANTA DIOP DE DAKAR

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WASCAL

West African Science Service Center on Climate Change and

ECOLE DOCTORALE SCIENCES JURIDIQUES, POLITIQUES, ECONOMIQUES ET DE GESTION

(ED-JPEG)

FACULTE DES SCIENCES ECONOMIQUES ET DE GESTION

(FASEG)

Année: 2019 **N° d'ordre:**

Climate change, migration and its effects on agricultural productivity in rural Mali.

Thèse de Doctorat

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ACKNOWLEDGEMENTS

Above all,

I wish to thank God for giving me the opportunity to witness this unforgettable moment of my life of going through a PhD programme. I am grateful to my parents for always giving the chance to choose, my wife, family and friends for the inspiration and sacrifice that brought me this far.

Then, “My sincere appreciation goes to the Federal Ministry of Education and Research (BMBF) and West African Science Centre on Climate Change and Adapted Land Use (WASCAL) for providing the scholarship and financial support for this programme.”

I remain indebted to the wisdom and painstaking supervision I received from my supervisors Professor Babacar SENE and professor Ahmadou Aly Mbaye. Their strategic suggestions guidance and comments have deeply moulded and made this research possible. I also acknowledge the opportunity to present in a doctorate seminar facilitated by them. I wish to thank ICRISAT for guidance and facilitate me throughout my fieldwork, data collection and analysis.

I would like to thank my friends doctoral students for their feedback, cooperation and of course friendship from Ghana and Côte d’Ivoire respectively William Adzawla and Aristide Jean Nicaise Aman. In addition, I would like to express my gratitude to the staff of the University Of Cheickh Anta Diop Of Dakar.

I also wish to thank the villages, households and experts for providing me the information and data during my fieldwork.

Finally, I wish to recognise the immense contribution of my past teachers, supervisors and anyone who has contributed one way or other to my education, Mr Sidy Mallé, Bakary Diallo etc.

DEDICATION

I dedicate the thesis to the Mr. Sidy Malle and his wife Aïssata Togo. To my mother and my wife, I say you have been very inspirational and supportive to my course.

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ABBREVIATION

CSP/SDR : Cellule statistique de Planification/Secteur de Développement Rural

EACI : Enquête Agricole de Conjoncture Intégrée

EMOP : Enquête Modulaire auprès des Ménages

FAO: Food & Agriculture Organisation

GRP: Graduate Research Program

Ha : Hectare

INSTAT : Institut National de la Statistique

IOM: International organisation for Migration

IPCC: Intergovernmental Panel on Climate Change

Kg: Kilogramme

LSMS: Living Standard Measurement Study

MMEIA: Ministère des Maliens de l'extérieur de l'Intégration Africaine

MNL: Multinomial Logistic Regression

NEM: New Economics of Labour Migration

NEM: New Economy of Labour Migration

OIM: Organisation Internationale pour les Migrations

RGPH: Recensement Général de la Population et de l'Habitat

SSA: Sub-Saharan Africa

UCAD: Université Cheickh Anta Diop de Dakar

VAR: Vector Autoregressive Regression

WDI: World Development Indicator

ABSTRACT

The subject Climate Change and Human Mobility has become a topic in the heart of international issue, since it recommendation at COP 21 in Paris in 2015. Thererfore, there is an increasing body of literature review on climate change-induced migration such as with no concensus on the topic. The review has been carried out several channel on the relationship between climate change and migration. The main objective of this study is to examine the rate of migration in response to climate change and its effect on agricultural productivity in rural Mali. In addition, it will explore the influencing factors of agricultural production in rural area of Mali. This study builds on the Model of Vector Autoregressive (VAR) to assess the impact of climate change on migration in the first objective and combines with a multinomial logistic regression model to analyse the perception level and the causes of out-migration in Sikasso region. In our last objective we used a theoretical model to test is whether the reliability of the insurance mechanism is negatively correlated with our measure of unobservable household-specific productivity level. The study is mainly based on secondary data (EMOP and EACI or LSMS of the World Bank survey in Mali) both national survey from national institutions and website data (for example UN population division world bank etc.). These data were completed with the survey data of selected farm households in the third region of Mali (Sikasso). The study concludes that despite unfavourable climate change among rural farm households, migration remains mainly due to the poverty or unemployment. Furthermore, the study finds that the reliability of the insurance mechanism is negatively correlated with our measure of unobservable household-specific productivity level.

Key words: climate change, migration, Mali, VAR, MNL.

CHAPTER ONE

1.1 Background

Historically, Malian are known for frequent migrations, especially the Soninké people, for the purpose of searching opportunities abroad, such as leave their origin place for working elsewhere during the dry season. The inhabitants from the region, “Kayes”, are also known for travelling around the world for trading. Nowadays, migration habits have spread from the Kayes region the other Malian regions. For the last two past decades, internal and external migration have become more frequent as people continue search for opportunities abroad.

Migration is a natural social phenomenal that can be understood as a permanent or temporal change of residence of a person or a group of persons. Migration exists since the coming of human to earth, hence not a new concept. People historically move from place to place over time, mainly from a ‘bad’ place to a ‘better’ place. This means that migration is for a variety of reasons, and there are many modes and categories of human mobility (Wilkinson et al., 2016).

The United Nations (1970: p. 2) cited in (Handbook, 1997) defined migration as “the movement from one migration-defining area to another (or a move of some specified minimum distance) that was made during a given migration interval and that involved a change of residence”. Therefore, a migrant is a person who has changed his or her usual place of residence from one migration-defining area to another or who moved some specified minimum distance, at least once during the migration interval.

Migrations within and from sub-Saharan Africa (SSA) are an important macroeconomic issue with spillovers for both origin and destination countries. Among rapid population

growth, migration in SSA has been briskly increasing during the last 20 years (Gonzalez-Garcia et al, 2016). Up to the 1990s, the stock of migrants was dominated by intraregional migration, which early in that decade represented 75 percent of total migration.

In recent decades, international migrations have received more attention, especially the large inflow of Eastern Europeans to Western Europe (about 20 million in the last 25 years). The patterns of migration in SSA migration within the region, although migration to the rest of the world has been growing faster in recent decades. Most of the intraregional migration is to relatively stable economies such as Côte d'Ivoire and South Africa.

The prevailing pattern of intra-regional migration in West Africa is a North-South movement from the Sahelian landlocked countries such as Burkina Faso, Mali and Niger to the coastal states, especially to Côte d'Ivoire, sometimes Ghana and other countries (Hummel et al, 2012). In addition to the interregional migrations, there is also migration from one area of the country to another area of the same country.

The aforementioned indicates that migration is a multidimensional phenomenon, which in general encompasses the movement, the displacement of people from one place (birthplace) to other, called place of residence. In most cases, people move from one place to another in pursuit of increased utility resulting from better employment opportunities, higher wages, a desired bundle of amenities, and many other reasons. Generally, the factors driving migration can be categorised into push and pull factors. The push factors are those factors taking place in the origin of the migrant that drive people to move to another place. These includes poverty, war and environmental disaster. On the other hand, the pull factors are conditioned in destination, and these are factors that make the

destination attractive to the migrant. These pull factors can be economic opportunity, political stability or high democracy.

Migration occurs all over Africa but for West African people, it is a way of life (Adepoju, 2003). Far Adepoju (2003) argued that historically, people have migrated to overcome the poor economic conditions of their own origin countries, the environmental disasters, the population pressure, conflicts and negative effects of macro-economic restructuring. Both, immigration and emigration are occurring in West Africa as well as those countries, which are historically known as immigration or emigration countries. Migration within the sub-region includes seasonal migrants, temporary cross-border workers, professionals, clandestine workers and refugees. Therefore, most cross-border movements, including farm labourers, female traders, unskilled workers and nomads who paid little attention to arbitrary national borders are essentially intra-regional.

West African countries are exposed to a number of natural disasters, (Gemenne et al., 2014), especially Sahelian countries such as Mali. These natural disasters are not new thing, except that there is a significant increase in the intensity and the frequency of these disasters in the last decade. Floods, droughts, winds reinforcements and waves of heat are meteorological extremes events, the most tangibles which affect west African people, (DARA., 2013, Gemenne et al., 2014). The most Sahelian countries in West African, Mauritania, Mali and Niger are seriously affected by droughts since 2000, as there are about 50 million people that has migrated. Climate shocks strongly influence the rural population, irrespective of their geographical position and the rainy zone. This population are suffering from the short periods of the rainy season, as more than 95% of crop production is linked to rain fed. Specifically in Mali, a landlocked country, about 2/3 of

the territory is dessert, the rest are located in the semi-Arid tropics zone, with the majority of the population being employed by the agricultural sector. Agriculture is the main source of subsistence for the rural population in Mali, with over 80% of the population being agricultural workers, while the agricultural sector contributes 35% of the Gross Domestic product (GDP) (Abdulai et al., 2013). In West Africa, particularly Mali, the economy is especially vulnerable to climate change, because of the high dependence of the population on agriculture, particularly, rain-fed agriculture (Simonet, 2015).

Among climate shocks and stresses in Mali, drought accounts for about 20%, and this affects over 80% of the population (Sheffield et al., 2014). Climate shocks (drought and flood) in Mali occurred several times from 1980 up to 2013. The most relevant was the drought, which occurred in 2011, affecting over 3,500,000 people in Mali. A similar high impact drought occurred in 1980 with a total 1,500,000 people been affected. On the other hand, the impacts of floods on the population is less compared to drought. In recent times, the flood of 2007 recorded the highest impact of 47,255 victims.

The department of International Organisation of Migration (IOM) in Mali conducted a survey to get the key data on environmental migration and climate change in Mali. They concluded that 93% of households quote at least one environmental or climatic phenomenon as a factor for migration. So that direct or indirectly, climate change contribute to drive migration. In fact, the majority of the population depends on agricultural production for both income and subsistence. The respondents also confirmed that their everyday life has been affected by events linked to temperature increase (dryness and time of heat wave), and to problems related to water (rainfall variability, flooding and water pollution).

Despite the high attribution of migration to economic factors, the potential threat of climate change on most economies, especially, the vulnerable rural farm households, climate induced migration has become an important aspect for both policy makers and researchers. The case of rural Mali is no exception and therefore warrant this study.

1.2 Problem statement

Brown and Bean (2005) cited in Adger et al. (2014), in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) defined migration in terms of temporal and spatial characteristics; a permanent or semi-permanent displacement by a person of at least one year that involves crossing an administrative, but not necessarily a national border. Adger et al. (2014) argued that permanent migration, as well as temporary and seasonal migration, are prevalent in every part of the world, and are driven by economic and other imperatives. These other imperatives in their definition signify many other things that are worth exploring.

Black et al. (2011) identified multiples drivers of migration as: i) economic drivers; ii) social drivers; iii) political drivers; iv) demographic drivers; and v) environmental drivers. The authors argued that the environmental factors play an important role in migration. Migration has become an option that households use to sustain their livelihoods in the long run, and to secure access to food in the short to medium-term (Findlay & Geddes, 2011; IOM, 2010; Poncelet & al, 2008).

As an adaptation and/or a strategy, migrants aimed at improving their livelihood especially through higher incomes. With remittances for instance, it is expected that households with migrants may increase their income. On the other hand, migration affects household

labour for agriculture activities, which means that farming may be negatively affected. This provides a mix result of migration on households with migrants.

Therefore, it is important to examine the effect of migration on rural household's income to provide a policy direction on migration. The existing literature have also been silent on migration especially due to climate change in rural Mali. As sited during the drought of 1983-1985 in the first region of Mali (Kayes), there was a dramatic rise in the migration of women and children (Findley, 2004). This was also observed in a Gourma case study done by Pedersen (2016) on drought, migration and population growth in the Sahel. In another study conducted by Cissé, et al., (2010) over 230 households in the first region of Mali, they argued that households use migration as an adaptation strategy to climate change.

In line with these, this study aims to examine migration in a West African country, Mali, particularly, migration that is induced by climate change and climate variability, and the effects of this migration on household income as well as crop production. Nowadays, migration has become an inevitable aspect of the real world. It plays an important role especially in the economic development of countries like Mali.

1.3 **Research questions**:

The main research question of this study is what are the impacts of climate change on migration and its effects on agricultural productivity in rural Mali?

The sub-questions are:

1. What is the rate of migration induced by climatic variables?
2. What are the perceptions and the causes of migration in the study area?
3. What is the effect of migration on agricultural productivity in rural Mali?

1.4 Objectives of the study

The main objective of this study is to examine the rate of migration in response to climate change and its effect on agricultural productivity in rural Mali

Specifically, the study aimed at:

1. To examine the effects of climate extremes on migration;
2. Analyse the perceptions level and the causes of migration in the study area;
3. To estimate the effect of migration on agricultural productivity.

1.5 Hypotheses:

The following null hypotheses would be tested:

1. Climate extremes have no significant effect on migration;
2. Socioeconomic factors do not have significant effect on migration in Mali;
3. There is no statistically significant effect of migration on agricultural productivity.

1.6 Justification of the research:

Mali has a long history of emigration, since the post-colonial time, Mali has become an important transit point for migratory flows within the region and beyond. Mali is characterised by migration trends, ranging from cultural practices that promote migration as a rite of passage for young men, to circular and seasonal migration (IOM, 2013). Although economists' understanding of migration as an insurance device are essentially correct, it must be qualified to fit the evidences (Azam & Gubert, 2006). As such, the social–anthropological dimension helps to understand the migration determinants more accurately.

The government of Mali since some few years ago created a ministry called ‘Ministère des Maliens de l'Exterieur et de l'Intégration Africaine’. According to this ministry, more than four million of Malians are abroad, thus, a quarter of the Malians citizen are abroad (MMEIA, 2013).

Climate change and migration have received unprecedented visibility, especially, at the Paris negotiations. The Paris Agreement gave the International Organization for Migration (IOM) the political impetus that it needs now of multiple, complex migration crises (IOM, 2015). Since this conference, migration is included in the world debates, a high-level round table on human mobility and climate that was organised by the International Organisation for Migration. This was the first time that a number of initiatives had been taken on climate change related to human mobility concepts, which provided opportunity to present a wide range of views (researchers, decision-makers, civil society, etc.) on this thematic area.

Generally, the impacts of climate change are diverse. As such, households respond differently, depending on the prevailing economic circumstances and the opportunities that exist for responding. People, especially the youths, are beginning to move within and outside the country as a result of environmental challenges. Although migration is a long-standing phenomenon, climate change is gradually worsening the situation, especially in Mali. As an adaptation or mitigation, migration have an implication on household income.

Although the implication of climate change on migration have been established in most setting, the case of rural households in southern Mali are yet to be known. The complexity of migration drivers including economic reasons suggest that a conscious effort has to be put into examining the effect of climate change on migration. This would help policy

makers to identify the specific factors that should be targeted to address migration and respond actively to climate change. It is therefore important that a research of this kind is conducted to understand climate induced migration and its implications on improving the income of the households. This research would be useful for policy makers and other developmental organisations, since the factors influencing climate-induced migration would be identified, and the implications of such on production would be known.

1.7 Outline of the thesis

This study contains seven (7) chapters. The first chapter looks at general background of the research, the statement of the problem, the research questions, the objectives of the study followed by the hypotheses and the justification of the study. The second chapter takes a look on the stylised facts of migration and climate change in the context of Mali. Chapter three contains an overview of the review both literature and empirical studies on methods used to assess climate change effects on migration and also the effects of migration on agricultural productivity. The fourth chapter presents a brief introduction, data analysis and results and interpretation on "*the effects of climate change on migration in Mali"* using VAR model applied to time series. Chapter 5 highlights also a short introduction, study area, data analysis, results and interpretation of the second specific objective "*the perceptions and the causes of migration in sikasso's region*" using the multinomial logit regression applied on a cross sectional data. Chaper 6 in the same way addresses the "*migration's impact on agricultural productivity in rural Mali"*. Finally the last chapter brings the general conclusion of the study, the policy implications, the limitations and future research.

CHAPTER TWO

STYLISED FACTS OF MGRATION AND CLIMATE IN MALI

2.1 Introduction

From its geographic position, its history and its culture, the country Mali is characterised by the high mobility of its population, such as internally and externally. Considered as a strategy to survive also as a method of adaptation to overcome a crisis or a shocks, these migrations practices are done especially in Sahelian countries like Mali.

In Mali, like most of the other countries in Africa, contrary to other demographic phenomenon, there were not enough researches on migration topic ten years ago. Migration topic did not get the same interest as mortality, fecundity and marriage rate. At national level, migration theme did not get much survey on it, however, the first source of migration data in Mali comes from the General population and household survey called in French Recensement Général de la Population et de l'Habitat (RGPH) done in 1976, 1987, 1998 and the last in 2009. After the national household survey, many other studies have been done which interest was pointed migration. For Instance, especially l'enquête malienne sur la migration et l'urbanisation (1992-1993), les questions migratoires au Mali (Francis 2009), program FSP with the project "International Migrations" territorial reconstruction and impacts on the places of depart (2008), project ANR/AIRD with the project "West African mobility" (Cissé et Konaté, 2009). All of them are cross sectional survey based mostly sociological studies.

In the analysis report on migrations and poverty of 2009 household survey, international migration was not analysed as well as better also most of the studies cited above. Regarding these studies migrants from the first region are oriented to France et the central Africa countries, but migrants from Sikasso (third region) are as principal destination Côte

d'Ivoire). According to Cissé and Daum, 2009) results from these works show that Malian migration is mainly men irregular migration.

2.2 Internal migration in Mali

It is a migration which is done inside a country without cross border, in fact the country border. It is about any movement from your origin place to another place within administrative zone for at least six months according to the general population and household census. Complex as it is, migration is not described as the same way in different studies. Many methods are used to size migration phenomenon such as temporal or spatial.

2.3 Internal migration RGPH 2009:

In general the migrant population (internal and external) based on the general census of 2009 was 2,330,860 migrants over the 14,528,662 inhabitants of the country. Considered as more that the 16% of the whole population presented in table 1. In fact, the sharing of these is almost proportionally distributed by sex.

Table 1 : The share of the resident population by migration status and by gender

Migration status	Sex		Total	
	Male	Female	%	Number
Migrant	51.3	48.7	100	2,330,860
Non migrant	49.3	50.7	100	12,187,846
ND	50.9	49.1	100	9,956
Total	49.6	50.4	100	14,528,662

Source: Author's field research

The table 2 reveals the composition of the different categorical migrants by sex. Migrants between the different regions of the country represent 74.7% of the whole migrants. Migration within the counties from the same regions represents 20.2% of the migrants.

The movements between different communes of the capital is 5.2%, but there is no enough different between the migration by sex.

Table 2 : The share of different categories of migrants by sex, RGPH 2009

Migrants categories	Male		Female		Total	
	Number	%	Number	%	Number	%
Internal migrant						
Within region	693809	50.9	669773	49.1	1363582	74.7
Region-region	184510	50	184684	50	369194	20.2
Within county	43156	46.8	49116	53.2	92272	05.1
International migrant						
International	159590	50.9	153764	49.1	313354	81.65

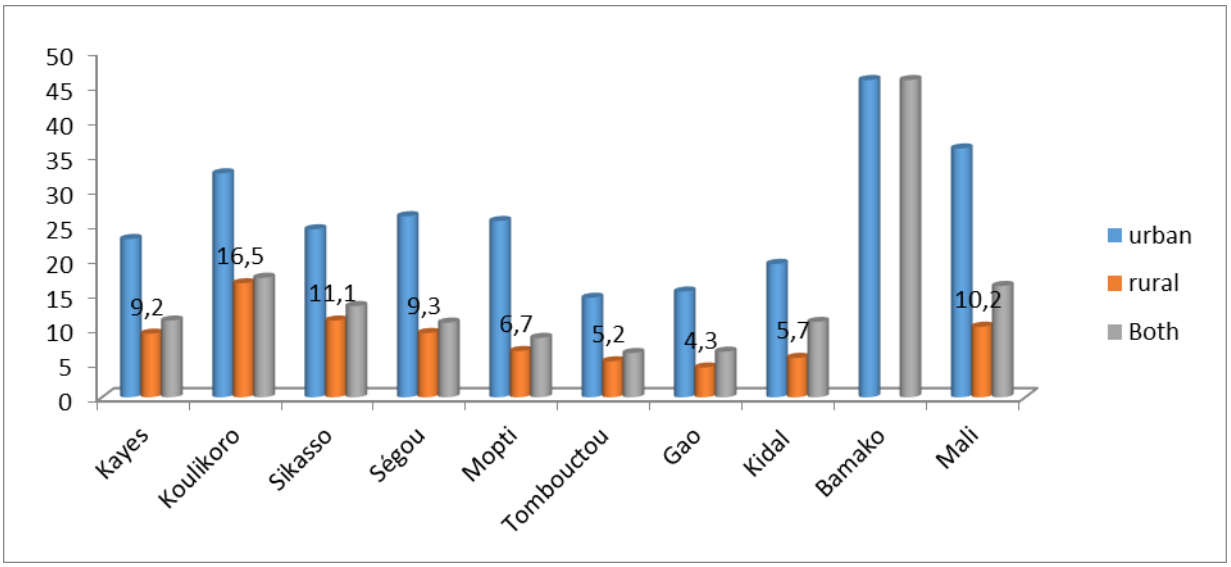
Source: Author's field research

Migration is a real-life phenomenon over the whole country in Mali. It fullness is still different from one administrative region to another administrative region. This table reveals that migration is more view in the southern region (Sikasso and Ségou) in the central region (Mopti) and in the west region (Kayes) than the northern regions (Toumbouctou, Goa and Kidal) Goa's region has the very small proportion of migrants (6.4%) such as the capital Bamako has 45.9% as proportion of migrants. The population is largely touched by migration in urban area than rural area due to the fact that rural people come to look for document (passport) in urban area.

The urban area is clearly different to rural area in terms of migration. Regarding the while country, the proportion of migrants is greater in urban area than rural area, respectively 36% and 10.2%. The regions of Kayes, Koulikoro, Sikasso and Ségou receive more

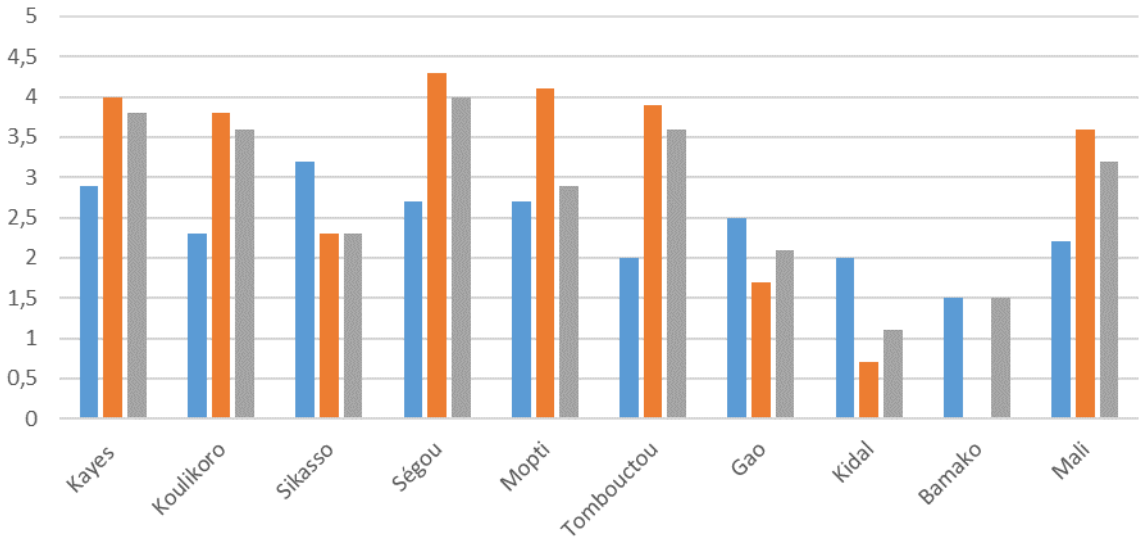
migrants compare to other regions. At regional level only the northern regions have a proportion of migrants less that 20%. In rural area, only Koulikoro and Sikasso regions have the high proportion of migrants respectively 16.5% and 11.1%. Bamako has the high proportion of migrants over the whole country.

Figure 1: Share of permanent internal migrants by region and by zone using RGPH data 2009



Source: Author's field research

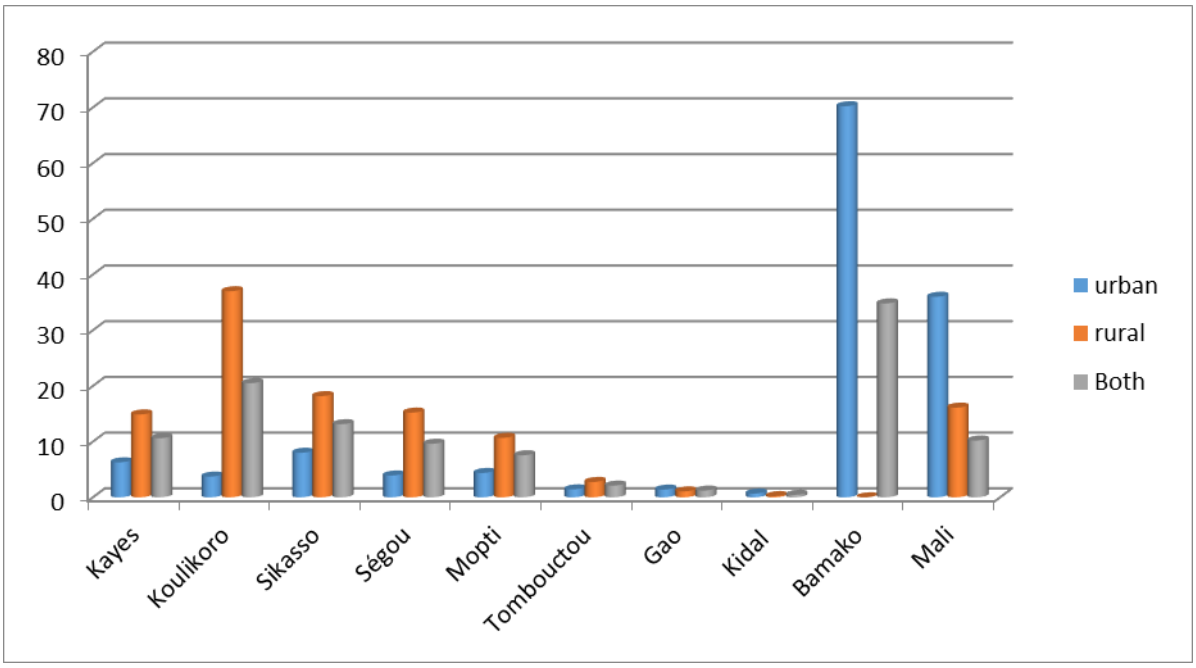
Figure 2: Sharing of permanent internal migrants by region and by zone using RGPH data 1998



Source: Author's field research

The sharing of recent migrant by region and by zone (urban or rural), five years ago before the census comes cross to see the repartition of the resident population by administrative zone (county, region) and the whole country. The general census of the population and the household counts 400000 recent migrants and 35% of these migrants resident in the capital (Bamako). The capital is following by Koulikoro region with 20%, Sikasso region with 13% and Kayes region with 11%.

Figure 3 : Repartition of recent internal migrants by region and by zone using 2009 RGPH data



Source: INSTATA, RGPH_2009, author calculation

Characteristics of the internal migrants

Education level of internal migrants

Analysis of the level of internal reveals a low level of education, in fact, woman is less educated than man (25.6% VS 30.6%). Only 9.5% in both sizes have done with the first level (Fondamental_1). This percentage is too low regarding the fundamental (level 2) with 5% for men and 4.2% for women. At the university level such as the level is very low but men's is three times greater than women's level respectively 4.1% and 1.3%.

By region, the non-educated migrants are most numerous with no significance in both sizes men and women. The capital city represents the lowest proportion of migrants no educated (19.5%) and Mopti has the high proportion (35.9%) men size. In the same case the non-educated women are high in Mopti region 37.1% and Kidal has the less proportion of women non-educated (22.2%).

Table 3 : Share of internal migrants by region, by education level and by sex

Region	Education level										Whole	
	0		1		2		4		5			
	M	F	M	F	M	F	M	F	M	F	M	F
Kayes	32.2	30.4	10.6	8.4	4.8	3.1	5.2	2	2.1	0.3	55.8	44.2
Koulikoro	23.5	27.9	11.7	11.6	5.6	4.9	6.2	3.8	3.6	1.2	50.5	49.5
Sikasso	31.4	33.4	9.4	8.1	4.3	3.3	5.3	2.5	1.8	0.4	52.2	47.8
Ségou	29.6	35.1	8.8	8.1	4.4	33.6	5.2	2.8	1.9	0.5	49.8	50.2
Mopti	35.9	37.1	6.5	6	2.9	2.5	4.4	2.2	2	0.5	51.7	48.3
Tombouctou	29.3	29.7	8.6	8.5	4.1	3.3	7.7	4.1	3.5	1.3	53.2	46.8
Gao	27.2	30.7	9.6	9.1	4.6	3.3	7.3	4.3	3.1	0.6	51.9	48.1
Kidal	26.9	22.2	11.8	9.3	7.5	2.8	10.1	2.5	6.1	0.9	62.3	37.7
Bamako	19.5	28.6	9.1	10.2	5.7	5	7.9	5	6.7	2.3	48.8	51.2
Mali	25.6	25.6	30.6	9.5	9.5	5	4.2	6.5	3.7	4.1	1.3	50.7

(0=non-educated; 1=Fundamental1; 2= Fundamental2 3= Secondary school, 4= University level)
Source: INSTATA, RGPH_2009, author calculation

- ✓ Marital status of the migrants

Looking well on the data, most the migrants are monogamous married (41%), more than 1/3 of them are single (36.1%). Less than ¼ (19%) are polygamous married. The number of widowers or widows is not considerable.

In general view, the married migrants represent more than 2/3 of the internal migrants in all regions. Internal migration of men touches mostly the single men and the married one. The monogamous married represent the high proportion in this group in all regions except Kidal region and the capital city Bamako where the single men represent the high proportion. The monogamous married women represent the high proportion in all regions. 42.8% of internal migrants were single at the moment of the census and 29.2% of internal migrants were single women.

Analysis by region show that the northern regions Gao and Kidal distinguish from other by their high proportion of monogamous women married (57.7% and 53%). Only Gao region holds the high proportion of men monogamous married (51.6%), in other region this proportion is less than 50%. The proportions of married men in Bamako and in Mopti region are less high respectively 36.9% and 47.4%.

Table 4 : Sharing of proportion of internal migrants by region, by matrimonial status and by sex

	Men matrimonial status						Women matrimonial status						Both women and men matrimonial status					
Rgion	Single	Married 1	Married 2&	Widow	Divorce	Free union	Single	Married 1	Married 2&	Widow	Divorce	Free union	Single	Married 1	Married 2	Widow	Divorce	Free union
Kyes	45.4	38.9	14.8	0.4	0.3	0.1	20.9	42.5	31.6	4.1	0.8	0.1	34.8	40.5	22.1	2	0.5	0.1
Kkor	44.5	40.9	13.5	0.5	0.4	0.1	29.7	42.3	22.5	4.6	0.7	0.2	37.2	41.6	17.9	2.6	0.6	0.2
Skso	36.1	45.4	17.4	0.5	0.4	0.2	20.3	44.9	29.1	4.3	0.5	0.2	28.6	45.1	23.3	2.3	0.5	0.2
Sgou	37.3	46.4	15.2	0.7	0.3	0.1	22.4	45.3	25.2	6.4	0.6	0.2	29.8	45.8	20.2	3.6	0.5	0.1
Mopti	37.5	47.4	13.5	0.9	0.5	0.1	21	48.5	22.9	6.5	0.9	0.1	29.5	48	18.1	3.6	0.7	0.1
Tbtu	39.3	47.2	12.4	0.5	0.6	0	22.2	49.8	18.4	7	2.5	0.1	31.4	48.4	15.2	03.5	1.4	0
Gao	36.7	51.6	10.3	0.6	0.7	0.1	24.3	53	14	6.4	2.3	0.1	30.8	52.2	12.1	03.4	1.5	0.1
Kidal	48.8	43.6	6.4	0.4	0.8	0.1	28.1	57.4	6.5	3.7	4.1	0.2	41.4	48.4	6.5	1.6	2	0.1
Bko	46.5	36.8	15.3	0.7	0.4	0.4	36.9	35.6	19.9	6.2	1.1	0.3	41.6	36.2	17.6	3.5	0.8	0.3
Mali	42.8	42.8	41	14.9	0.6	0.4	100	29.2	40.9	23.1	5.6	0.9	100	36.1	41	19	3.1	0.7

Source: INSTATA, RGPH_2009, author calculation

2.4 International migration in Mali

2.4.1 Introduction

The international migration are treated in this section from the data of the 4th RGPH and the data of EMOP 2016. These data gathered information on both side as well the immigrations as the emigrations. For better, foreign migrants and emigrants are analysed successively regarding their characteristics. The section measures the scale of the international migratory phenomenon and clarifies the country of the departure and the country of destinations. This analysis will be made according to the environment of residence. Well shall also describe as possible the socioeconomics characteristics.

2.4.2 International migration in Mali using RGPH 2009

In this sub-section we underline the migration in both size emigration and immigration. We enlighten where they are coming from and where they are going to, for the both immigrants and emigrants.

Estimation of the number of immigrants in Mali

With a total population resident of 9,810,910 in 1998, 167,406 were immigrants (born out of Mali). This represents a proportion of 1.71% of the whole population. Compare to the census of 1987, the number of immigrants were 159,490, with a resident population of 7,696,348, this gives a proportion of 2.1%. But in 1976, the immigrants' number was estimated to 146.468 and it represented 2.3% of the resident population at that time.

Therefore, during the period within census 1987-1998, we can estimate an immigrant flow to 167406-159490 equal to 7916 with an annual number of immigrants of 80 migrants compare the period 1976-1987, with a number of immigrants of 130.

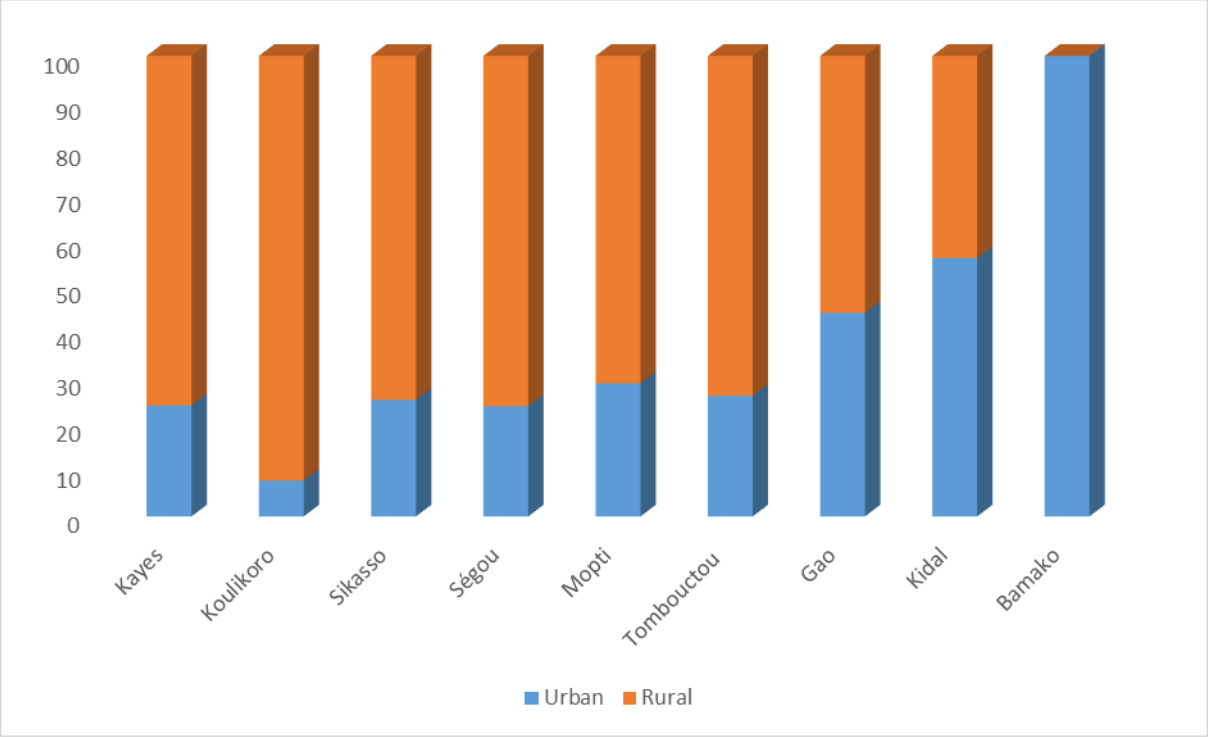
The data of general census of 2009 allow estimating around 313,000 immigrants in Mali. On the total staff, more than 51.2% reside in rural area except the region of Kidal. The percentage hides a high disparity in the space distribution. The region of Koulikoro widely catches the attention with more than 92% of rural immigrants, maybe due the high international NGO workers in this region rural area. This region is respectively followed by the regions of Ségou, Kayes and Sikasso.

Table 5 : Share of number of immigrants by region and by area

Region	Urban		Rural	
	Number	%	Number	%
Kayes	8,266	24.1	26,043	75.9
Koulikoro	2,774	7.8	32,954	92.2
Sikasso	18,926	25.3	55,766	74.7
Ségou	8,555	23.9	27,257	76.1
Mopti	5,390	28.9	13,249	71.1
Tombouctou	701	26.2	1,978	73.8
Gao	2,241	44.2	2,828	55.8
Kidal	266	56.1	208	43.9
Bamako	105,952	100	0	0

Source: Author's field research

Figure 4 : share of percentage of immigrants by region and by area in Mali



Source: Author's field research

Estimation of the number of emigrants of Mali

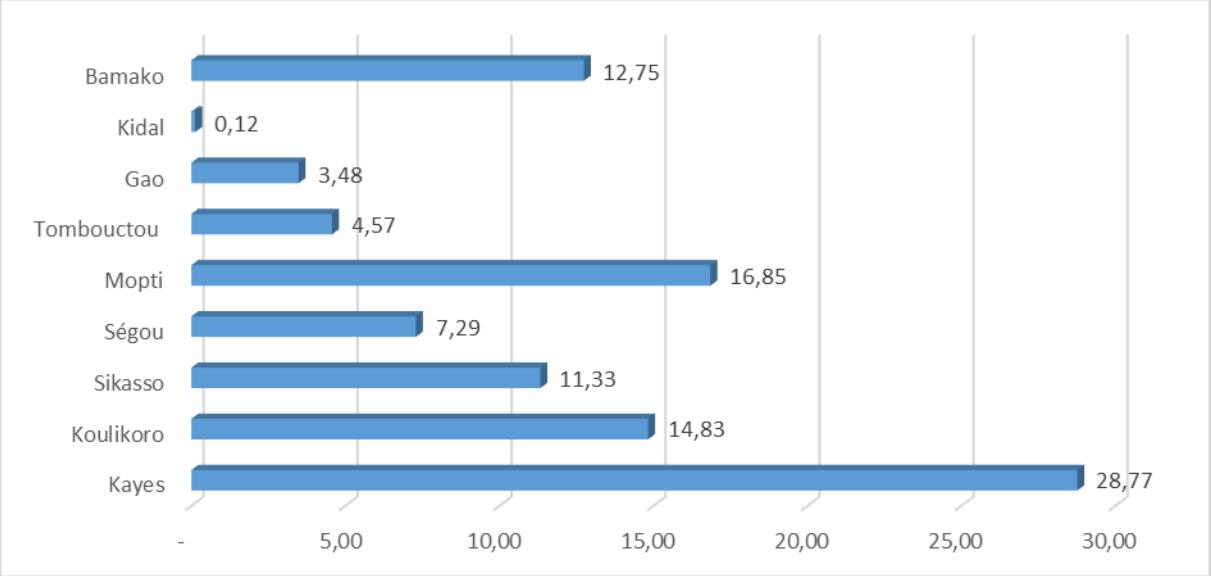
The emigrant population during the period of 1988-1993 was estimated to 483,000 persons with 41% of these emigrants were located in SSA countries. But the Malian resident population to abroad was certainly underestimated. Conferring to the survey REMUAO, the estimation was 800,000 persons, which represents 10.5% of the resident population. According to the RACE (recensement à caractère electoral), Abidjan and Bouaké town have around 1.7 million of Malian.

Places of depart of international emigration in Mali

The international emigration affects all region of Mali, especially the region of Kayes; the region of rough climate, by itself counts approximatively 29% of these migrants (RGPH, 2009). Mopti comes in second position after Kayes. The rural in Mali is the big supplier of emigrants with a proportion of 80.4% against 19.6% in urban area. This result reveals that

the rural population likely opt more for the emigration than the population of the urban area. This same observed is made in all region where more three-quarters of the aspirants for emigration are coming from the campaign. In fact, only the region of Gao and Kidal have significant proportions exit from urban area respectively 24.3% and 44.1%. The international emigration depart from rural area is particularly very strong in the region of koulikoro (97.3%), Tombouctou (96.7%), Mopti (95.2%), Ségou (93.8%), Sikasso (90.9%), and Kayes (89.3%)

Figure 5 : Share of international emigrant by region of depart



Source: Author's field research

Place of depart of emigrants by region by zone (urban & rural)

International emigration occurs in all regions of Mali, in total 107,316 of international emigrants. Kayes's region with a rough climate, it counts alone 28.77% of these migrants, Mopti comes at the second position. The major amount of the migrants are from rural areas, around 80.4% of the whole migrants are from rural areas against 19.6% from the urban areas. This result means that the rural population like to choose international

migration that urban population. This situation is observed in all region, where more than 2/3 of emigrants come from rural areas, except the region of Gao and Kidal. They are a significant proportions exit from urban area, respectively (24.3% and 44.1%). Emigration, going from rural areas is particularly very high in Koulikoro (97.3%), follow by, Tombouctou (96.7%), Mopti (95.2%), and Ségou (93.8%) Sikasso (90.9%) and Kayes (89.3%).

Table 6: Place of depart of emigrants by region by zone (urban & rural)

Region of depart	Urban		Rural		Total	
	Number	%	Number	%	Number	%
Kayes	3305	10.7	27567	89.3	30872	100
Koulikoro	427	2.7	15490	97.3	15917	100
Sikasso	1106	9.1	11057	90.9	12163	100
Ségou	483	6.2	7342	93.8	7825	100
Mopti	867	4.8	17220	95.2	18087	100
Tombouctou	160	3.3	4740	96.7	4900	100
Gao	909	24.3	2829	75.7	3738	100
Kidal	60	44.8	74	55.2	134	100
Bamako	13680	100	0	0	13680	100
Total	20997	19.6	86.319	80.4	107316	100

Source: Author's field research

2.5 Migration using EMOP data: current evidence

2.5.1 Overview

The Modular and Permanent Household Survey called in French Enquête Modulaire et Permanente auprès des Ménages (EMOP). It is a permanent collection instrument set up by the National Institute of Statistic of Mali (INSTAT) with the technical and financial support of Sweden to meet the monitoring and evaluation needs of the strategic framework

for growth and poverty reduction like the sectoral programmes implemented by government of Mali.

- Specifically, the subjects addressed by EMOP cover socio-demographic characteristics of the population, education, health, employment, housing, food security and household consumption expenditure,
- In addition, EMOP was designed to update le *Cadre Stratégique pour la Croissance et la Réduction de la Pauvreté (CSCRP)* in line with of the objectives of the Millennium Development Goals and the sectoral programs implemented by the Government of Mali,
- EMOP is two-stage stratified sample survey based on a sample estimated at 7176 households over the whole country. It carried out annually in four moves and each move lasts three months of collection. The results of this survey are representative at the national level, in each of the eight (8) regions and the capital city of Bamako, and by residence (urban and rural).

Emop started in 2011, up to now we count 6 series of Emop survey since in 2012 it did not happen due the coup d'état, which happened in Mali at this year. With four moves spread on two years (for instance from April 2017 to Mars 2018). The module on migration is included in the second move that takes place every year from July to September.

This survey defined migration as:

Any movement of an individual from one area of residence to another (within the country or crossing the border of the country) for a stay at least six months or with the purpose of residing there for at least six months.

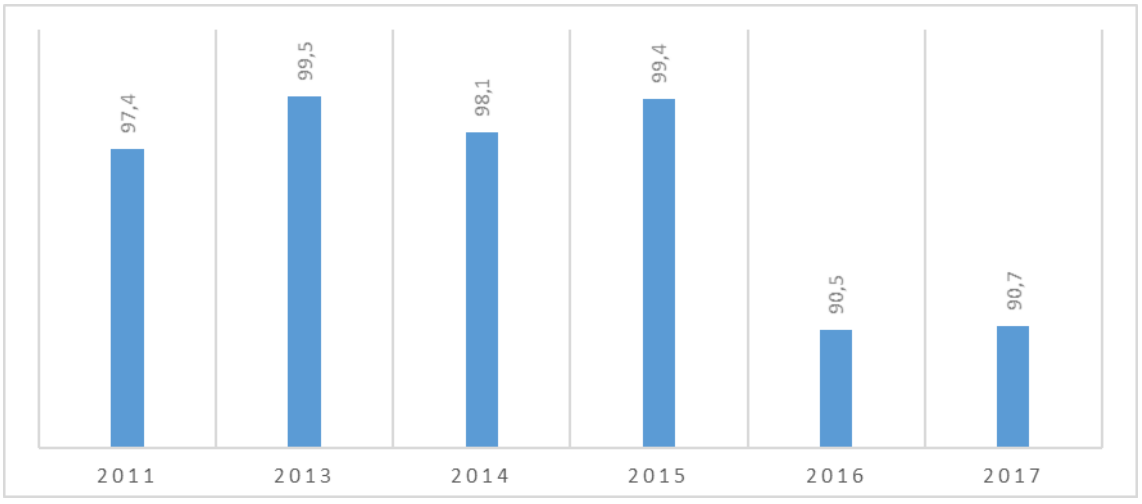
On the side of the area of residence of departure, the movement corresponds to emigration and the individual is an emigrant. On the side of the destination residence area, the movement corresponds to immigration and the individual is an immigrant.

In this survey, migration is captured through the following question as:

Is there one or more members in your household living and working outside your community in this moment? The information relates to the number of migrants by region and by residence as well as by destination as well as the proportion of households receiving a transfer of which at least one (1) member lives outside their locality.

EMOP is annually carried out in four passages throughout the whole country. It has been 6th time this representative survey of the country is taking place. From the first happened to the last one around 95% as average of the households supposed to be surveyed, have been interviewed over the six moves. From the beginning up to the last survey we remark a fine decline in the rate of recovery of the survey, this situation can be explainened by the fact that the deplacement of some households and also due to the denial of the interviewer some households.

Figure 6 : Rate of recovery of the survey during the passed emop

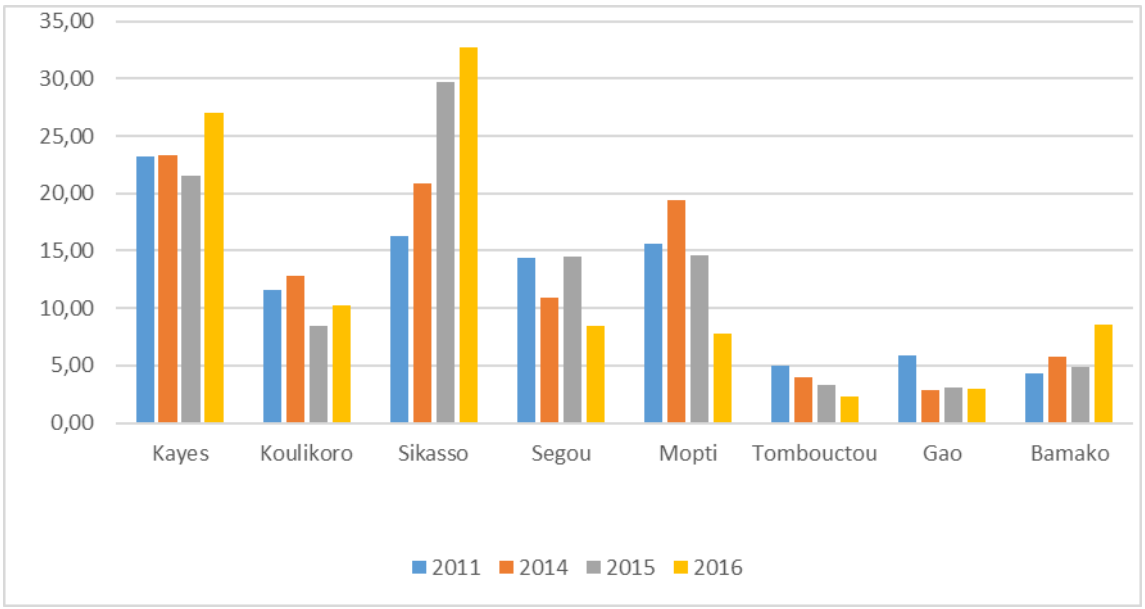


Source: Author's field research

- ✓ *Distribution of migrants by region of depart based on these four surveys (2011, 2014, 2015, 2016)*

Following these four passed survey, it's clearly showed the higher number of migrants in the first and third regions respectively the regions of Kayes and Sikasso. In fact, the figure shows that Sikasso region becomes a bieg provider of emigrants three over ten emigrants come from Sikasso region in 2016. There is a considerable gradually increase in emigrants number in the region of Sikasso from 2011 to 2016. This result is similar to those previous studies such IOM (2015). However, for the regions of tombouctou and Gao, the figure shows a fair decrease in emigrants number in these regions during the same period. This situation can be explained by the fact that the insecurity issue in these regions. For the region of Koulikoro and Segou the figure 7 show unstable state of emigration. The high rate of emigration in the region of Mopti in 2014 is linked to the insecurity at this time.

Figure 7 : Distribution of migrants by region of depart over these four years (2011, 2014, 2015, 2016)



Source: Author's field research

2.5.2 **Internal migration using EMOP data**

- ✓ *Percentage of households with members outside their locality*

Table 7 presents percentage of households with members outside their locality. Based on the six passed survey emop, Mali is characterised by a fort mobility of its population. Around one over three (1/3) households (32 .2% in 2011, 32.2% in 2014, 29.5 in 2015, 20.0% in 2016 and 22.7 in 2017) recognised had one or more households members living and working outside their locality for the whole country. Comparing the urban area to rural we can simply say that the depart of migrants is high in rural area than the urban area.However, looking at the region level we can clearly see that the mobility of the population is not the same from one region to another. Kayes region, which is recognised as the most mobile population in Mali is now behind Sikasso. When taking account the average of this series of survey, Sikasso region shows a high mobility of its population compare to Kayes region. In average over this series of survey Sikasso region has 41.58% and Kayes region has 35.96% of households, who have one or more households' members outside their locality. Beside the maximum of the percentage of households with members outside their locality is seeing in the region of Sikasso and the minimum is seeing in Tombouctou region.

Figure 8: Percentage of households with members outside their locality

Area of residence	2011	2014	2015	2016	2017
Kayes	37.6	46.5	32.0	33.3	30.4
Koulikoro	31.0	30.7	24.6	17.2	20.1
Sikasso	40.3	38.7	49.3	41.7	37.9
Ségou	37.2	26.0	29.8	13.4	19.6
Mopti	36.7	37.3	36.8	15.6	22.9
Tombouctou	26.4	14.7	14.2	7.0	3.1

Gao	23.1	34.4	23.7	13.0	21.7
Bamako	18.4	15.9	14.1	12.6	17.4
Urban	24.6	22.3	21.1	15.9	19.2
Rural	34.8	34.7	32.7	21.6	24.1
Mali	32.2	31.2	29.5	20.0	22.7

Source: Author's field research

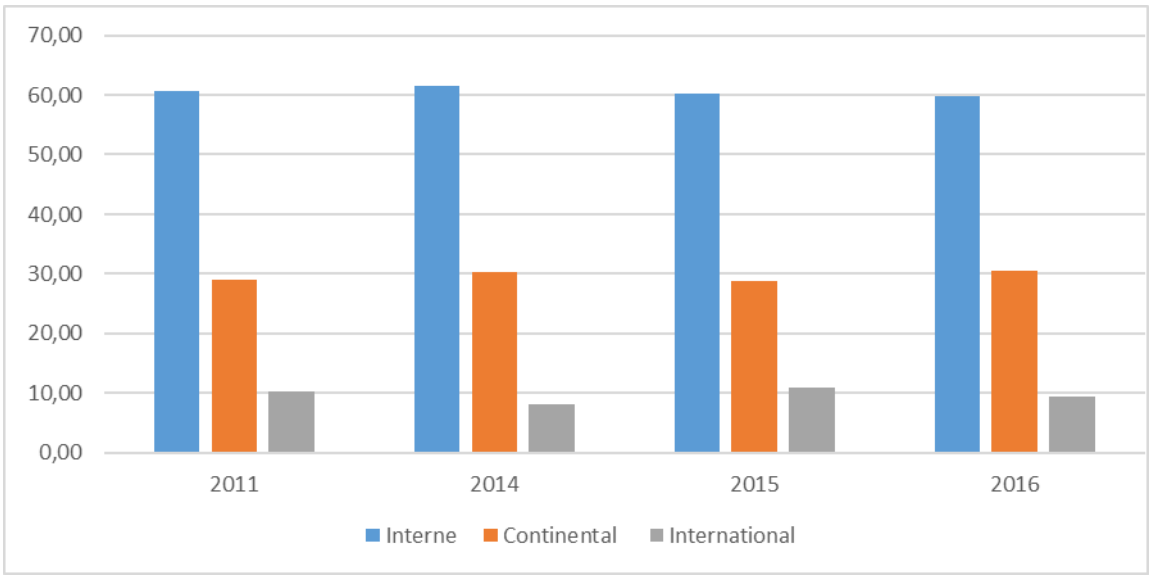
- ✓ Average number of men and women by Household

There is a high difference between the tendency of average number of men and women following the survey. The average number of men and women also vary from one region to another. From the literature, in fact from the last report of world migration (2018), the average number of women and the average number of men were almost equal. However, using the results of Emop in the case of Mali, there is no similarity between the both results.

2.5.3 **International migration using emop data**

Figure 9 presents the distribution by destiont Malian emigrants internal and external. In this figure 9 regardless the three types of destionation of the Malian migrants showed that over the whole more than sixty percent (60%) move inside the country and around thirty percent (30%) migrate within the continent of Africa especially the West African countries and less than ten percent cross African continent borders. From the previous studies most of these migrants moving continentaly had as destination Côte d'Ivoire. According to EMOP survey two over five Malian emigrant reside in Côte d'Ivoire. Only 2.5/10 migrate outside Africa, therefore it simply reveals that the number of Malian crossing the African continent border is enough small compare to the continental migrant.

Figure 9 : Share of migrant by destination



Source: Author's field research

2.6 Climate in Mali: current evidence

Mali is a landlocked country in West Africa that is one of the poorest in the world, with over 60% of the population living in poverty. Mali is a highly diverse country, in terms of both culture and the diversity of its environments. The country can be divided along a north-south axis, with the northern areas extending into the Sahara and Sahel, and the southern region, where most of the country's economic activity is concentrated. Agriculture is the mainstay of the Malian economy, accounting for 50% of the country's GDP and employing a substantial portion of the country's workforce. Cereals dominate the Malian diet, and the main subsistence crops grown are rain fed millet and sorghum millet, with commercial agriculture devoted to cotton and rice, the latter of which is irrigated. In spite of this heavy reliance on agriculture, only 14% of the country's land area is considered suitable for agriculture, making sustainable land management a major concern. The major investments and advancements in Malian agriculture (extension services, market development and increased use of inputs) to date; have been focused on

cotton and rice production. Only little emphasis placed on increasing production of crops critical to the country's food security like sorghum and millet, whose yields have remained constant over nearly half a century.

Rainfall: Mali spans four different eco-climatic zones with an average annual precipitation oscillating between 100 mm and 1700 mm. There is only one rain season exclusively limited to the summer that lasts up to six and decreases to two months respectively in the southern and in the northern part. According the Emergency Events Database of University Catholic of Louvain (EM-DAT), climate extremes happened several times in Mali from 1960 up to today. The early of 1960s, 1990s and 2000s (2002, 2007, 2013s) were particularly wet years in Mali. Among the six severe droughts occurred in Mali between 1960 and 2015, the greatest affected 3,500,000 people occurred in 2011 follow by the one happened in 1980, which affected 15, 00,000 inhabitants.

The related hazards of climate in Mali are floods, droughts and crops pest. They are natural hazards occurring in Mali that nevertheless pose serious matter on the growth of food security and their intensity and frequency are likely to increase a changing climate. While unpredictable rainfall is to be expected, more frequently and longer droughts, which have overwhelmed Mali in this recent times (decades), exacerbating natural adaptive capacities. The 2004 drought across the north, carried about by lack of rainfall extremely affected transhumant populations, pushing pastoralists to remain closed to water sources and foremost to significant overgrazing.

Another way, expanding agriculture, together with poor land management practices, particularly on the River Niger flood plain, has importantly amplified erosion and

sedimentation, and also the propensity of some areas to experience severe flooding and subsequent crop loss.

Even though it remains difficult to pin particular disasters like droughts and floods to the changing of climate. It is known that an unstable climate system, combined with other forms of environmental damage, will bring havoc more frequently, specifically in already stressed and marginal areas like Mali.

Climate change is more than an average values, it is becoming a matter of extremes events. The projected increase in temperature (maximum and minimum), is associated with the reduced or erratic rainfall are likely to make natural hazards more frequent and severe. Without improved forecasting and controlling, the frequency and effects of these disasters could intensify. Vulnerability is a key factor that could be influenced by expected changes in climates. Poor population have limited access to the resources and few income-generating opportunities, and laws, policies, and economic forces over which they have little or no control often affect their living conditions.

2.6.1 **Evolution of the rainfall from 1901 to 2015**

The variability of clmate in Mali in terms of rainfall received various change from 1901 up to nowdays. Looking at this evolution, the remark is that, beside the seasonal variability, there is a decreasing in average monthly rainfall for Mali over the time period from 1901 to 2015. As we can see on these four figures, it is easy to highlight or to underline the variability during the time period especially the monthly change of rainfall. The time period divided in four, from 1960, the rainfall stated to decreasing, the results were the droughts of 1970 and 1980, since these periods there is a considerably decreasing

in the quantity of rainfall. Mali counts four (4) climatic zones (see appendis), which follow as:

Sudanian zone represents 18% of the territory, the southern part of the country and precipitations rise from 600 to 1200 mm per year. This zone covers the whole area of the third region and some small parts of the first and the second regions.

Sudano-Sahelian covers the far south of Mali, which represents 8% of the superficie of the country. Located between the 12th and the 14th parallel N, it covers the sandstone plateau region of the West and the South Mali with average rainfall going from 700 to 1200 mm per year spread over 4 months (June to October) with an average of 60 to 80 days of rainfall occurrence.

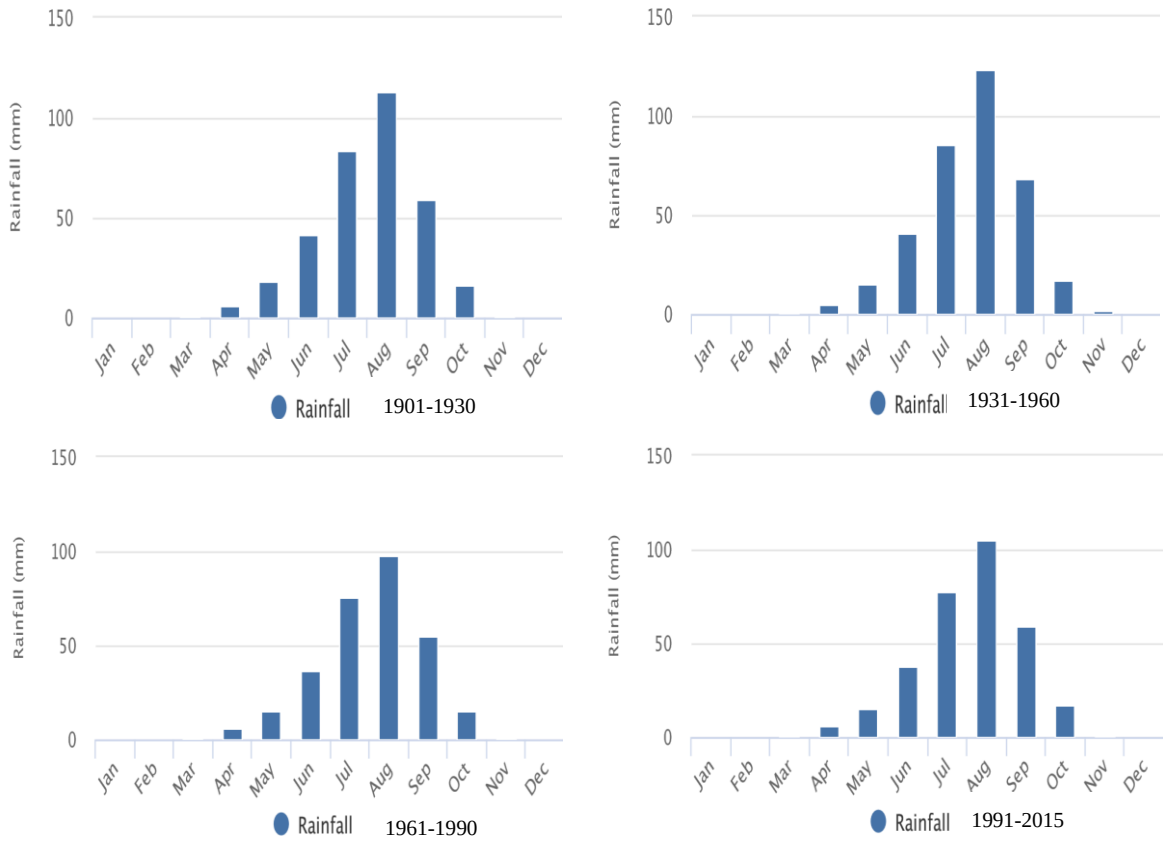
Sahelian zone represents nearly a quarter of Mali's total surface area, between the 14th and 16th parallel N. the precipitations that decreases from 700 to 200 mm per year on its northern border, are concentrated during a short winter from June-July to September-October with an average of 30 to 40 days of rainfall.

Southern Saharan, the desert region of northern Mali with rainfall often below 100mm. The harmattan that blows there is a wind that aggravates the effects of drought. The Saharan zone corresponds to the desert climate. This area covers an area of 632 km2, or 51% of Mali's territory. In addition, this area covers two third of the country’s surface area. It greatly reduces the availability of the Arab land.

Speaking about the rainfall in Mali, rainfall has considerably changed from one decade to the next, with years of very severe drought in the 1970s and 1980s. The figure 10 shows

that there is a decrease in the patterns of rainfall. In fact, there is a high variability over the time and also a big variability intra year.

Figure 10 : Average Monthly Rainfall for Mali (1901-1930); (1931-1960).



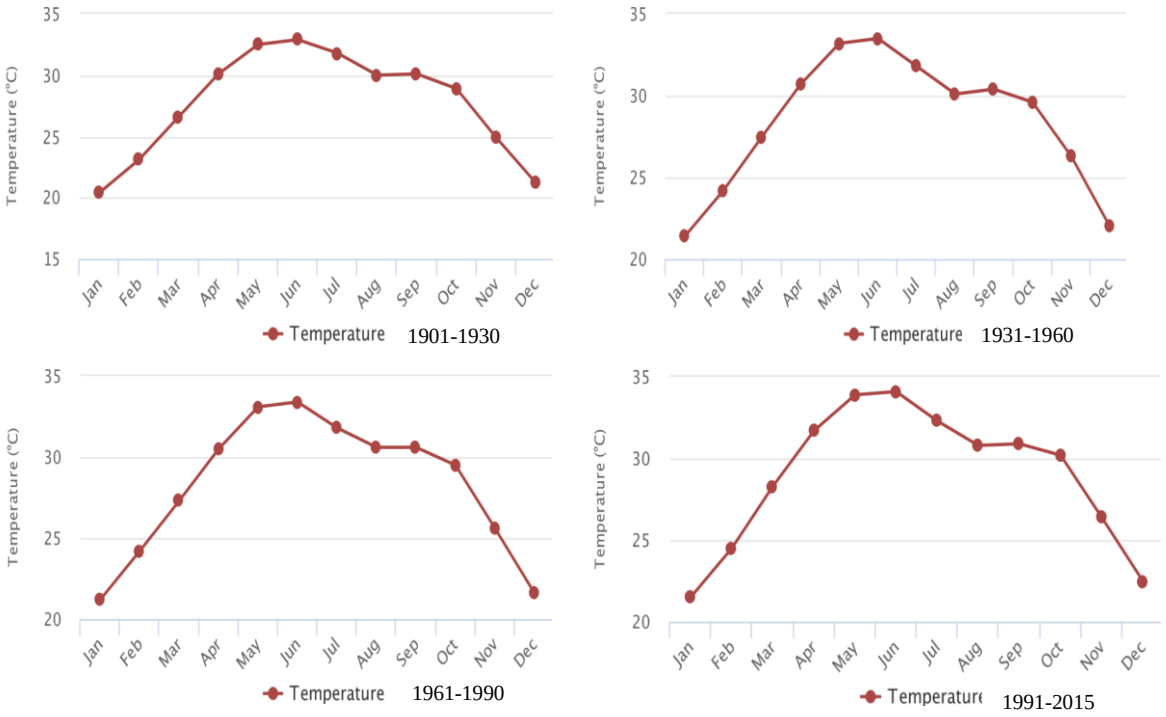
Source: Author's field research (climate portail WB)

2.6.2 **Evolution of the tempeture from 1901 to 2015**

With an average monthly temperature of 28.28 °c, the minimum temperature is about 19.54°c and the maximum at 35.08°c from 1960 to 2015, Mali is one of the hottest countries in West Africa Sahel. A very strong radiation throughout the year with little differentiated average temperatures, the maximum relative humidity varies between 31 and 75% and the minimum is between 11 and 38%. Evaporation and evapotranspiration

are so important. Speaking about figure 11, we can see clairly the high temperature over these periods, especially the last period 1991-2015. This rising of temperature has an effect on human living conditions such as direct or indirectly.

Figure 11 : Average Monthly Temperature for Mali from 1901-1930



Source: Author's field research (climate portal World Bank)

2.7 Conclusion

Mali, like the rest of West Africa Sahelian countries, has experienced changes in climate such as in recent decades, includind a sharp decline in the number of rainfall since 1970. In fact, this decrease has reduced crop yields and pushed up farmers to reduce the practice of fallowing and colonise new areas, thus modifying land use and decreasing land fertility. These changes and the decrease in rainfall have had significant effects on the water cycle and particularly on surface runoff, but the trend depends largely on the location of Mali.

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

This chapter starts by giving some definitions and conceptualizations of terminologies. An in-depth understanding of these expressions is very important in terms of explaining the relationship between migration and the relevant drivers of migration. The chapter also reviews literature on the determinants of migration, how it affects agricultural production in rural Mali. The literature focused mainly at providing some theoretical and empirical evidence on how households or individuals decide to migrate and how it influences agricultural production.

To start saying something about migration, it is a world while challenge issue and complex reality. Individuals who migrate are inspired by multifaceted mechanisms of causes principally by socio-economic causes; political instability and conflict are playing a relevant role. Additionally, seeking a good education, household reunification and the effects of natural hazards and climate change are also significant drivers of migration. Individuals might moreover migrate because of lack of doable alternative to bear their livelihoods in their place of origin. However, in terms of defining migration, apart of general definitions of migration, such as those established in dictionaries, there are various precise explanations of key migration-related terms, as well as administrative concern, legal, statistical spheres and research. In fact, there is no universal consensus definitions about migration, though, several explanations are generally recognised and have been advanced in different backgrounds.

1.1. Definitions of concepts and key terminologies:

1.1.1. What is migration?

The definition of the migration in the literature review is not homogenous. Many authors have defined migration only in their own interest and it varies from one country to another country. However, the definition of migration in terms of climate change is a critical issue, therefore, the debate on the relationship between climate change and migration remains a subject to clarify.

Brown & Bean (2005) defined migration in terms of temporal and spatial characteristics, that is permanent or semi-permanent move by a person of at least one year, which involves crossing an administrative, but not necessarily a national border. However, the 2014 report of IPCC stated that the most important contemporary overall trend in migration continues to be major movement of people from rural to urban settlements (Adger et al., 2014).

Susan et al., (2002) argued that migration can be described using several heuristic distinctions, definitely the most basic difference is that there are voluntary and involuntary migrants, but great majority of the migrants are voluntary, who choose to migrate.

International Organisation for Migration (IOM) defines environmental migrants as follow: "*persons or groups of persons who, for compelling reasons of sudden or progressive changes in the environment that adversely affect their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad".*

Migration induced by the effects of climate change can be understood as part of environmental migrants, with a reviewed explanation reading that "climate change

migrants" are:

"persons or groups of persons who, for compelling reasons of sudden or progressive changes in the environment as a result of climate change that adversely affect their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad".

The IOM Glossary on Migration may catch readers and also useful as reference. Reachable at the IOM online bookstore: www.publications.iom.int/.

1.1.2. Concept climate induced migration

Wilkinson, Kirbyshire & al., (2016) argued that, there is no universally agreed definition concerning climate-induced migration. Thus, they tried to categorise the concept referring to four broad categories in which people choose to migrate or people have forced to move when the situation is unbearable. First of all, the displacement of people by climate-related disasters (often-temporary migrants). Secondly, the forced to migrate but more permanently due to the recurrent events, thirdly, those also forced to migrate such as to avoid worsening slow-onset deterioration of the environment; and finally, people that choose to move as a strategy to adapt, and more in reply to environmental stresses and other factors. According to Mortreux & Barnett, (2009), in fact there are two main key issues needed to be considered in weighing up whether an individual may migrate due to climate change: with climate change, what they perceive to be the risks associated; and how from migrating and/or staying they analyse the benefits against costs arising.

3.2 Theoretical frameworks of migration

There are a number of approaches to explain migration especially international migration. The overview of the theories relevant to this work are presented in this section to ensure that the study is conducted within the confines of economics and well-grounded in theory.

The field of migration is multidimensional and offers various levels of investigation (Kurekova, 2011). According to Arango (2000) cited in Kurekova (2011), there are several theoretical models or perspectives which can be employed. Amongst migration theories, six of them focused on the determinants of migration as subjects to analysis.

3.2.1 Neoclassical theory of migration: macro and micro framework

The neoclassical theory explains migration to be caused by differences in returns to labour across markets (Kurekova, 2011). In the works of Hicks (1932), Lewis (1954) and Harris and Todaro (1969), the most initial basic model was developed to describe migration in the procedure of economic improvement. The model emphasised that, migration results from actual wage differentials across markets or heterogeneous degrees of labour market rigidity (Kurekova, 2011). The neoclassical theory explains that migration is induced by geographic differences in labour supply and demand as well as differentials in wages between labour-rich versus capital-rich countries.

Assuming that there is full employment, neoclassical approach predicts a linear relationship between wage differentials and migration flows (Bauer & Zimmermann, 1999; Massey & al., 1993; Kurekova, 2011). The wage differential must be high than 30% of the local income (Krieger & Maitre, 2006; Mansoor & Quillin, 2006; Kurekova, 2011). The key variable of neoclassical model is earnings weighted by the probability of

getting employment, therefore, migration is estimated by expected earnings rather than the current earnings (Bauer & Zimmermann, 1999; Massey et al. 1993; Kurekova, 2011).

Another adjustment of the neoclassical theory and the empirical tests of the model argues that the linearity relationship in the wages-migration pair does not hold and also the degree of income differential and the level of the country income must be incorporated. Likewise, migration is associated to the ability to move with a minimum costs, therefore, the poorest person cannot migrate and the poorest countries cannot send enough labours (migrants) (Haas, 2008; Kurekova, 2011;Faist & Schade, 2013).

The neoclassical macro-level elaboration might can be reduced to a micro-level choice and this has been described as *human capital theory of migration* (Todaro, 1969). Sjaastad (1962) introduced the human capital theory of migration by incorporating the socio-demographic features of the individual as a relevant determinant of migration at the micro-level (Bauer and Zimmermann 1999). In the heart of these analyses is a rational individual who chooses to migrate with the objective of maximizing his or her revenue. Individual migrant are therefore related with expectations, human capital endowments, age, marital status, gender, occupation, skills and labour market status of the individual.

The theory of human capital has also been criticised for being too optimistic in interpreting migration. However, scholars who supports the theory holds the view that, migration is not all-time a voluntary process to maximize profit. Massey et al. (1998) found that there exist a positive relationship between income and migration flows – while generally sustained – was by no voluntary process to maximize gains.

3.2.2 **World systems theory**

World-system theory is a highly political approach to the problem of economic development in the Third World (Chirot & Hall, 1982). for the theory is relevant to demonstrate how policy-oriented intellectuals in countries at a medium level of development accounts for their society's demonstrable incapability to catch up with the rich countries.

The world system theory links the factors impacting migration to structural transformation in world markets and views migration as a function of globalization, the improved interdependence of the emergence of new forms of production and economies itself (Massey et al., 1993). The development of export manufacturing and export agriculture linked strongly to foreign direct investment flows from advanced economies to semi-developed or emerging economies has led to a disruption in traditional work structures and has mobilized new population segments into regional as well as long distance migration. Capital mobility is hence a crucial factor for the world system theorists. The theory presents capital and labour mobility as interconnected and as two sides of one coin. Within this context, migration is viewed as a natural outgrowth of the disruptions and dislocations that inevitably occur in capitalist development and can be observed historically. The theory also incorporates global political and economic inequalities. It has been confirmed that historic structural approaches prevent migrants to make free migration decisions in a more deterministic form (Haas, 2008).

However, the study of international migration in the latest years has lost much of the world systems or international development view (Kurekova, 2011). The existence of the theory in earlier works (Haas, 2008) was perhaps o due to the fact that it is difficult to

derive a set of testable hypotheses and the character of this framework is strongly descriptive because it emerged as *ex ante* formulation of empirical facts (Bijak, 2006; Favell, 2008a; Kurekova, 2011)

3.2.3 **Dual labour market theory**

Dual labour market theory tries to link migration to structural modifications in the economy (Kurekova, 2011). It describes migration dynamics with the demand side (Kurekova, 2011; Massey, Goldring, & Durand, 1994). In the early 80s, Piore (1981) developed the dual labour market theory, which suggests in advanced economies a dual pattern of economic organization and a divided occupational structure. Duality unfolds along the positions of two types of organization in the economy (Kurekova, 2011), namely capital-intensive where both trained and untrained labour is employed, and labour intensive where untrained labour succeeds (Piore, 1981). The theory explains that migration is motivated by labour demand rather than supply. The character of the economy in advanced countries creates a demand for low-skilled jobs which domestic workers refuse to take up due to, for example, status. As immigration becomes desirable and necessary to fill the jobs, policy choices in the form of active recruitment efforts follow the needs of the market.

The theory exaggerates formal recruitment practices and ignores sending countries (Piore, 1981). In countries with similar economic structures, it is not able to account for differential immigration rates (Kurekova, 2011). On the other hand, it offers a bright description for the co-occurrence of structural unemployment in receiving countries and chronic labour demand for foreign nationals (Kurekova, 2011; Arango, 2000). Empirical

assessments relied on the difference between primary and secondary sector, which is frequently subjective, and hence can lead to unpredictable outcomes.

3.2.4 **New economics theory of migration**

The new economics of migration (NEM) theory challenge some of the assumptions of the neoclassical theory, by offering a new level of analysis and the nature of the causes of migration by shifting the focus of migration investigation from individual independence to mutual interdependence (Becker, 1993; Kurekova, 2011). The key argument is that migration decisions are not made by isolated individual actors but actually by families or households. Further, the decisions of migrants are influenced by a comprehensive established of factors, which are shaped by circumstances in the country of origin. As such, migrant decisions are not based only on individual utility-maximizing calculations but are rather a household response to both earnings risk and to the failures of a variety of markets such as labour market, credit market, or insurance market (Massey & al., 1993). Hence, migration in the absence of reasonable wage differentials or the absence of migration in the presence of wage differentials does not involve irrationality. However, other variables correlated with relative deprivation, for example a household carrying out relatively worse to other households will be prepared to send a member abroad as a risk-aversion and risk-minimization of household income (Stark, 1991; Stark, 2003). Stark (2003) holds the view that there is risk aversion by poor households in developing countries, where there are lack of institutional mechanisms such as government agendas or private assurance markets. Therefore, migration provides a meaningful strategy in dealing with diverse market failures.

Remittances bring a significant and integral part in the new economics of migration investigation as they directly support the concept of household interconnections and the expansion of risk (Taylor 1999). While being able to analyse in parallel the causes and impacts of migration, the new economic theory of migration has been disapproved for sending-side bias and for its limited applicability due to the complications of isolating the special effects of market non-functioning and also risks from other income and employment variables. In general, the theory has not received enough following or empirical testing. The NEM is fundamentally a social choice account, and has also been critiqued for overseeing dynamics within households, such as the roles of gender and being too heavily future guided (Kurekova, 2011).

Beside all these insufficiencies, the new economics of labour is proving its strengths in terms of analysis the relationship between migration and agricultural production.

3.2.5 **Conclusion and relevant of the theories to the present study**

The theoretical reviews provided in previous sections are widely used as theoretical anchor to empirically investigate migration. Based on the assumptions and focus of each of these theories, they can be classified under two streams. First are those that explained the perpetuation of migration or the directional flow of migration and secondly, those that analysed the determinants of migration. Therefore, considering the primary objective of this research work of exploring the driving factors of migration and its impacts on household's income, the neoclassical theory and the new economics theory of migration are more relevant. Hence, the study proceeded on the trajectories of these theories. But where necessary, some assumptions of the other theories were made to provide a more detailed analysis of migration in Mali.

The subject labour migration is one of the main issues in the world news, and it is gradually getting a remarkable consideration in international level. A large number of literature has attempted to carry out the determinants of migration trends, and from the economic literature, several causes have been acknowledged to describe why individuals or household are more likely to move away (Naudé, 2010; Kurekova, 2011; Zahonogo, 2011). From the literature, in most of the cases migration is driving by two categories of factors as well as push factors (in origin country) plus pull factors (in destination country) of the migrant. The push factors are things that are not favourable about the place that migrant lives in, and pull factors are things that pull migrant to another place. Means that push factors are the opposite of pull factors. In fact, there is large number of migration factors. According to Lee (1996), these factors are going from the opportunities given by the country (jobs, education, medical care) to the institutional infrastructures, political instability, civil conflicts, the country climate in fact natural disasters.

According to the International Organization for Migration IOM (2018) last report, "*Human migration is an age-old phenomenon that stretches back to the earliest periods of human history*". Therefore, the research field of migration is multifaceted and offers various levels of investigation (Kurekova, 2011). According to Arango (2000) and Kurekova, (2011), in the area of migration research, there are currently a several theoretical models or perspectives which employ unpredictable concepts, framework of assumptions and levels of analysis. All these theoretical models are evolved separately, so the majority of them were developed from some specific empirical observations.

In this modern World, the current situation of migration is driving by several factors. Researchers are divided in how to understand migration issue with theory. In one hand,

some of the research addressed migration with subject of analysis *"perpetuations of migration and/or directionality of flows";* in other hand, some threatened it with subject of analysis the *determinants of migration.*

In this work, considering climate change as one of the determinants of migration, our interest will be on those theories threatening migration with subject of analysis the determinants of migration. Amount these theories the closers to this work stand for the two dominant theories in explaining causes of migration are the *neoclassical theory* and the *new economics theory of migration.*

The neoclassical theory of migration: The leading theory in describing sources/causes of migration is the neoclassical theory with its hypothesis that migration is motivated mainly by rational economic considerations of relative returns and costs, mostly financial but also psychological. The fundamental idea of the neoclassical approach thus focuses on wages.

The new economics of migration (NEM) (Stark & Bloom, 1985)*:* It came to deal with some of the hypothesis of neoclassical theory, proposing a new level of investigation and different nature of migration determinants. The essential idea of this theory is that migration decisions are made by households or families rather than isolated individual persons.

3.3 Drivers of migration

3.3.1 Conceptualising Drivers of Migration

Drivers of migration have been understood as the factors that push people to migrate and/or remain at original location (Massey et al., 1998; Hear, Bakewell & Long, 2017). In other terms, these drivers, also called factors, get migration moving and preserve it

moving once started. The clarifications of the perpetuation and inception of migration have frequently been motivated on disparities in circumstances between diverse residences (Awumbila, 2017). These factors can either be push or pull factors. Push-pull models suggest that the emigrants were pushed by low return in terms of earnings in their regions or countries but pulled by the favourable situations (prospects) in wealthy areas (Harris & Todaro, 1970; Lee, 1996; Haas, 2008; Awumbila, 2017). According to Oded Stark & Bloom (1985) at the micro or meso level household use migration as strategy to overcome an eventual coming risk. Therefore, social network facilitate family decision making about migration. Others have highlighted the significance of chains, networks and culture in keeping migration working once the initial movement is made (Awumbila, 2017).

Over the most important drivers of migration, poverty remain a major factor pushing people to migrate. However, some scholars acknowledged since the early 1990s that the poorest people cannot migrate since they lack the means for migration, particularly, international migration (Hear & al., 2017). This situation received much discussion about the link between migration and development, in particular whether development can bring down the forces that drive migration or in fact can stimulate more migration by giving people the resources to move.

Generally, the literature recognises several drivers of migration. The developmental level and socioeconomic characteristics of Africa provides a number of factors to influence migration. For instance, Africa is one of the poorest continent in the world. At macro level, these drivers include social factors such as the search for better education opportunities or commitments to kin through inheritance practices or marriage. In addition, political factors such as persecution or discrimination, levels of security, civil

war and policy incentives also influence migration decisions. The demographic factors that embraces the density and structure of the population and threat of diseases are considerable drivers. Quite recently, the environmental factors covering exposure to land productivity and hazards are becoming a major concern for migration. At micro level, individual characteristics such as age, sex, education, wealth or marital status can also influence migration.

A large number of studies highlighted that the drivers of migration do not happen in isolation from each other (Naudé, 2010; (Black et al., 2011; Awumbila, 2017). These authors argued for instance that, demographic factors alone are not likely to induce migration, however high densities for instance in grouping with low income could well bring people decide to migrate. In addition, environmental change affects agricultural productivity, and this can distress economic factors such as earnings of the agricultural sector, particularly the rural people. The implication is that analysing the drivers of migration should be reflected within the caveats of the interconnections in the drivers of migration. In the following sections, a detailed analysis of the major drivers of migration is provided.

3.3.2 **Development Processes as Drivers of Migration**

Generally, the focus on the drivers of migration has the tendency to point to poverty, underdevelopment and violence as the key drivers of migration. Researches have shown an increasing trends of migration out of Africa (Flahaux & Haas, 2016). A large number of circulating migrants moving intra regionally seems to be driven by social transformation and social progressions of development occurring in the world. The trend is likely to increase in the future following the development processes. The poorest

countries of Africa (such as the landlocked Sub-Saharan countries) have lesser levels of total emigration and most emigration is dominated by continental migration to nearby African countries. This explains the mobility transition theory (Zelinsky, 1971).

This situation is stood from the fact that African countries are practically at the same levels of development (such as in the coastal West Africa or Maghreb), had the tendency to have the topmost intensity of extra-continental migration. Thus, economic progress and associated social renovation initially overlap with increasing levels and a larger geographical reach of emigration. This is explained that development processes typically expands people's option to get access to material resources, education, social networks, knowledge and media. The developments in transportation and infrastructure also creates travel with less cost and risk, allowing migration over rising distances. Thus, improving education quality, income, and access to information and networks generally increases people's abilities and goals to leave their own place.

Thus, recent increases in African emigration may be explained from processes of development and social transformation. This have increased young Africans' capabilities and aspirations to migrate, a trend which is likely to continue in the future. Within these frameworks, some scholars argued that there is the need to focus on "migration aspirations" (Carling, 2002) rather than drivers as the former approach would allow a better understanding of how several factors can, depending on the situation, shape migration incentives (De Haas, 2007)

3.3.3 **Role of states and policies as drivers of migration**

National policies play an essential role for the migration pattern across the world and in particular, explains both the increasing intra-regional movement and the rising emigration

trends in Africa. The role of policies in overall influencing migration flows and specific in Africa did not get much study, somewhat due to the non-existence of adequate policy data. However, the general rise in restrictive of the visa to African inhabitants might be an indicator of a fractional driver to a growing spatial variation of migration patterns. This reflects the broader argument that immigration restrictions change the character of migration rather than decreasing overall volumes of migration as such.

3.3.4 **Demographic determinants**

Migration within and from SSA is an important macroeconomic concern with spill-overs for both the origin and destination countries. With a rapid growing population, migration in SSA has been briskly increasing during the last 20 years (Gonzalez-Garcia et al, 2016). The population of SSA region has doubled during 1990 to 2013, and this is the fastest record of population growth in the world. Until the 1990s, about 75 percent of the stock of global migrants was dominated by intraregional migration.

The demographic determinants such as the growth rate, size, the density and the structure of the population exerts pressure on migration. These population features are most frequently associated with the effect on natural resources, conflict and competition over scare and/or valuable resources (Hatton & Williamson, 2002, 2003). As explained by Hatton & Williamson (2002), younger people particularly migrate more easily for economic reasons. A study of Awumbila et al, (2016) indicates that the marital status of a female migrant domestic worker, especially widowed and divorced women was a significant factor that affected their migration decisions.

3.3.5 **Economic determinants**

At macro level, the causes of migration are inter-regional and intraregional disparities. However at micro level, the fundamental cause of migration is the lack of employment opportunities resulting from the low standard of living conditions between different socio-economic groups. Migration generally takes place because of the push factor of less opportunity to improve living conditions in the socio-economic situation and also because of pull factors that exist in the more developed countries. Harris & Todaro (1970) explained that the expected net economic returns (remittances) from migration drive the decision whether or not to migrate. The potential migrants would compare the differences in wages, as well as the probability of getting a good job in a possible destination country. Within this context, migration itself is seen as a strategy at the household level different from the individual level (Naudé, 2010). The effect of economic opportunities on migration using data on GDP per capita and GDP growth were also found to have influence on migration decisions (Bie and Broeck, 2011; Naudé, 2010). There are also the reverse effects of migration and economic status. According to Naudé (2010), international migration may affect a country's growth (GDP), its population demographics and may have an effect on conflict (in both the sender and receiving countries).

The economic impacts can both be push or pull factors of migration. Push factors would typically include deficit in wages and incomes, rising poverty and unemployment and the lack of basic amenities. Pull factors generally include better access to jobs, amenities, social services and education opportunities. Economic push and pull factors are widely considered important in SSA in the light of economic stagnation in most of the economies since the 1980s (Mafukidze, 2006; Ndulu et al., 2007b). The extent to which these economic push and pull factors eventually lead to international migration will depend on

immigration laws in the destination countries (Katseli et al, 2006). However, the lack of quality data on migration in Africa makes it difficult to explain the wage differentials in migrating and destination countries.

3.3.6 **Violent conflict**

Political instability, civil and/violent conflict are among the most significant determinants of international migration (Crisp, 2006; ECA, 2006; Mafukidze, 2006; Adepoju, 2007). Despite this recognition, very few studies so far have empirically analysed the impact of these factors on migration from SSA. In particular, none have used direct measures of political instability and violent conflict in relation to net migration. Using the stock of refugees in a country at the end of a particular year as dependent variable and various dummies for different types of violent conflict as explanatory variables, Hatton and Williamson (2001) investigated the effect of violent conflict on refugees. Distinguishing between coups, guerrilla warfare and civil wars, they found that these generate, respectively, 45, 30 and 64 refugees per 1,000 inhabitants.

Traditionally, there has been less emphasis on whether and how international migration in SSA contributes to violent conflict. Recently, however, the possible role of migration as a cause of violent conflict in destination countries has been raised (Reuveny, 2007; Smith, 2007). According to Reuveny (2007), environmentally forced migration may be more likely to result in conflict due to the 'scope and speed' at which it can occur (as for instance, after a natural disaster), and this does not allow the migrants to be 'absorbed more slowly'. Smith (2007) points out that, migrants are often seen as a burden, competing for jobs, resources or even constituting a political threat. Salehyan and Gleditsch (2006) consider the possibility that migrants may 'spread civil war' and find that

the probability of violent conflict is more than three times higher in migrant-receiving countries. A panel data model is used to determine the extent to which violent conflict contributes to net migration from SSA, and to investigate whether or not migration contributes to violent conflict. Data on the incidence of violent conflict are taken from the UCDP-PRIO (PRIO—International Peace Research Institute Oslo) database (Naudé, 2010). The report of this study shows that over the period 1965-2005, armed conflicts,

3.3.7 **The natural environment, climate change and migration**

Environmental influences as drivers of migration start with the concept of 'vulnerability' (McLeman and Smit, 2006; Black et al., 2011). Therefore, the natural environment is perhaps an old determinant of migration and displacement of people. It affects migration through three channels: (i) scarcity of water and land, (ii) conflicts over natural resources, (iii) natural hazards and natural disasters. Climate change is expected to intensify these aspects (Black et al., 2011 Naude´, 2009)

Rainfall is unpredictable and the variability is very high in many regions of Africa, particularly in the Sahel and may also be on the decline (Barrios et al., 2003; Naudé, 2010). In addition to water scarcity, most SSA countries are faced with land degradation (Bojö, 1996; Semazzi & Song, 2001). How quick migration will take place in response to these environmental changes is uncertain. Environmental degradation often takes place slowly, leading to gradual migration. Moreover, as Reuveny (2007) points out, migration is neither the only nor the first response of a population to environmental degradation.

In recent decades, international migration has received much attention, especially the high inflow of Eastern Europeans to Western Europe (about 20 million in the last 25 years). Generally, international migration patterns varies significantly over the time and across

origin and destination countries (Mayda, 2010). Migrations have always happened, but in the last decades migration flows suddenly augmented. Recently, migration due to climate change have become one of the most debated topics by researchers and by policy-makers. The surging climate attention has led to the incidence of mass migration currently witnessed in various parts of the world.

The movement of human capital is motivated first by economic factors, social and cultural, demographic and environmental factors in the origin or/and the destination country. In the origin country, these factors are considered as push factors but called pull factors in the destination country (Drabo and Mbaye, 2014). Principally, the reason for international migration acknowledged by empirical and theoretical literature is differences in economic opportunities or, further precisely, wages differential (Ghatak, Levine, and Price, 1996; Drabo and Mbaye, 2014). Aside the wages differential, migration is recognised as a technique to multiply the income sources, to offset the impacts of bad political institutions, large social inequalities, conflicts and the lack of good infrastructure in the originating country. People can also migrate because of family reasons. Therefore, migration is seen as the possibility for people to increase their quality of life. Unfortunately, these migration driven factors are directly or indirectly influenced by climate change.

In fact, one of the main critique moved by previous empirical analysis employing a multivariate methodological approach (Piguet, 2010; Drabo & Mbaye, 2014) is the rough and unsophisticated identification of climate variables.

This study is closely related to the extensive discourse on climate change and the macro-economic literature on the factors which influence migration as well as the impacts of

environmental shocks and other forms of shocks on migration. Although there is a wide range of studies on migration, there is no universal conclusion on the impact of environmental shocks on migration. Climate change has without any doubts heterogeneous impacts across countries and presents identification issues (Black et al, 2013 cited in Beine and Parsons, 2013), which are linked to the socio-economic idiosyncrasies at origin, and which in turn determine individuals' vulnerability to climate change. As a result, various existing studies have given alternative conclusions in a variety of differing contextual settings. For example, Munshi (2003) finds a statistically significant and positive correlation between emigration and low rainfall at origin from rural Mexico to the United States. In the same way, Barrios & al, (2006) found that, rain shortages significantly raise the migration level from rural areas across SSA, but not in other parts of the developing world. Also, Marchiori et al, (2012) found that climate variations outgrowth internal migration as well as international migration in SSA but argued that urbanization may mitigate the effects of climate change on international migration. Further broadly, Afifi & Warner (2008), found that a number of variables that were used to measure environmental degradation are positively correlated with increased numbers of international migrants. Conversely, Findley (1994) in the case of Mali found that episodes of drought led to decreased number of migrants due to the tightening of credit constraints, the result of rising food prices; especially to other African countries and to France. This is relatively an old reference and may not reflect present trends, thereby, the need for present empirical study on migration-climate change discourse in Mali.

Barrios & al., (2006) investigated the role of climate change in the patterns of urbanization in SSA countries compared to the rest of the developing world. This study involved a cross-country panel data set, covering seventy-countries and spanning over a thirty-year

period (1960–1990) and estimated the determinants of urbanization (increase in the size of urban population attributed to migration from rural areas). Their econometric analysis results suggest that climatic change, as measured by rainfall, has acted to change urbanization in SSA, but not elsewhere in the developing world. They showed that a 1% fall in normalized precipitations increases urbanization rate by 0.45%. Therefore, the authors concluded that migration to urban areas is encouraged by decreased rainfall. Also, the link between migration to urban areas and fall in rainfall has become stronger since the independence, which is likely due to the legislation that free internal movement of Africans within Africa (Barrios et al., 2006).

Gray & Mueller, (2012) used event history methods and a longitudinal dataset of over 10 years from rural Ethiopian highlands to examine the drought's effects on population mobility. The results demonstrated that men's labour migration increases with drought and those land-poor households are most vulnerable. In addition, in drought periods, marriage related migration by women decrease. The results suggested a hybrid narrative of environmentally induced migration that identifies multiple dimensions of adaptation to environmental change.

Bie & Broeck, (2011) review the existing literature on empirical evidence of how climate variability and climate change in Less Developed Countries (LDCs) affect two main drivers of migration. Migration models in the economic literature, namely income level differentials between destination and origin areas and income changeability in origin areas, and how they in turn affect migration, identified this. They found that there are gaps in both environmental and economic literature that makes it impossible to make sound and strong predictions of how increased climate variability and climate change will affect the

economic drivers of migration, and of how these in turn may change the existing patterns of migration. The authors acknowledged some empirical indications that income differentials may increase due to lower income levels in the origin areas of Less Developed Countries, nonetheless found no tangible evidence of increased climate variability or the effects of climate change on income variability. They additionally argued that, although a number of researchers has established an undesirable relationship between migration and rainfall, the evidence underlying this relationship is found to be limited. They added that the net effect of climate change on income levels would be mitigated by the variety of adaptive strategies in place for most rural households in LDCs.

Grote & Platz, (2010) explored the linkages between environmental factors and migration with a focus on four SSA countries: Ghana, Mozambique, Niger, and Senegal. The study acknowledged the occurrence of high rate of migration in environmentally deprived areas of each of the four countries. The authors argued that environmental factors might not directly lead to migration, instead, its influence is observed through fundamental drivers of migration such as livelihood insecurity and income inequality. Although the paper is unable to eventually make clear the causal links between environmental change and migration, it helps to recognize and separate the issues on migration in a systematic manner.

Gray (2011) analysed soil quality and human migration in Kenya and Uganda. This involved a longitudinal survey dataset from Kenya and Uganda containing information on household-level soil properties to estimate the effects of soil quality on population mobility. The result reveals that soil quality significantly diminishes migration in Kenya, principally for temporary labour migration, but marginally raise migration in Uganda.

These conclusions are consistent with several previous studies who demonstrated that, although adverse environmental conditions tend to raise migration, it is not a generalized conclusion. This indicates that the general assumptions about environmentally induced migration may not be applicable in all context, hence, analysis at specific geographical locations such as in this study is well justified.

Naudé (2010) estimated the determinants of migration from 45 SSA countries over the period of 1965–2005. The authors found significant effect of lack of job opportunity and armed conflict on migration in SSA. Although, demographic and environmental pressures were found to have less direct impact, the study provided that these factors may have an indirect impact on migration through conflict or job opportunities in the countries. The author as well argued that since environmental shocks may be slowly felt by affected communities, the extent of migration arising from such shocks are gradual or occurs at a very slow process.

A study by Black & al., (2011), presented a new framework to understand the effect of environmental change on migration. The framework identified five categories of drivers, which affect migration decisions as social, political, economic, environmental and demographic drivers. The authors noted that the environment drives migration through mechanisms characterized by accessibility and reliability of ecosystem services as well as exposure to risk. These associated drivers operating in combination hence affect individual migration decisions and flows; the effect of the environment is therefore highly dependent on the social, economic, demographic and political context. Environmental change potentially can affect directly the riskiness of place. Environmental change also affects migration indirectly, in specific case through economic drivers, for example

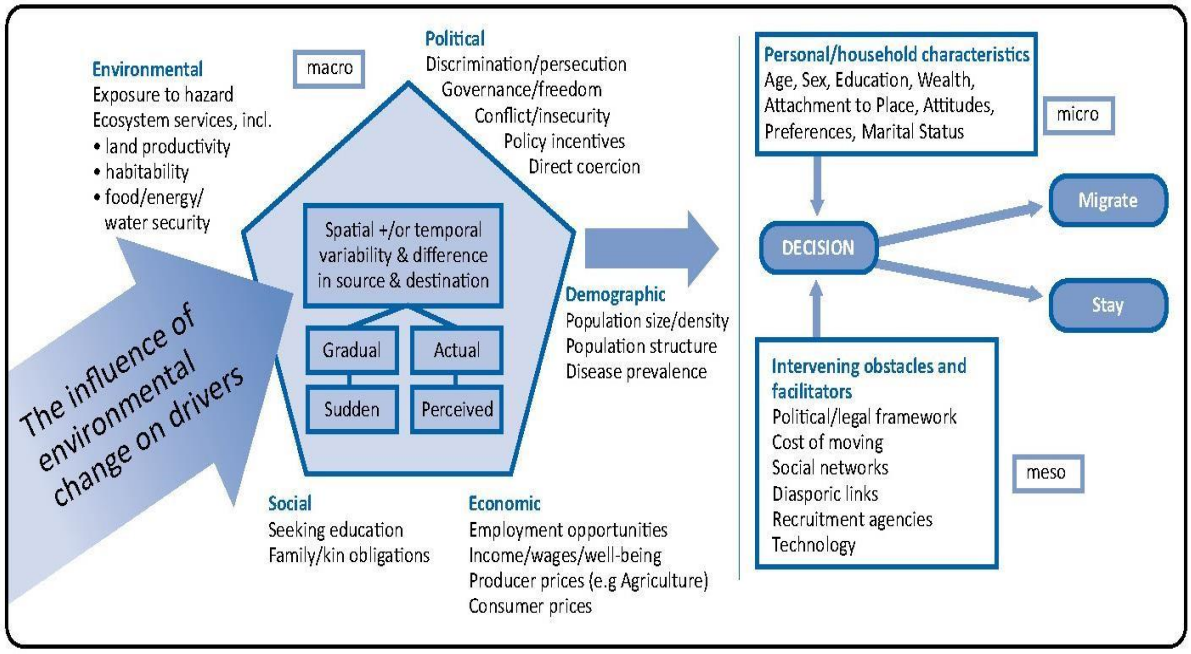
change in livelihoods, and political drivers through process such as conflicts over resources. The authors therefore future a framework that is applicable to both internal and international migration.

Koko & Afifia (2014) in their paper titled "Where the rain falls: Evidence from 8 countries on how vulnerable households use migration to manage the risk of rainfall variability and food insecurity," relied on an original micro-level data from eight countries (Bangladesh, Ghana, Guatemala, India, Peru, Tanzania, Thailand, and Vietnam). Their results from Ghana shows that household's decisions on migration are mostly centered on factors influencing agricultural production. The most important triggers of migration among households are crop production decline, unemployment, rainy season shifts, longer drought periods causing unreliable harvest, and drought frequency. However, in times of such environmental shocks, migration alone serves as a temporary mitigation strategy but do not totally lead to the improvement in overall well-being especially for household's members left behind. In Tanzania, they identified linkages between unpredictable and changes in the patterns of weather and the decision to migrate. For Tanzania, the top three factors affecting households' migration decisions were: (1) longer drought periods, (2) increased drought frequency, and (3) water shortage. Households in this study used migration as part of 'climate survival strategies' which ultimately increase their sensitivity to climatic risks like changes in rainfall variability. Similarly, households with less access to adaptation options practice internal migration during the hunger season, which reduces labour for crop production, maintaining land tenure, and interrupts household's investment in education as a survival strategy in an overall setting of erosive coping measures which leave or trap households at the margins of decent existence.

Kniveton & al, (2011) employed an agent-based model to demonstrate the role of the environment in the decision to migrate using scenarios of future climate change, demographic, social, economic, and political in a dryland context of Burkina Faso. The results of this study found that in terms of climate change, the incidence in the context of a drier environment produces the largest total and international migration fluxes when combined with changes to inclusive and connected social and political governance. From these reviews, the empirical factors that influence migration is discussed under the following heads.

In the Foresight's project in 2011, they built a conceptual framework in their report to show the drivers of "migration and the influence of environmental change on these drivers. An important feature of the graph below is that the existence of migration drivers does not necessarily imply that migration will happen, whether migration occurs or not depends on a series of intervening factors and also the characteristics of individual or household. This is important in the context of environmental change. Substantial social, economic and human capital may be required to enable people to migrate, especially internationally (Foresight, 2011).

Figure 12 : Framework climate change influence migration decision



Source: adapted from Foresight 2011(Author's field research)

Beside all these written above, the internal migration has some especially case:

Migration without cross countries' border, involves people movement between administrative units inside their own state. The United Nations Development Programme (UNDP 2009) estimates that around 740 million were internal migrants universally at the turn of the millennium more than three times the number of intercontinental migrants.

According to Bell and Charles-Edwards (2013), the number of internal in 2005 was 763 million individuals, who were internally moving. These estimates were likely modest and the number of internal migrants is higher today. China only, counts 150 million internal migrants, principally from rural areas, living in urban areas in 2009 (Chan 2013). The lack of accurate data and methodological subjects make it hard to evaluate the current number of worldwide internal migrants.

Internal migration differs from country to country and also from an administrative zone to another within the same country (heterogeneity of internal migration) (Bell and Charles-Edwards 2013). For instance, the intensities of internal migration (e.g. the total number of internal migrants as a share of the general inhabitants), have decreased in Latin America but for China and some countries from African have increased. The major destination of these migrants is the major cities in the country. Such as according to Tacoli et al (2014), internal migration brings a large contribution to the growth of urban area. Recently the share of residents in urban areas has increased practically in all countries. Mostly in developing countries, the urban growth rate is highly related to migration (Montgomery 2008). In fact, the shape of internal migration is not identical from country to another, migration accounts less than 1/3 of urban inhabitants in Sub-Saharan Africa but very high in Asia (Tacoli & al 2014). Internal migration can be circular pattern, both rural-rural or into urban areas. Seasonal, circular rural emigration is a key element of rural livelihoods so that it intensifies the stability in rural places and offers agricultural workers opportunities in wealthier regions particularly for unskilled migrants.

Regarding all these situations, there a need to try to understand what is behind the migration especially the internal migration. The 2011 Foresight's conceptual framework for the drivers of migration reports that environmental change influence migration through the existing drivers such as social and political drivers, economics and demographic drivers.

A significant proportion of internal migrants will end up in major cities. Internal migration is a large contributor to urbanization (Tacoli and others 2014). The share of the population living in urban areas has risen in practically all countries. It averages 32 percent, 49

percent, and 78 percent, respectively, in least developed, less developed, and developed countries (PRB 2016; UNDESA 2014). About 40 percent of the urban growth rate in low and middle income countries is related to migration (Montgomery 2008), although the shape is not uniform across countries: Migration represents less than one-third of urban inhabitants' growth in Sub-Saharan Africa but far more in Asia (Tacoli and others 2014).

Nowadays, it highly acknowledged by academic and policy makers that climate effects are reducing the local livelihood opportunities and increasing the risks for vulnerable people across the world especially in developing world. Because in these places the majority of populations living in these places rely on rain fed agriculture. They are even often driving to change address to other locations in avoiding climate impacts (Black & al 2011). This subject of human migration is at the frontier of current policy debates seeing that change in climate will affect countries across the world but not at the same way and intensity (Foresight, 2011). International Panel on Climate Change (IPCC) in its Fifth Assessment Report considered human migration as a consequence and adaptation strategy to climate change. The report connected climate change induced migration with issues relating to human security (Adger & al 2015), the challenges of urbanisation (Beauchemin & Bocquier, 2004). Beside all these drivers, there are a multiple drivers of migration such as social vulnerability in rural areas (Dasgupta & 2014). In the key message is that the involuntary migration is exacerbating by the increased exposure to environmental issues and associated with environmental challenges such as demographic and economic vulnerability in many climate-affected countries.

However, according to Dasgupta & al 2014, understanding the multifaceted interaction between the numerous drivers of migration in different context of hazard rests a key

challenge (including economic and social, demographic and environmental). Moreover, the recent thoughtful of human migration recognizes it as a multifaceted process involving the short term and long term aspect (Piguet, 2011). From the growing literature review, most of them examine and track the long term, or geographical aspect of human change address (Lu & al., 2016), a few examinations have acknowledged the temporal dimensions

Further, available information on how certain hazard contexts may influence temporary (short-term) or permanent (mostly long-term) migration, or population displacement, is inconclusive (Piguet, 2011). Therefore, more studies are required to adequately develop policies to address the challenges of contemporary migration (Piguet et al., 2011).

3.3.8 **Proponent of the impact of climate change on migration**

A review of the literature suggest two differents schools of thougts on the impacts of climate change on migration. These are those who agreed that climate change leads to increase migration and those who indicated that no impact of climate change on migration. These are discussed in the subsequent section.

3.3.8.1 Pros results climate change impacts migration

Climate change impacts are likely to distress population distribution and mobility (Tacoli, 2009), and this remains at the vanguard of the international development policy debate (Beine & Parsons, 2013). Climate change no doubt has heterogeneous effects across countries, particularly between vulnerable countries (poor countries) and rich countries (Black, Kniveton, & Schmidt-verkerk, 2011; Beine & Parsons, 2013), which can be considered as a function of the socio-economic habits at origin, and which in turn influence individuals' vulnerability to climate change.

Many existing studies have provided different conclusions, perhaps due to a variety of differing contextual sceneries. Munshi, (2003) cited in Beine & Parsons, (2013) for example, finds that, there is a positive correlation between emigration to the United States from rural Mexico and low rainfall in rural Mexico. Similarly, Barrios, Bertinelli, & Strobl, (2006) find rainfall scarcities significantly lead to increase migration from rural areas across SSA, but in other parts of the developing world, there was no significant impact. Marchiori, Schumacher, & Schumacher, (2012), realise that climate variations increase both internal and international migration in SSA and in addition, urbanization may reduce international migration induced by the effects of climate change. In general, Afifi & Warner, (2008) argue that many variables which measure environmental degradation are positively correlated with increased numbers of international migrants.

Kniveton et al. (2008), from two Mexican regions, find that in the context of international migration, greater volumes of rainfall lead to increased numbers of emigrants to the United States. However, in the literature, the researchers recognised that there is truly thing as a climate or environmental migrant called also environmental and/ ‘climates refugees’ in the narrow sense of a migrant completely moving for environmental reasons.

3.3.8.2 Proponent no climate change impacts on migration

Among scholars, there are no recognised methods of providing overall quantitative predictions regarding the extra human migration that could be caused by climate change (Piguet, 2010). Stefan Liehr (2016) argued that, in extreme cases, population dislocations are always the result of a multi-causal relationship between environmental, economic, political, cultural and social dimensions. Environmental, climate shocks do not affect all individuals, households, and communities at the same level, and that further information

related to climate change is not perceived in the same way everywhere and by everybody. Even when confronted with severe climate extremes or environmental degradations, human beings and communities are resilient and have at least some minimum agency in deciding to migrate or to choose other adaptation strategies (Tacoli, 2009; Piguet, 2010; Naudé, 2010).

At least two limitations concerning the data on climate change. Firstly, the lack of the environmental or climate variables used as indicators, are very basic and concern either natural disasters or rainfall (Renaud, Bogardi, Dun, & Warner, 2012), a part of elaborating indicators of environmental degradation or climate change. The second limitation is more related to the method itself and the fact that exposures and responses are measured for spatial aggregates rather than for individuals (Piguet, 2010; Renaud et al., 2012). In the literature on the migration and climate change, the knowledge in this field remains very fragmented as well as limited (Gómez, 2013), because there are worries surrounding the actual mechanisms at stake (Piguet, Pécoud, & de Guchteneire, 2011). For an example, one of the most cited studies based on two surveys,1982 and 1989 conducted in rural Mali with a sample of 7079 individuals and 309 households before and after a series of droughts which affected the country (Findley, 1994; Piguet, 2010), revealed no increase in international emigration, while around 64 percent of the migrants adopted circular pattern, e.g. went to food-surplus zones. During this series of droughts (1982 and 1989), the most major migrants were women and children.

In the same vein, Paul (2004) surveyed 291 respondents from eight tornado-affected villages in Bangladesh and realises that none of their household members had dislocated because of the tornado of the 2004, no respondent was conscious about any out- migration

within their localities, and that one-third of respondents even assumed that outsiders had been flocking into the tornado-affected villages in the hope of profiting from calamity relief schemes.

3.3.9 **Climate change and migration: the importance of agricultural sector**

The relationship between climate change, agriculture and migration is a very complex topic. Even though the influences of climate change especially on food security and in general on agriculture are relatively well recognised. However, the flowing impacts of climate change on migration and its magnitudes on agriculture have not been sufficiently evaluated (FAO, IFAD, IOM & WFP 2015). Therefore, there is a need for research to fulfil this gap of knowledge. Climate change address migration by weakening the socio-economic factors of migration such as food security, poverty, and absence of employment opportunities, imperfection of social protection, and the weakening of natural resources.

The largest proportion of migrants' population in Africa are coming from rural zones and in achieving their livelihoods needs, they are highly depending on agricultural sectors and natural resources, which are typically exposed to and vulnerable to climate change. However, the direct link from climate change to migration pass through the increasing in the sudden and slow-onset events. Extreme climate events are sudden-onset events, which probably lead to immediate effects on migration. These events includes droughts, floods or heavy rains and tropical storms.

However as underlined by numerous studies (Black & al 2011; Awumbila, 2017), migration drivers do not happen in isolation to address migration each other. Climate change and/or environmental change for instance leads to a decline in agricultural productivity and this can disturb economic factors such as revenue, specifically the

amount of people living in rural areas. Change in climate is a multiplying threat to violence, conflicts and natural disasters that cause migration of populations reliant on agriculture.

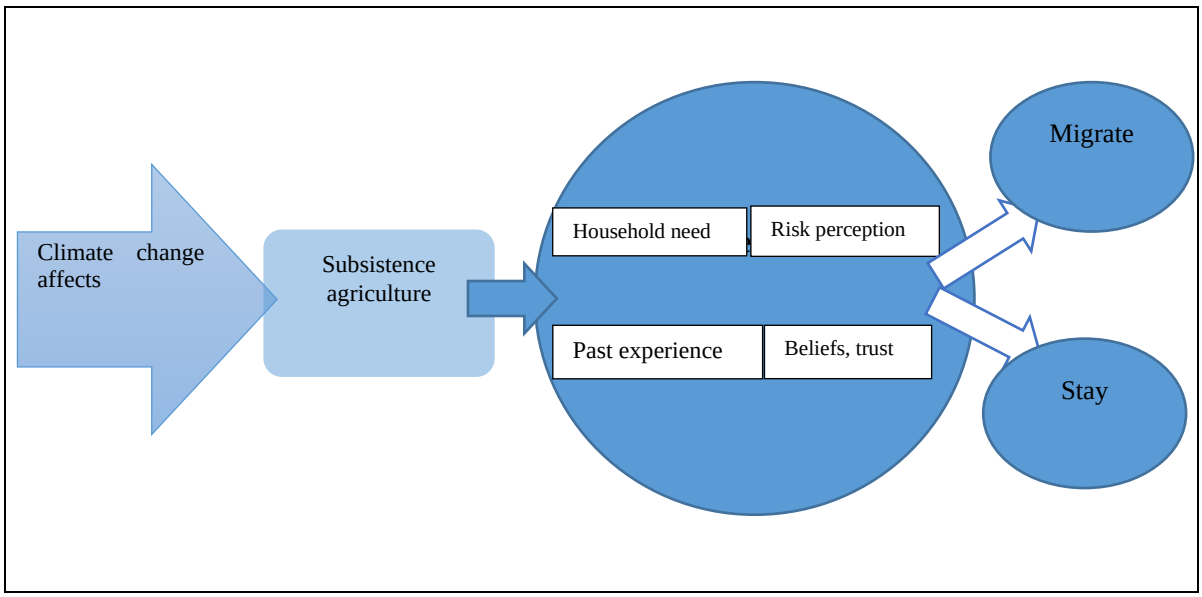
The universal climatic system is altered by greenhouse gas emissions and that is resulting in a global warming tendency and an intensification of the frequency and the severity of weather events such as droughts, floods and storms (IPCC, 2013). According to IPCC, associates of climate change such as climate variability and weather events will affect all countries, but peoples living in less developed agricultural world will be strongly impacted because they depend deeply on the environment to generate income and for their subsistence (Nawrotzki & Bakhtsiyarava, 2016; Huq & al, 2004). Peoples from less developed agricultural world regularly have in absence of access to infrastructure and technology such as irrigation that may be employed in manufacturing countries to restrain adverse climate influences (Gutmann & Field, 2010). In fact, those researchers have acknowledged the possibility to have large number of migrants from climate change by mid-century (Myers, 2002; Stern, 2007). While some authors have criticised these works as excessively over-simple and non-accurate (Gemenne, 2011), proof from the longer path of the history of human demonstrates that climate variability and weather extravagances have affected human migration behaviour through the world (McLeman & Smit, 2006). Similar confirmation such in the review for more recent years the effect of climate on migration patterns are found (Hunter & al, 2013; Nawrotzki & al, 2013; Bohra-Mishra & al, 2014; Mueller, Gray, & Kosec, 2014).

For the continent of Africa, studies discovery that climate aspects mostly intensify short distance e.g. domestic migration then might reduce probably of international migration

(e.g. Findley, 1994; Henry & al, 2004). Climate change has the prospective to influence migration drivers through various pathways including adverse impacts on the agricultural sector (Mueller et al., 2014) and armed conflicts (Burke & al, 2009; Nawrotzki & al 2003).

While the agricultural pathway is expected in most works on the climate migration relationship (Mueller et al., 2014), it is non-frequently verified empirically.

Figure 13: The influences of climate change on migration via agriculture channel



Source: Author's field research

3.3.9.1 Agricultural pathway connecting climate and migration

In Africa, a large part of its population is still employed in the agricultural sector, in fact, mostly in subsistence agriculture (R. J. Nawrotzki & Bakhtsiyarava, 2016). Absence of wealth and financial properties stops rural households to be employing in technological means to mitigate the adverse effects of climate change (Gutmann & Field, 2010). For illustration, only 2% of the African agriculture was permanently under irrigation (e.g. under irrigated agriculture) in 2000 (FAO, 2015). Therefore, in case of the increase of

droughts, floods or heatwaves, climate change may threaten the livelihoods and also these extremes will lead to the decline in agricultural revenue, increase unemployment, reduce food production for sustenance (Mueller et al., 2014). Facing economic pressure, there are many strategies of adaptation households first use in place to overcome climate change extremes, for example change farming practices systems, sell assets, look for public assistance programs, borrow cash from other family or friends, (C. Gray & Mueller, 2012). In failure of these strategies of adaptation, households may change their way of migration to secure their livelihood (McLeman, 2011). Going from this thought, most of the studies on climate change and human migration undertake that the influence of climate on migration is refereed through the agricultural sector, in lack of empirically tests of this assumption (e.g. Mueller et al., 2014).

3.3.9.2 Migration and agricultural productivity

The interactions between migration and agricultural productivity are very complex. The authors variously appreciate the consequences of emigration. Some authors support that migrant who leave, deprive the community's labour and thus contribute to reduce the production. Therefore, these emigrants can create the dependence of community with the imported products. Also the family members preferring to use transfers to get food than practice agriculture (Lipton, 1980; Azam & Gubert, 2002). Others families, by the way, focus on the positive impact of investments carried out by the migrants on the agricultural productivity through the improvement of human capital, and the acquisition of the agricultural equipment (Konseiga, 2004).

McCarthy and al. (2006) evaluated the impact of massive emigration on agriculture in Albania. Following the theoretical model of the new economic of labour migration, the

authors used a model of utility by maximising the revenue of the household subject to certain constraints. They find a significant effect and negative of international migration on the production of staple crop (cereals) and also fruits. These results confirm the expected of the authors so that the cereals production requires a massive use of labour force. They were surprised that for fruits, so that as regards fruits culture requires rather important capital.

A contrarious, the authors obtain a positive impact and significant migration on the forestry and the pastures with a positive effect on breeding practice.

Beaudouin, (2005) studied the impacts of migration on Bangladeshi rural economy. The study used a three-stage Least Squares regression, it determines and measures the net effect of migration on household's income. This empirical study reveals that the out-migration of one member of the household has a negative effect on their revenue. However, this effect is compensated in party by the among send by the migrants. This conclusion confirmed the assumption of the new economic of labour migration which argues that transfer carried out by the migrants contribute to reduce the constraints of credits in his origin affecting the agricultural production. The results also show that the negative effect is especially observed on the agricultural revenue, but migration has no impact on the non-farm income.

Naiditch & Vranceanu, (2009) analysed the interaction between migrants' income and remittances and between remittances and the labour supply of residents. The model used in their study was cast as a two-period game with imperfect information about the residents' real economic situation. In order to receive or to perceive more transfers, the members remained at the origin place send signals of a difficult economic situation, even

if it is not it really. To reduce this kind of behaviour, the migrants in their turn reduce the among of theirs transfers. This asymmetric information results in a situation of balance, which does not support the residents.

Dana, (2007) studies the effects of the sendings of funds on the behaviour of the members of household of origin in Indonesia. By considering account, the endogenous character of the transfer and the number of migrants, the author ends and finds a negative influence of the sendings of funds on labours' effort in the non-farm informal sector. However, the study does not find any evidence of the reduction of the child labour.

As regards, Mali is a country where the migration touches a very important fringe of the population. From our best knowledge very little studies have been done or were interested to the link between migration phenomenon and agricultural production in Mali. Gubert (2000) within the framework of his thesis, analysed the impact of migration and the transfers on family behaviour and the production in the area of Kayes in Mali. The author used the method of fixed effects to build a relevant indicator of technical efficiency and the participation in migration. She explains by the fact that the existence of an implicit contract of insurance between the migrants and the families of origin might favourite an apparition of a collect of rent from the families behind in time of agricultural production stagnation.

This paper contributes to two streams of literature. Firstly, the literature on the impacts of climatic shocks on migration and secondly, the literature on environmental shocks and migration.

A well understanding of movement, whether it is migration, displacement or relocation necessitates research which is able to carry out the various issues that influence the movement (Knomad, 2012). An excellent framework provided by the foresight project for identifying the factors that help determine whether people move but also when and where they go is provided in Figure 1. The graph includes the macro level factors, showing the multiples features of movement such as economic, social, political and demographic as well as environmental. The graph also reveals the key drivers of movement; in fact, the actual and perceived differences between conditions in origin and destination communities are likely to drive people mobility.

From the current literature on migration drivers, researchers' still maintained poverty and the violent conflicts as key drivers of migration rather than those other factors such as social, demographic and environmental issues, this is so complex endeavour. However, the scholars recognised that these factors alone would not necessarily result in movement of people. The decision to migrate or to stay is therefore influenced by individual and household demographic socio-economic features.

3.3.10 **Empirical studies on climate change migration through agriculture**

From the literature on climate change and variability migration through agriculture or agricultural sector, the empirical test on this scenario is so limited. However, several researches have shown that climate variability and change will continuous to reduce crop production in Africa especially in Sahelian regions (AGRA, 2014). According to the 2014, report on SSA agriculture the temperature is already raised by 0.85°C and it is reflected through every regions of SSA. The future increase of temperature is about 1.5°C by 2030, which is practically sure. Indeed, climate change agriculture and food security (CCAFS)

has reported in its researches that climate change, essentially increase in temperatures will cause reduction in the yields of the major staples crops in SSA, in addition to, loss of land currently cultivated for these suitable crops.

Nawrotzki & al (2015) used methods of geostatistical interpolation to build two climate change variables, seizing the duration of wet and warm spell, centred on daily temperature and precipitation from 214 weather stations through Mexico. They combined these climate variables with comprehensive migration histories gained from the Mexican Migration Project and model the effect of climate change variables on household-scale migration from 49 urban cities and 68 rural villages. During the research period, their results report that there was a significantly increased in international migration by extreme precipitation and temperature warming using multi-scale event-history models. However, the observed of climate effects have been seen in rural areas. The interactions show that through employment in the agricultural sector only temperature affects migration flow. Nawrotzki & al (2015) make two important suggestions for policy implications, first, project international climate migration must focus more on urban-rural disparities in the impact of climate on migration. At the end, since rural population rely on rainfed agriculture the likely risk of climate change and variability will endure to intensify international migration from rural zones.

Nawrotzki & Bakhtsiyarava, (2016) used logistic regression models on sociodemographic data available and census new Terra Populus data from IPUMS-International to investigate international climate migration in two West African countries (Burkina Faso and Senegal). The case tried to improve a prior study by using a set of climate events that measures the variations of precipitation and the temperature in the month at the

department/province scale gathered with a representative of the national census data from Burkina Faso and Senegal. This research report an analysis of the climate driver mechanism as opposed to the climate inhibitor mechanisms and enhances our knowledge about the agricultural pathway. As a result of this non-direct nature of climate influences on livelihoods principally linked to rained agriculture, the few significant observed of climate impacts on international migration is not surprise. Although extreme precipitation is positively correlated with international migration going from Senegal, otherwise the heatwaves reduce the chance of international migration from Burkina Faso. The empirical support for the adverse climatic conditions decrease migration is provided by the directionality of the climate influences: between disregarded populations in rural areas in Africa, adverse climate conditions inhibit international migration although favourable climate conditions facilitate international moves. Adverse climate conditions probably challenge the resource base required for funding an international move (Henry et al., 2004). Moreover, their results distribute the agricultural pathway. Outcomes from interaction models reveal that the consequence of droughts on international migration from Senegal is robust for areas deeply implicated in the production of groundnut crop.

To deal with the relationship between climate change and migration as agriculture the key channel, Falco, Galeotti, & Olper., (2018) employ a panel dataset on 150 countries, indeed all of the available countries in the world spanning the period 1960 and 2010, to investigate the connection between weather changes, disparity in agricultural productivity and international out-migration. The migration dataset used is a global matrix of bilateral migrant stocks from 115 countries to 115 countries covering the period from 1960 to 2000 with 10 years gap extended until to 2010 based on the estimation of the same World Bank references, to add one more decade of observations. About the climate dataset is the

outcome of aggregate at the country level of international monthly mean temperature and precipitation data at 0.5 x 0.5 °C. They used OLS and 2SLS approaches, in fact, the stage findings point that, on average, a decrease in agricultural productivity. Saying that 1%, decrease in agricultural output implicates an increase in the out-migration rate of about 2% in the sample of less developed (poor and middle-income) countries; however, for developed nations the effect is never statistically significant. Therefore, the key finding from their study display that, along the lines of theoretical predictions, adverse shocks to agricultural output affected by weather variabilities significantly intensify migration in less developed countries but the poorest and the rich countries are not included.

Falco, Donzelli, & Olper., 2018) offers a fine review of the classical economics-based literature on climate change and migration, concentrating on the scope to which agriculture might be taken as a key facilitating channel connecting climate change to migration. Overall, the international economy is expected to get large and negative impacts from climate change. However, agricultural sector particularly in developing countries are experienced these effects of climate change. Where, individuals and households, enabling them to cope, among other things, with weather-induced risk, can see migration as an explicit method of coping implemented. From there, agricultural importance appears from both sufficiently of micro-level country researches and compare to few macro-level studies based on cross-sectional data during longer time periods. Consequently, policy programs directed to maintainable agriculture and rural improvement can together help solve the challenges made by climate change and provide opportunities in the aspect of growing migration matters. However, they also care about the current evidence, which is built on statistical relationship that have not something to do with causal inferences. This demands for the practice of a more structural approach and

more sophisticated study designs, enabling the scholars to better differentiate among diverse instruments concurrently at work. Additionally, further investigation should be addressed to the role played by food security, a complex dimension largely missing in the current debates on climate change and migration.

Still moving on the relationship between migration, climate change through agricultural sector, Eni & Mattei, (2015) investigate in two West African countries, Ghana and Nigeria, whether relocation is an alteration that households use to adapt to climate. They employed two households' surveys to conduct this study, the general household survey of Nigeria and the living standard surveys of Ghana to explore these predictions. Their study report a peak- shaped connexion between temperature in the dry season and the tendency to emigrate in households employed in farms production. They also get a significant peak-shaped linkage between precipitations in the wet seasons and the probability to migrate in households employed in farms production. Beside, non-farm households were not affected by climate. Generated by General Circulation model climate scenarios expose that, ceteris paribus, migration may degenerate in Ghana and in Nigeria.

Hermans-neumann & al (2017) in considering out-migration as a potential reply to environmental impacts, they study whether these regions the highlands and the Great Rift Valley are more likely involved in out-migration compared to other regions in Ethiopia in terms of land degradation, climate variability and socio-ecological pressure in Ethiopia. They used a high-resolution remote sensing data on the subject of rainfall variability, population census data of the district level plus land cover and land degradation. In addition, their results show that districts with a high density of population is experienced a steep decline in net primary production (NPP) with large precipitation variability. The

impacted areas are principally regions with big activities based on agriculture. They recognised that these regions are particularly disposed to lack of local natural resources, high population density; moreover, environmental changes. The findings next confirmed that at the regional scale, degradations of environmental conditions could be at the time the cause and the effect of migration.

Cai & al (2016) investigated the importance of agricultural linkage in climate variability induced international migration. They employed a unique dataset during the period of 1980–2010 of stocks of foreigners in 42 destination countries and of bilateral international migration flows from hundred sixty three-origin countries, mostly from OECD countries. Relying on the country-pair fixed-effects regression model, they find as results saying that in the agriculture-dependent countries, there is a strong relationship between increase in temperature and the international out-migration, which confirms the adverse effect of temperature on agriculture production. Additional, the temperature migration connexion is non-linear and look like the nonlinear temperature–agricultural productivity connection. Moreover, recent migration movements going to major destinations are particularly temperature-sensitive. Programmes to bring down these issues associated to climate-induced international out-migration would be effective if concentrated on people relied on agriculture especially those with subsistence agriculture where likelihoods mostly depend on agriculture.

Thiede, Gray, & Mueller, (2016) studies the variability of climate on the inter-departmental in South America during the period 1970-2011. The essential objective of this investigation was to examine the impact of the variability of climate on human migration shapes through a huge multi-national region, and then offer a result, which can

be generalised compare to several present studies. They underline three specifics objectives to solve the main objective. First, how climate changeability distresses the probability of intra-department of South America's migration, second, assess the impact of uncovered to repetitive or persistent climatic extravagances, third try to see whether climate disturbs intra-department relocation to urban areas instead of rural end point. Using the data of 25 censuses covering 21 million respondents of persons with aged from 14 to 40 in 8 South America countries. Trying to solve the gap regarding the existing methodologies disparities among previous investigations, they used a usual analytic approach and identical explanations of migration and climate through the countries. In several time, assess the impacts of the variability of climate on migration and also estimate the heterogeneity through the individual characteristics (sex, age) and socioeconomic groups, through countries, and crosswise memorable climate situations. By disaggregating migration issue by the rural/urban status of last stop. The result shown that the uncovered areas to monthly temperature percussion has the most stable special impacts on migration compare to those uncovered to monthly rainfall percussion and ongoing climate changes in excess of multi-year periods. Result also find confirmation of heterogeneity through demographic clusters and countries.

Viswanathan & Kavikumar, (2015) sought to discover the three-way linkage concerning weather, the performance of agricultural and India internal migration at the national and region level. Employing the national-level data during the period of 1981–2001 and regional-level data over the period of 1991–2000. In investigating these issues, they tried to understand whether there is evidence of intra-state migration provoked by weather through crop yield variability and the adverse effect on migration of agricultural yield fluctuations at the inter-state level. They used 2SLS/LIML estimation for panel data and

results come out from these regressions show that climate-induced agricultural by reducing it outcome could provoke migration from rural areas to urban areas. The scale of the reply is relatively small regarding the reported in the literature for developed countries. For example, the Mexican migration to USA and the inter-migration of USA (Feng et al., 2010, 2012). However, the results from this study are comparable to the results reported in other developing countries such as sub-Saharan Africa (Marchiori et al., 2012)

Summary

The empirical review on climate change induced migration through agricultural sector is a growing recent study on these aspects. Looking well at these empirical tests, most of the cases the climate variables especially the increasing in temperature reflects in decreasing in crop yields, which possibly push population from middle and low-income countries to migrate. So that these population are relied on subsistence agriculture. Data used to deal with the issue climate induced migration the importance of agricultural sector are various such going from cross sectional data, time series and panel data. Moreover, scholars are also employed different kind of estimations.

CHAPTER FOUR

EFFECTS OF CLIMATE CHANGE ON MIGRATION IN MALI

4.1 Introduction:

In 1990, the Intergovernmental Panel on climate change carried out that the impact, the most marked in the variation of climate can be fingered on human migration, with the displacement of millions of people due to the erosion of coastal zones, flood of the coastal areas and the disturbance of the agriculture. Therefore, those countries like Mali where the population rely on subsistence agriculture will be simply affected by this situation. Although, in searching to cover the primary needs, people will be looking for other opportunities rather than agriculture. Climate change induce some movements of the population by doing certain regions of the planet, places impossible to live in. However, climate change and climate variability is not new thing for Malian people. They have many coping approaches to help themselves to reduce their vulnerability to the stress of climate change and climate variability, particularly drought and flood. This objective comes to assess the effects of climate change on migration especially on emigration flow in Mali, which is something getting the attention of the decision makers since long time ago.

4.2 Data analysis

4.2.1 Exogenous variables of migration

In this study, three dependent variables were used as the magration rates, and each covers the 1960-2015 time period. These are the out-migration rate, the in-migration rate and the net migration rate.These are defined as follows:

$$\text{Out - migration rate}\,1960\text{ - }2015\,\text{OUT - MIG} = \left(\frac{\text{Out - migrants}\,1960\text{ - }2015}{\text{Total population}\,1960\text{ - }2015} \right) * 1000$$

4.2.2 **Vector auto-regression**

General representation of the vector autoregressive model:

One of the most useful, flexible model for the analysis of multivariate time series is the vector auto-regression model. It is the extension of the univariate autoregressive model to dynamic multivariate model. VAR has been especially proven useful in describing the dynamic of behaviour of financial and economic time series over the time and for forecasting. It provides a larger forecast to those from univariate time series models and elaborate theory-based simultaneous equations models. In fact, VAR models forecasts are merely flexible since they can be made conditional on the potential future paths of specified variables in the model. There are other many uses of VAR model such as for the structural inference and policy analysis. This section describes the analysis of nonstationary multivariate time series using VAR models that can cointegration relationship.

According to Bourbonnais 10th edition, the generalised representation of Vector Autoregressive model with *p* lags "noted VAR (*p*)" can be written under this matrix form.

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots\ldots\ldots\ldots A_p Y_{t-p} + v_t \,.$$

(1)

With $$Y_t = \begin{bmatrix} y_{1,t} \\ y_{2,t} \\ . \\ . \\ y_{k,t} \end{bmatrix}; A_{i\neq 0} = \begin{bmatrix} a_{1i}^1 \; a_{1i}^2 \; ....a_{1i}^k \\ a_{2i}^1 \; a_{2i}^2 \quad a_{2i}^k \\ . \\ . \\ a_{ki}^1 \; a_{ki}^2 \quad a_{ki}^k \end{bmatrix}; A_0 = \begin{bmatrix} a_1^0 \\ a_2^0 \\ . \\ . \\ a_k^0 \end{bmatrix}; v_t = \begin{bmatrix} v_{1t} \\ v_{2t} \\ . \\ . \\ v_{kt} \end{bmatrix}$$

(2)

We note that: $\sum_v = E(v_t v_t^{'})$, the matrix with dimension (k,k) of variances covariance's of errors. This matrix is unknown.

This representation can be written using the operator lag:

$$(I - A_1 D - A_2 D - ..... - A_p D^p) Y_t = A_0 + v_t \;\; more \;\; A(D) Y_t = A_0 + v_t$$

(3)

Condition of stationarity:

A VAR model is stationary, if it satisfies these three classics conditions:

$$\_ E(Y_t) = \mu \forall_t ;$$

(4)

$$\_ Var(Y_t) < \infty ;$$

(5)

$$\_ Cov(Y_t, Y_{t+k}) = E\left[(Y_t - \mu)(Y_{t+k} - \mu)\right] = \Gamma \forall_t$$

(6)

We demonstrate that a process VAR *(p)* is stationary if the polynomial defined from the determinant: $\det(I - A_1 z - A_2 z^2 - ... - A_p z^p) = 0$ to its external roots of unit circle of the plan complex.

In VAR model, each variable is at the same dependent and independent variable because each of depends on itself lagged, on the current and lagged values of the other variable and on an independent and identical distributed (iid) error term.

The VAR model denote the correlations between a set of variables, these variables are often employed to analyse certain aspects of the relationships among the variables concerned. There are three major ways to interpret a VAR model. These interpretations are all closely related.

The Granger-Causality or Instantaneous Causality, and Multi-Step Causality. Introduced by Granger (1969), the idea behind this concept is that the cause always comes before the effect and not the contrary. (e.g if a variable x impacts or affects a variable z, x called the former variable should help improving the predictions of z called latter variable).

The Impulse Response Analysis: In fact, the Granger may not show us the complete story on the relationship among the variables used in the regression. It is important to know the response of one variable to an impulse in another variable in the system, which involves a number of further variables as well. To investigate the impulse response among two variables in a greater dimensional system, there is an effect of one variable to an impulse in other variable usually call the latter causal for the former variable. This kind of causality by tracking the effects of exogenous shock or innovation in response analysis is

often called *multiplier analysis*. For example, an increase in the interest rate might be ordered by the central bank for reasons outside.

The forecast error variance decomposition one-way to determine how important the different exogenous shocks are in explaining the dependent variables is to calculate the fractions of the forecast error variance of these variables attributable to the respective orthogonal shocks. The variance of any given dependent variable in response to the orthogonal shocks to it can be thought of as the variance of the errors in forecasting it using (17) because without the shocks we would forecast the variable to remain unchanged. The central question is what fractions of these forecast errors are due to the individual shocks.

- ✓ *The empirical VAR model*

Here the VAR model of the variable outmigration in their log form. In the situation we have to note that the u is the stochastic err terms often called impulses, innovation or shock. The dependent variable outmigration is a function of it lagged value and the lagged values of the other variables in the model. VAR must be specified in levels. Hence, VAR in differences would be mis-specified (Cuthberson, K. (2002, p.436). In this study interest is focused only on out-migration.

However, here are the different equations of the vector autoregressive model

Out-migration

$$\ln out-migratei_t = \sigma + \sum_i^k = 1\beta_i \ln out\_migratei_{t-i} + \sum_j^k = 1\phi j \ln gdpcap_{t-j}$$
$$+ \sum_m^k = 1\varphi m \ln agri\_gdp_{t-m} + \sum_n^k = 1\gamma n \ln rain_{t-n} + \sum_p^k = 1\eta p \ln unemplrate_{t-p} \quad (7$$
$$+ \sum_r^k = 1\lambda r \ln antem_{t-r} + u_{it}$$

)

GDP per capita

$$\ln gdpcapi_t = \sigma + \sum_i^k = 1\beta_i \ln gdpcapi_{t-i} + \sum_j^k = 1\phi j \ln out-migrate_{t-j}$$
$$+ \sum_m^k = 1\varphi m \ln agri\_gdp_{t-m} + \sum_n^k = 1\gamma n \ln rain_{t-n} + \sum_p^k = 1\eta p \ln unemplrate_{t-p} \quad (8)$$
$$+ \sum_r^k = 1\lambda r \ln antem_{t-r} + u_{it}$$

Agricultral value added share in

$$\ln agri\_gdpi_t = \sigma + \sum_i^k = 1\beta_i \ln agri\_gdpi_{t-i} + \sum_j^k = 1\phi j \ln gdpcap_{t-j}$$
$$\text{GDP} + \sum_m^k = 1\varphi m \ln out-migrate_{t-m} + \sum_n^k = 1\gamma n \ln rain_{t-n} + \sum_p^k = 1\eta p \ln unemplrate_{t-p}$$
$$+ \sum_r^k = 1\lambda r \ln antem_{t-r} + u_{it}$$

(9)

Rainfall as proxy of climate change

$$\ln raini_t = \sigma + \sum_i^k = 1\beta_i \ln raini_{t-i} + \sum_j^k = 1\phi j \ln gdpcap_{t-j}$$
$$+ \sum_m^k = 1\varphi m \ln agri\_gdp_{t-m} + \sum_n^k = 1\gamma n \ln out-migrate_{t-n} + \sum_p^k = 1\eta p \ln unemplrate_{t-p} \quad (10$$
$$+ \sum_r^k = 1\lambda r \ln antem_{t-r} + u_{it}$$

)

Unemployment rate in

$$\ln unemplratei_t = \sigma + \sum_i^k = 1\beta_i \ln unemplratei_{t-i} + \sum_j^k = 1\phi j \ln gdpcap_{t-j}$$
$$\text{Mali} + \sum_m^k = 1\varphi m \ln agri\_gdp_{t-m} + \sum_n^k = 1\gamma n \ln rain_{t-n} + \sum_p^k = 1\eta p \ln out - migrate_{t-p}$$
$$+ \sum_r^k = 1\lambda r \ln antem_{t-r} + u_{it}$$

(11)

Annual average temperature as proxy of climate change

$$\ln antemi_t = \sigma + \sum_i^k = 1\beta_i \ln antemi_{t-i} + \sum_j^k = 1\phi j \ln gdpcap_{t-j}$$
$$+ \sum_m^k = 1\varphi m \ln agri\_gdp_{t-m} + \sum_n^k = 1\gamma n \ln out - migrate_{t-n} + \sum_p^k = 1\eta p \ln unemplrate_{t-p} \quad (12$$
$$+ \sum_r^k = 1\lambda r \ln rain_{t-r} + u_{it}$$

)

For VAR interpretation, individual coefficients in the estimated VAR model are sometime difficult to interpret, there the practitioners often estimate the impulse response function (**IRF**). In fact, the IRF traces out the response of the dependent variable in the VAR system to shocks in the error terms. It is the centrepiece of VAR analysis.

The impulse response function explains the reaction of an endogenous variable to one of the innovations. Describes the evolution of a variable interest along a specified time perspective after in a given period. An essential tool in empirical causal analysis and policy effectiveness analysis. It also traces the impact of a variable on other variables in the system. It traces the effects on present and future values of the endogenous variable of one standard deviation shock to one of the innovations. In signal processing, the impulse response of a dynamic system is its output when presented with a brief input signal, called an impulse. The impulse response function is also used in explaining the concepts of *"pass through"*. The degree at which the changes in a variable are passed to other

variables at different stages either directly or indirectly. Lastly, it can be used to further assess the tendencies of significant Granger causality results.

- ✓ *Exogenous variables descriptions*

Poston et al. (2009) have noted that the so-called ‘‘attractive” forces, or ‘‘pull” factors, that attract migrants to a community are ‘‘reflected by the rate of migration into the community” (1993: 160), that is, the in-migration rate. Conversely, the ‘‘strength of the ‘unattractive’ factors in the community which ‘push’ persons out of the community is reflected in the rate of out-migration” (Galle, Burr, & Potter, 1993). The net migration rate thus represents the ‘‘differences between these two sets of attractive and repelling forces” (1993: 160).

The set of variables that were expected to be associated with migration are defined and the source of the data are provided in Table

Table 7 : Data sources and description of variables

Measures and variable name	Description	Sources of variables
Migration *out – migrate*	An annual average over the year periods 1960-2015	UN Population Division https://esa.un.org/unpd/wpp/DataQuery/ National Institute of Statistics of Mali.
GDP per capita *gdpcap*	Gross Domestic Product per capita for Mali, current dollars, 1960-2015	https://fred.stlouisfed.org Federal reserve economic Data and World Bank development indicators online

Temperature *antem*	Annual average of temperature 1960-2015	National institute of meteorology http://malimeteo.ml/
Rainfall *rain*	Total annual of rainfall 1960-2015	National institute of meteorology http://malimeteo.ml/
Unemployment rate *unemplrate*	The % of the total labour force	International Labour Organization, ILOSTAT database
Agriculture as % of GDP *agri _ gdp*	Agriculture value added as a percentage of GDP is the net output of agriculture (forestry, hunting, and fishing, as well as cultivation of crops and livestock production) adding up all outputs and subtracting intermediate inputs.	World Bank national accounts data, and OECD National Accounts data files.

Source: Author's field research

Descriptive statistics

Following (Naudé, (2010); Chort and De La Rupelle (2016) Chort, (2017) the migration flow data employed in this research are constructed from the UN development population, the national institute of statistics of Mali and World development indicator, surveyed annually from 1960 to 2015 at the country level. The GDP per capita was obtained from the world development indicator and Federal Reserve economic Data with 286.490 US dollars current. As a low income country, a minimum of $7.83 GDP per capita and a maximum of $835.09 was obtained for the country.As a Sahelian country, Mali has a rainfall which varies between 226.653 mm as and 398.103 mm, with an average rainfall of 312.054 mm. There is no much variation in Mali's temperature, it varies between 27.42 °c and 29.75 °c, however the average of the temperature is 28.55 °c. The unemployment rate goes from 1.35% to 15.51% during the period, the less rate is the one in 1960 and the

high rate of unemployment in Mali happenned in 1993 the earlier of the democratic system. The agriculture valued added share in GDP is a key issue to look at the economy of Mali, so that the major active population is employed in this sector. Therefore, once this sector has a shock that will quickly affect all the inhabitants of the whole country.

Table 8: Summarize of the variables used in the regression

Variables	Observations	Mean	Std. Dev.	Min	Max
Outmigration	56	22.72	4.27	17.15	31.83
Gdpcap	56	286.49	234.14	7.83	835.09
Agri_GDP	56	47.91	13.63	33.02	72.95
Unemployment rate	56	6.95	4.04	1.35	15.51
Annual temperature	56	28.56	0.49	27.42	29.75
Rainfall	56	312.05	39.95	226.65	398.10

Out_migrate = out-migration rate; GDP per cap= Gross Domestic Product per capita, Agri_gdp= Agriculture valued added share in GDP.
Source: Author's field research

Stationarity test

There are many tests to carry out the unit root, to test the mechanism of the non-stationary of the series. Some of these tests are Dickey-Fuller, Phillips-Perron and Kwiatkowski-Phillips-Schmidt-Shin, were used in this research. Estimating a vector auto-regression means to assume that the relationship between the lagged of a variable and the explanatory is linear. This is the hypothesis of linearity. If this hypothesis is violated, the linear regression will attempt to fit a straight line to a data that does not follow a straight line. A scatter plot between the response variable and the explanatories variables was also plotted to see if nonlinearity is present. Under these tests, the hypothesis is that:

H_0 = the series has a unit root

Ha = The series has no unit root

Time series has stationarity when a shift in the time does not make change in the shape of the distribution over the time. The steady of the mean, the variance and the covariance over the time is the basics proprieties of the distribution.

Table 9: First-differencing of these variables

Item	ADF	PP	KPSS
Outmigration	-0.168**	-2.537**	0.17***
GDP per cap	-0.594**	0.454	0.069***
Agri_gdp	-1.262***	-3.145	0.047***
Unemployment rate	-2.088***	-6.232	0.027***
Annual temperature	-1.854***	-18.052**	0.022***
Rainfall	-3.034***	-31.333***	0.018***

ADF: Dickey-Fuller Augmented. PP: Phillips-Perron. KPSS: Kwiatkowski-Phillips-Schmidt-Shin (significance level * =10%; ** =5%; ***= 1%) GDP per cap= Gross Domestic Product per capita, Agri_gdp= Agriculture valued added share in GDP. *Source: Author's field research*

Test for cointegration

Two or more-time series are cointegrated if they tend to move together through time. In order to test cointegration, Engle and Granger in 1987 proposed a two-step. The first step is to run an OLS regression and the second is to do a unit root test. Engle and Granger's test has the advantage that it is easy to perform, and it is also intuitive. But there some limitation, hence, other tests such as the Johansen test.

After running the Regression one I(1) variables on another using least squares and tested the residual e, using Dickey-Fuller augmented test. In conclusion, the residuals are stationary, and the series are cointegrated.

Table 10: Test for cointegration using Dickey-Fuller test on regression's residues

Augmented Dickey-Fuller test for unit root		Number of obs =54		
		Interpolated Dickey-Fuller		
	Test Statistic	1%Critical value	5%Critical value	10%Critical value
z(t)	-3.407	-3.574	-2.927	-2.598
MacKinnon approximate p-value for Z(t) = 0.0107				

Source: Author's field research

Testing for cointegration Johansen's method

There are weaknesses when the Engle and Granger test is performed. Firstly, since the test includes and Augmented Dickey Fuller's test in the second step, all the problems of Augmented Dickey Fuller test are valid here as well. Especially taking the number of lags in the augmentation is a critical factor. Secondly, the test is built on the assumptions of one cointegration vector, apprehended by the cointegration regression.

Johansen's method test for cointegration is implemented in vecrank. The superior test for cointegration after Engle and Granger's test is Johansen's test (1995). The weakness of Johansen's test is that it depends on the asymptotic properties and sensitive to specification errors in limited samples.

Table 11: Johansen tests for cointegration

Johansen tests for cointegration				Number of obs = 54		
Maximum rank	parms	LL	eigenvalue	Trace statistic	5% critical value	1% critical value
0	80	-1363.9		200.585	170.80	182.51
1	95	-1334.93	0.658	142.544	136.61	146.99

2	108	-1314.3	0.533	101.319*	104.94	114.36
3	119	-1297.1	0.472	66.809	77.74	85.78

The λ trace show that at r =1, the trace statistic of 142.5444 exceeds its critical value of 136.61 at 5% level, and we can reject the null hypothesis of no cointegration equations. But at r =2, the λ trace value of 101.3192 is less than its critical value of 104.94 at 5% level, which means we fail to reject the null hypothesis that there is only one cointegration equations exist. *Source: Author's field research*

4.2.3 **Vector autoregressive residual tests**

Table 12 : Jaque-Bera test (Skewness/Kurtoris tests for normality)

Variable	observ	Pr(skewness)	Pr(kurtoris)	---Joint---	
				Adj Chi^2	Prob>chi^2
Residual	54	0.7440	0.5154	0.54	0.7624

Source: Author's field research

Table 13 : Correlation LM tests

Null hypothesis: No serial correlation at lag h

Included observations: 54

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	43.22686	36	0.1900	1.233647	(36, 134.5)	0.1962
2	37.60248	36	0.3957	1.052529	(36, 134.5)	0.4035

Source: Author's field research

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	43.22686	36	0.1900	1.233647	(36, 134.5)	0.1962
2	71.30531	72	0.5010	0.977362	(72, 136.4)	0.5357

Source: Author's field research

Table 14 : Heteroscedasticity tests (Levels and Squares)

Joint test:		Included observations: 54
Chi-sq	df	Prob.
525.9633	504	0.2411

Source: Author's field research

4.3 Results: Interpretation of a one standard deviation to the endogenous variables in VAR model

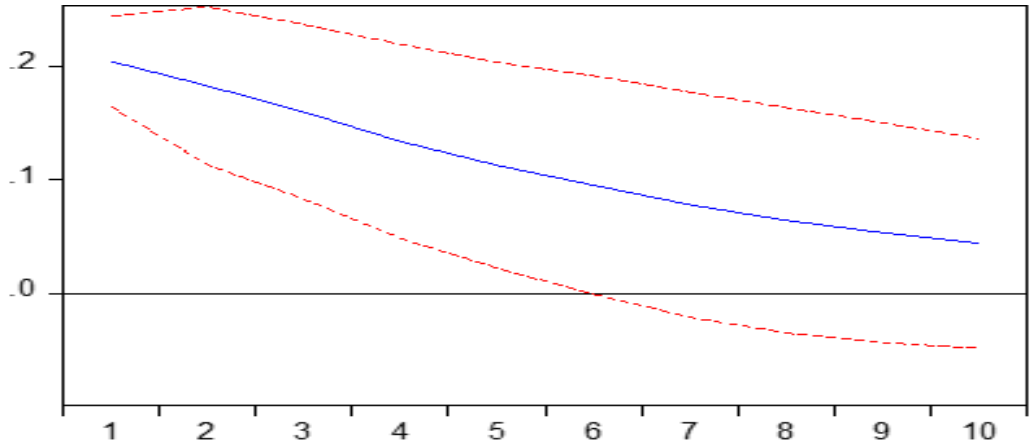
Response on emigration flow of a one standard deviation of past of out-migration

Regarding to graph 14, the blue line is the impulse response function while the red lines are the ninety-five percent confidence interval. This blue line (impulse response) must lies within the ninety-five percent confidence interval. To interpret this graph: A one Standard Deviation shock to the past of out-migration flow gradually decreases migration (out-migration). This negative response to gradually declines until to be under 1 period when it hits its steady state value. From the period one to three there is a slow gradually decrease of the flow of out-migration. After this period, we can see constant response decrease of out-migration up to period ten but remains in the positive region.

Meaning: shocks to the past of out-migration will have a negative impact on **out-migration** both in the short run and in long run. So that the dependent variable is a function of its lagged values and the lagged values of other variables in the model.

Response to Cholesky one S.D. (d.f. adjusted) Innvations ± 2 S.E

Figure 14: Response of out_migration to one SD shock out_migration



Source: Author's field research

Response on emigration flow of a one standard deviation shok of GDP per Capita

Based on the graph 15 impulse response of out-migration to a one standard deviation of GDP per capita is not showing much change in the behaviour of the population emigration. This situation can be explained by the fact that the Gross Domestic Product per capita in Mali is one of the lowest GDP per capita in the world (GDP per Capita in Mali is equivalent to 6 percent of the world's average). One of the key drivers of migration is wage differential, once the GDP per capita is low, the population search to move out of the country.

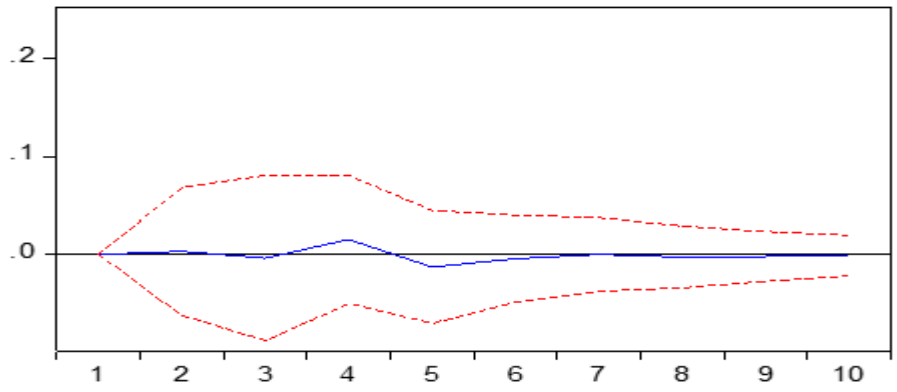
A one Standard deviation shock (innovation) to the gross domestic product per capita in Mali, the out-migration does not react from period one to three. But after that point three, there is a fair increase from period three goes to period five, after period five out-migration decreases up to period six and goes to zero line and continuous without change.

Meaning: shocks to the gross domestic product per capita in Mali will have a little bit impact on the out-migration in the short run and no impact in the long run. In fact, the impact is almost inconsiderable. The gross domestic product per capita in Mali is too

small to reduce the intensity of out-migration, in fact, emigration will normally continuous it process.

Response to Cholesky one S.D. (d.f. adjusted) Innvations ± 2 S.E

Figure 15: Response of Lout_migration to GDP per capita



Source: Author's field research

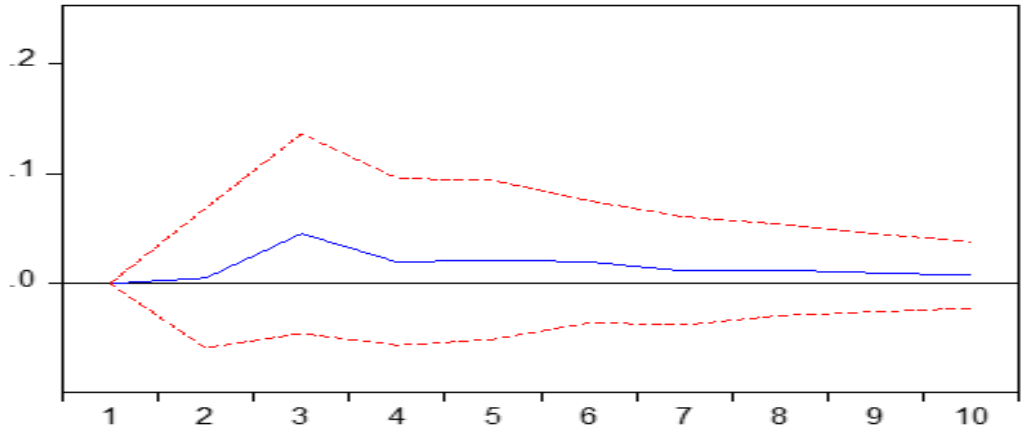
Response on emigration flow of a one standard deviation of Agricultural value added (percentage of GDP)

The value added in the agricultural sector as percentage of GDP is a key determinant of economy in a country like Mali so that most of the population is involved in this sector around 80%. In fact, the agriculture itself includes hunting, forestry, as well as the production of crops and livestock production.

A one Standard deviation shock (innovation) to this sector keeps out-migration at the initial movement up to period two, and rises it from period two to period three. From period three to period four a fine decreasing. Remains at the same position from period four to period six, and, gets slight decreases up to seven. This positive response remains linear from period seven to nine and gradually declines from nine to ten.

Meaning that shock to the value added in the agricultural sector, as percentage of GDP will have impact on the out-migration in the short run and in the long run. But in the long run as economies continue to grow, the percentage of the people involved in the agriculture sector declines. According to McCatty (2004) a 1% increase in GDP leads to decrease of a .052 in the percentage of people engaged in agriculture (McCatty 2004).

Figure 16: Response of out_migration to Agriculture share in GDP



Source: Author's field research

Response on emigration flow of a one standard deviation of unemployment

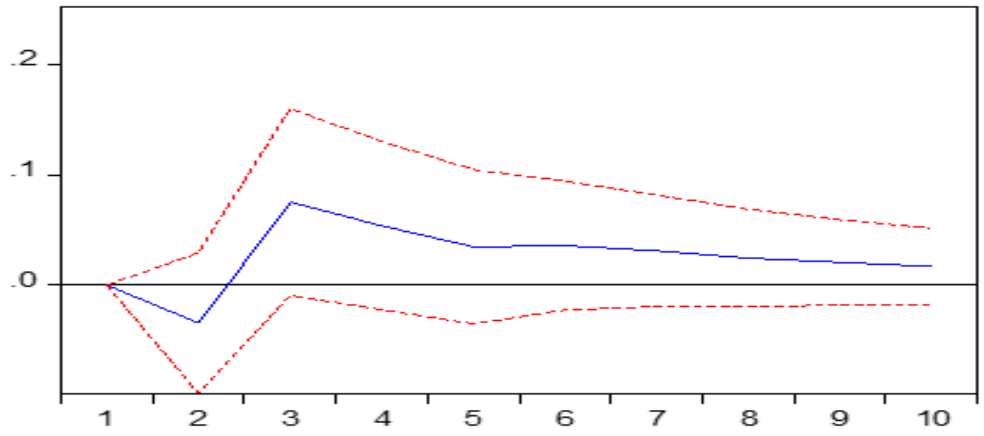
Mali with a very young population, unemployment rate is extremely high in the rural areas, which represents a clear threat to social cohesion within the communities. The unemployment whether it is structural, frictional and cyclical refers to the share of the labour force that is without work but available for and seeking employment.

A one SD shock (innovation) to unemployment rate temporarily decreases the out-migration from period one to period two in the negative region. Follow by a quick increase up to period three in the positive region. Still in the positive region, the out-migration decreases up to period five and follow by a linear movement. However, from period seven to ten we can remark a decreasing in saw tooth in the positive region.

Meaning that shock to unemployment will have negative impact follow by a positive impact from period three to ten.

Response to Cholesky one S.D. (d.f. adjusted) Innvations ± 2 S.E

Figure 17: Response of out_migration to unemployment_rate



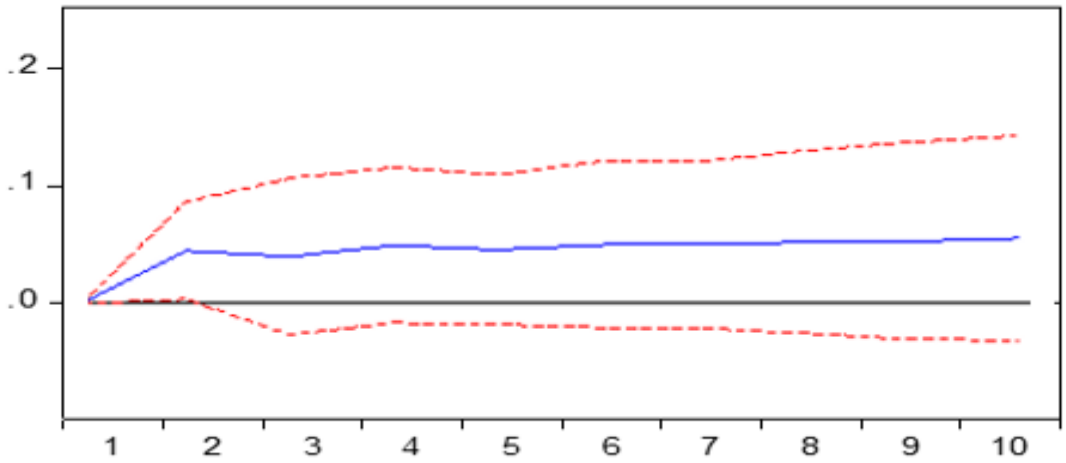
Source: Author's field research

Response on emigration flow of a one standard deviation of rainfall

Malian's rainfall remains characterised by high variability like any other rainfall in the Sahel. It ranks from 100 mm to 1700 mm. The southern party specifically the region of Sikasso is the moisten area. Regarding to all these situations change in precipitation will not probability make much change in emigration flow. In fact, looking at the result (the graph), there is a fair change in emigration.

A one SD shock (innovation) to the precipitation will increase the emigration up to close to two, follow by a fair decrease up to four and remains particularly linear until to period ten. Meaning that any shock in the precipitation will increase emigration due the fact that most of the major population get their subsistence in rain fed agriculture. Response to Cholesky one S.D. (d.f. adjusted) Innvations ± 2 S.E

Figure 18: Response of out_migration to one SD of rainfall



Source: Author's field research

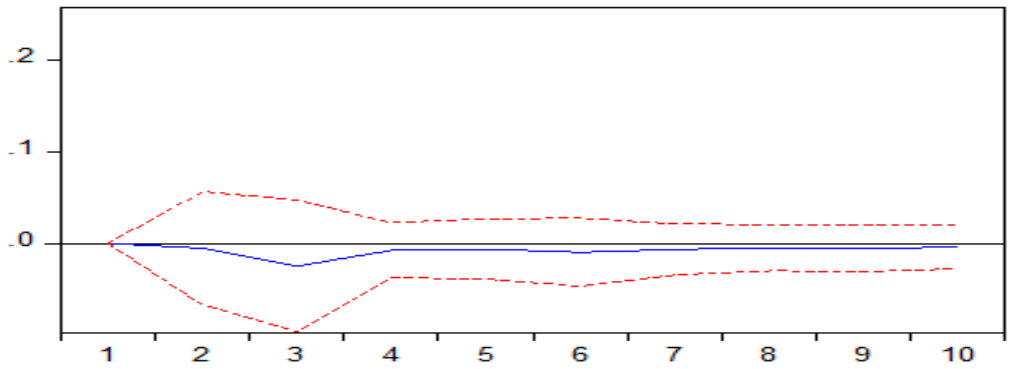
Response on emigration flow of a one standard deviation of temperature

Mean or change in monthly temperature compared to the reference period (1986-2005). In general, value of monthly temperature change varies between 0 and 4 degrees. Zero values indicates there is no change in projected monthly temperature compared to historical mean. Through the two climatic regions (Sudanese and Sahelian), temperature within these two regions is variable. Especially, in the Sahelian area there are considerable variations of temperature. From April to June the average temperature is about 30 degrees Celsius.

A one SD shock (innovation) to the temperature, the emigration will remain unchangeable up to around period two, start decrease below zero from period two to three. Still in negative area migration will increase up to period four and becomes linear up to period six, follow a little bit change, and linear through to the period ten.

Meaning the increasing of temperature will be a fact to increase human emigration from Mali.

Figure 19: Response of out-migration to temperature



Source: Author's field research

Variance decomposition of out-migration:

The main objective of the variance decomposion is to estimate for each innovation, its contribution in percentage to error variantion. It is therefore, the share of variation of the system, explained by an exogenous variable in the system. The Cholesky decomposition is a model used to determine the contributive sharing. When an innovation explains an importante contribution in error variation, then we deduce that out-migration is sensitive to a shock affecting this innovation. The table 30A (appendix) represents the variance decomposition of the system. Trying to interpret the table 30A, it explained how many percentage each innovation contributes to the variation of out-migration. Looking well on the table, lagged out-migration itself contributes to 69.51% of the variation of out-migration, followed rainfall 11.60%, unemployment rate 10.65%, temperature 6.73%, GDP per capita 0.77% and agricultural added value share in DGP 0.71% over ten years.

4.4 Conclusion:

In concluding this chapter, regardeless to these explanatory variables influencing out-migration from Mali, the situation of this country is very vulnerable to climate change and climate variability mostly due the fact that the majority of its population is based on

subsistence agriculture. However, it is recognised that agriculture is the most vulnerable sector to climate change and climate variability. Climatic conditions in the Sahel specifically in Mali, for instance the long dry season (6 to 9 months) and the high variability of rainfalls, inter- and intra-annual, leads to temporary migration from the rural zones. For the majority of the population in Mali, cyclic or impermanent labour movement from rural areas is a common activity and well-established approach to expand income. Particularly migration during the dry season is often an economic activity complemental to agriculture and crucial to reinforce households' food security and economic purpose such as social ceremony. Mali, one of the poorest country in the world, all the situations in this country favour people to move for better life. Migration in Mali is an integral part of people's way of life.

CHAPTER FIVE

PERCEPTIONS LEVELS AND THE CAUSES OF MIGRATION IN SIKASSO'S REGION

5.1 Introduction

Even if movement is a fundamental part of human being, in fact Mali has a long history of migration particularly emigration. Recently it has become an important transit place for migratory flows within the Sahelian region and beyond. The country is specific by its population involved in migration issue that linked to cultural practices in using migration as rite of road for young men. Mali has been experiencing seasonal and circular migration as well as nomadic and pastoral movements. A vast country is Mali with an estimated population of 18 million (2016) using the 2009 general population household survey. Mali is a vulnerable country to international commodity price fluctuations as well as to the effects of current global issue climate change mostly because of undiversified economy. With a high population growth rate among the poor countries in the world, plus droughts have severely induced more poverty, impacted food insecurity and instability. In addition, since the early of 2012, the political and the security situation in this country has been especially unstable. These conditions have imposed to the population to high displacement in this country.

Beside all those things, migration in Mali is not a new issue, it becomes a way of life. Historically, Malian are noted for frequent migration, especially the Soninké, for the purpose of searching opportunities abroad, such as leave their origin place for working elsewhere during the dry season. However, migration occurs in all regions of Mali. Referring to the two last general population and household survey the third region of Mali (Sikasso) represents a garret of emigrants. Nevertheless, this region by nature remains the finest region, in terms of receives the highest rainfall in the whole country, where

agriculture is mostly promoter. Irregularity in the rainfall and the fall of the price of cotton destabilize the stay of the population. Therefore they use to choose one of the three strategies rural livelihoods, which is migration among agro-pastoral activities and livelihood diversification (de Haan, Brock, & Coulibaly, 2002). Recently research reveals that migration particularly emigration in Mali is the response of negative factors for example population growth, environmental change and especially increasing economic pressure that pushes people to move.

Out-migration might serve additional as a coping strategy from households to expand livelihoods and to support the feeding costs of some of their members (Findley, 1994; Grace, Hertrich, Singare, & Husak, 2018). So that in terms of unpredictable climate, lack of well-functioning credit market, subsistence farmers try to deal with these sad conditions by sending a household member abroad. In this study, we purpose to contribute to the growing body of researches focused on out-migration in the study site through an examination of the causes and the perceptions level of the out-migration in rural area in south- eastern Mali.

5.2 Study area

The third region of Mali, Sikasso is the capital city of the region is the most populated region of Mali 1,782,157 inhabitants in 1987, 2,625,919 inhabitants in 2009. The region of Sikasso is divided in seven (7) cercles (prefecture or department): Bougouni, Kadiolo, Koutiala, Kolondièba, Sikassa, Yanfolila and Yorosso. Located in the southern part of the country, it is the southern-most region of Mali, with coordinates 11°11’59”N 7°5’49”W. Sikasso region is at 375 kilometers from southeast of Bamako, the capital city, borders the

north of Côte d'Ivoire and the west of Burkina Faso. The region covers a total area of 70,280 km^2 as density 37/km^2.

The local economy is fundamentally based on farming and Sikasso region receives more precipitations than any other Malian region. It is known for its numerous vegetables and fruits (particularly mangoes, for which Sikasso is especially renowned), commonly called kenedougou (region of greenery). Agriculture remains the main source of subsistence, for the majority of the residents of this region. However, the mechanisation of agriculture is far from favourable due to the poor situation of the country itself. Over the total production of cereals crops, the region of Sikasso alone produces 32% of the national production (CSP/SDR, 2017/2018).

The major ethnic groups of the region include the Senoufo, acknowledged for masks and reverence for animals, closed to them the Samoghos people, recognized for being the best farmers of the whole country. Sikasso region abounded in the main ethnic group of Mali, the Bambara people. Sikasso region was selected because of the current state of migration in this region and the accessibility. The recent researches on migration shown that Sikasso becomes the place mostly affected by out-migration (IOM, 2015).

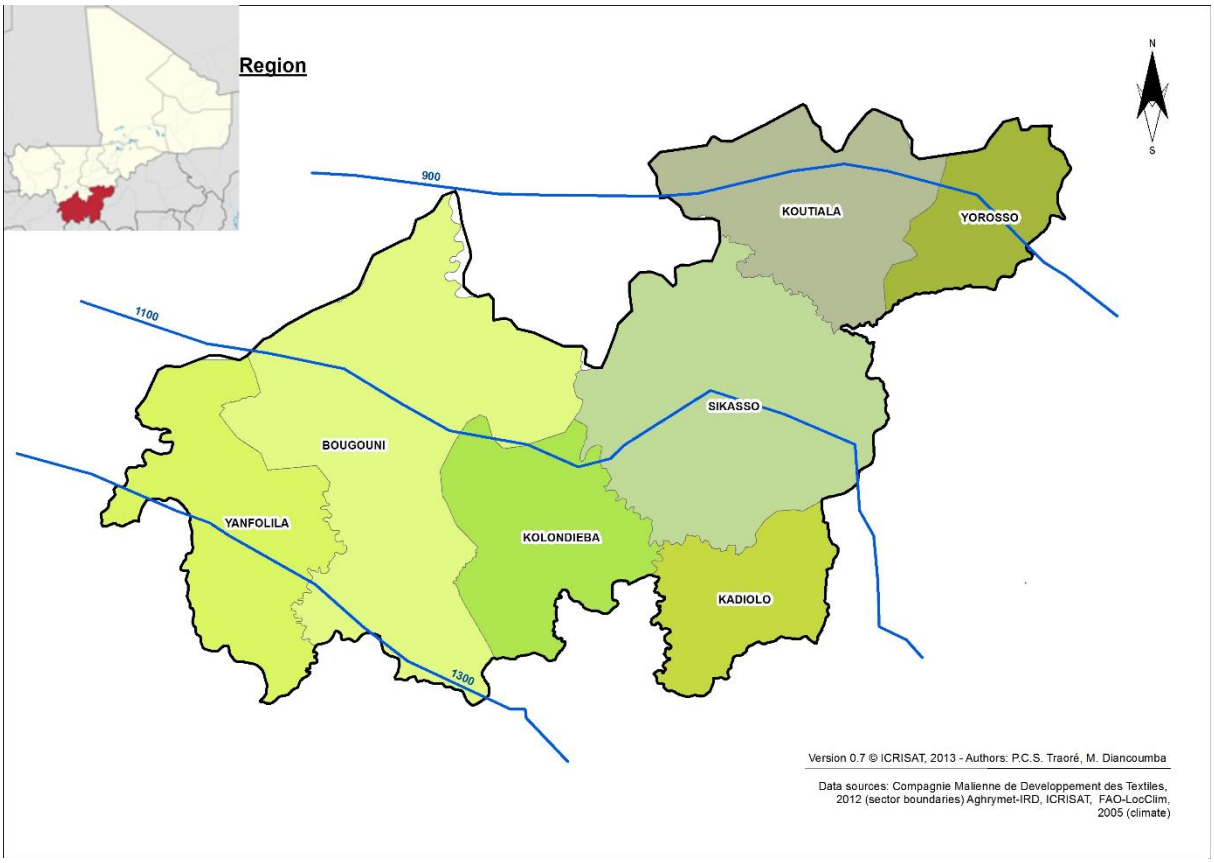


Figure 20: Map of Sikasso region showing the study area (the seven cercles of the region)
Source: Author's field survey (ICRISAT)

Data

Collected during May 2018, data is cross-section data, recorded in all the cercles of the region of Sikasso, except Yorosso (du to the lack of accessibility). The target population is all resident household in the region of Sikasso. The estimated population in 2016 using the 2009 general population household survey is estimated to 3,336,752 inhabitants (Direction Nationale de la population 2016). This population is mostly employed in agriculture sector. L'enquête agricole de conjuncture (EAC) of 2017/2018 revealed that population involved in agriculture in this region is 2,885,683 inhabitants for a number of 429 201 households, this represent more than 86% of the total population in this region (CPS/SRD) (Rapport EAC 2017/2018). However, the sample unit in the research is the household. A

multi-stage sampling procedure was used in this study. So that the combination of several forms of sampling procedures was employed to settle it. Multi-stage sampling procedure is a very flexible procedure mostly used to collect cross sectional data as this case involves.

Primarily the south-Est region of Mali (Sikasso) was selected because several interests (highlighted in the study area), then concerning the selection of the cercles was based on the most affected by the phenomenon migration such as emigration. In fact, over the seven cercles of the region, six were selected based on the high density of population, the accessibility to these cercles and their affected by emigration issue according to previous researches (EMOP, IOM 2015). Randomly chose two communities corresponding to two villages or cities. The selected cercles include Sikasso, Bougouni, Kadiolo, Kolondièba, Koutiala, and Yanfolila (see map for location).

Table 15 : population and number of household in this region by cercle in 2018

Cercle	1	2	3	4	5	6	7
Population	982415	612915	323355	269284	77581	284328	282843
Household	148 851	92 866	48 993	40 801	11 755	43 080	42855

Source EAC 2017/2018. Author calculation (Sikasso=1; Bougouni=2; Kadiolo=3; Kolondièba=4; Koutiala=5; Yanfolila=6; Yorosso=7) *Source: Author's field survey*

Table 16 : Data distribution

Cercles	Sikasso	Yanfolila	Koutiala	Bougouni	Kadiolo	Kolondieba
Household Surveyed	82	70	60	44	30	14

Source: Author's field survey

5.3 Data analysis

Estimation strategy of the multinomial logistic regression model:

From the literature, people migrate for several reasons including environmental or climate shocks. This means that a holistic approach must be adopted to identify the factors influencing the purpose for a migration. This is important as it will reveal the category of people migrating for a particular purpose, hence, policy variables that must be address to reduce or otherwise migration in rural Mali. The study would employ multinomial logistic model to address this objective. The multinomial logistic method (MNL) is a limited dependent model that allows to estimate the probability of deciding from a set of more than two alternatives. The technique simultaneously compares any given outcome with a reference outcome.

Historically, the inadequacy of natural resources to meet people's needs push them to leave their original settlement to another. This is largely due to lack of land or infertility of soil. Aside this, one key factor of migration in the Sahel, especially, Mali is poverty which drives people to move to a zone where there are high opportunities for employment (Bossard, 2004; Cissé,et al 2010). For instance, in Mali, cotton crisis facilitates the migration of a number of young people to look for work, also to get better living conditions or to escape local clanship rivalries. The specific characteristics of the Sahel zone, particularly, the long period of dry season, which is worsening over the years, has introduced another dimension into the drivers of migration. Cissé, et al, (2010) concluded that the main factors, which cause migration in Sahel zone especially in Mali, are passive rainfall, poverty and loss of production. Given the above description, one can conclude that the main reasons for rural migration in Mali are poverty, unemployment, demographic

pressures and climatic conditions. These drivers are non-exogenous, which means that they are influenced by a set of factors. To model for such multiple endogenous variable, the model can be given as;

$$P(y_i = j) = F_{ij}(X_{ij}^{'}\beta), \qquad i = 1,2,....., N \qquad j = 0,1,2.$$

(1)

Where $P(y_i = j)$ is the probability that an individual i will migrate due to the reason, j. $P(y_i = 0)$ is computed when there are two probabilities. Therefore,

$$\sum_{j=0}^{2} P(y_i = j) = 1. \qquad (2)$$

The multinomial logit model is given as

$$P(y_i = j) = \frac{\exp(X_{ij}^{'}\beta)}{\sum_{k=o}^{2}\exp(X_{ij}^{'}\beta)}$$

(3)

In this case, the log likelihood is specified by

$$\ln L = \sum_{i=1}^{N}\sum_{j=0}^{2} y_{ij} \ln P_{ij}$$

(4)

Where the variable y_{ij} is 1 when $y_i = j$ and 0 if otherwise.

Parameter β_j is required for the logit measurement for maximizing the log likelihood function in equation (4). Specifically, a new variable $X_0, X_1, \ldots\ldots X_M$, is specified for each explanatory variable X depending on the number of options. Coefficient estimates are computed with the coefficient $X_j\ (j = 1,2,\ldots\ldots M)$ where the X_0 coefficient is standardized as 0. In other words, the coefficient is estimated at $(\beta_j - \beta_0)$.

5.4 Results and discussion:

5.4.1 Descriptive characteristics of the sample

The characteristics of our sample carry out some of the most important characteristics of the region of Sikasso. With a fine diversified ethnic group, bamabara represents 27.67% of the sample, compare to the ethnic group foulani (peulh), which corresponds to 26.33%. The ethnic groups Mianka, Sénofou and Samoghos are some of the ethnic groups dominant in this region, they represent respectively in this sample 18.66%, 10.67% and 10%. Therefore, the remaining percentage ethnic groups is sharing between Sarakolé, Dafi, Bobo, Djonka and Gana.

From the colonial time up to the two last decades, the region of Sikasso was the most preferred place by the agricultural producers cause of it high rainfall, confirmed by the sample, 10% of the head households migrated to the region, which is in line with the report of EMOP (2017).

Over the 300 observations, more than 66% are employed in agricultural sector closed to the finding of the national institute of statistic (2015). The second high frequency is the breeder amount 15.33% of the sample, against 6.33% of traders. Only 4.67% of the

household head work in public sector, instead of working as joiner, butcher, builder, tailor, driver, pump attendant, tapestry-maker, marabout or housewife which represent 7% of the whole sample.

The main crop cultivated in the study area goes from cotton to peanut; include maize, sorghum and millet. According to EAC (2017/2018), the region of Sikasso came first in total producing cereals crops 31.01% of the whole country production. In this sample the area used to cultivate these crops are very variable from a producer to another one. In fact, the yield also highly vary from one producer to another one.

The most cultivated crop is maize; the average cultivated land is about 3.43 hectare with 3.471 tons. The crop cotton follows maize but the area cultivated in cotton is high than for the others crops. In average, cotton is cultivated on 4.08 hectares, with 3.823 tons as average yield in the study area. The remain cereals crop sorghum, millet and peanut are respectively 3.13 hectares, 2.99 hectares and 1.29 hectares with respectively 2.218, 2.073 and 0.809 tons as average yield (table 17).

Table 17 : Characteristics of the sample

Items	Number	Mean or %
Native of place	271	90.33
Number of years in village/town of non_native	29	18.72 (15.77)
Ethnic group		
Bambara	83	27.67
Peulh	79	26.33
Mianka	56	18.66
Sénoufo	32	10.67
Samogo	30	10
Other ethnic	20	6.67

Main activity		
Agriculture	200	66.67
Breeding	46	15.33
Trade	19	6.33
Public worker	14	4.67
Others main activity	21	7
Crop production		
Maize area cultivated	234	3.43 (2.33)
Yield of maize	234	3471.12 (3111.21)
Cotton area cultivated	128	4.08 (2.64)
Yield of cotton	128	3823 (3015.05)
Millet area cultivated	95	2.99 (2.34)
Yield of millet	95	2073.56(2221.62)
Groundnut area cultivated	86	1.29 (1.45)
Yield of groundnut	86	809.71(1255.35)
Sorghum area cultivated	45	3.13 (3.39)
Yield of Sorghum	45	2218.88(2553.72)

Source: Author's field survey

5.4.2 **Characteristics of the surveyed household**

The surveyed households characteristics is presented in table 18. The main activity of the household head of the sample is agriculture in the study site, which employs 66.67% of the total sample; this is in line with the reality in Mali, the agricultural sector employs over 80% of the active population of Mali. Follow by breeding practice 15.33% of the whole sample and the other activities include civil work, homemaker, tailor, mechanic, drive, stonework and joiner. In more of doing a main activity, 60.67% of the household head practice a second activity, the reason of doing a second activity varies from one household head to another. The main reasons of doing second activity include: 37.91% say to rise the revenue to improve the life condition, 24.73% of those practicing secondary activity do it

to prevent or to bear day-to-day expenditures of the family, such as 15.93% give as reason support the production of the season. There were 6.59 percent of surveyed population practicing second activity to improve their life conditions, the remains 15% is sharing between, overcome unexpected event, and practice by passion, by pleasure, to achieve the expensive of the condiments, revenue diversification and avoid unemployment.

Table 18 : Household surveyed characteristics

	All (n=300)	Migrant (n=246)	Non migrant (n=54)
Household head Sex	91% Male	90.65% Male	92.59% Male
Average age	52.49 (15.17)	52.91 (15.52)	50.55 (13.44)
Household size	19.83 (13.82)	20.77 (14.06)	15.51 (11.86)
Number of schooling years	7.74 (4.07)	7.44 (3.76)	9.28 (3.76)

Source: Author's field research Standard error in parentheses.

5.4.3 **Characteristics of the migrants:**

Table 19 contains the characteristics of the migrants, around 550 migrants surveyed amount 246 households, more than two migrants per household as average (2.23). However, sharing on the whole sample it likely 1.83 migrants per household. Most of the migrants are men such as 94.18 % against 5.82% women. Very young people are the migrants so that the average age of them turns around 25.49 years old with a standard error of (8.13).

Regarding the marital status of the migrants 61.82% of them are married and 36.55% are unmarried, only 1.64% which is the remaining sharing between divorced and widowed migrants. Sikasso's region primary activity is based on agriculture why around 2/3

(66.79%) of the migrants were employed in the agricultural sector before leaving their own place. In breeding and commerce activities, 10.40% were working in each of these sectors. About destination of migrants, more than 60% move internally that is in line zith the report of RGPH 2009. Average amount of remittances send by migrants to their family behind is 142124.39 FCFA with a standard deviation of 151326.23.

Table 19 : Characteristics of the migrants

Characteristics	N	Mean or %
Sex		
Male	518	94.18
Female	32	5.82
Age	550	25.49 (8.13)
Marital status		
Unmarried	201	36.55
Married	340	61.82
Divorced and widowed	9	1.64
Migrant activity before leaving		
Agriculture	366	66.79
Commerce	57	10.40
Study	45	8.21
Breeding	57	10.40
Other	23	4.20
Destination of the migrant		
Rural (village)	29	5.10
Urban (main town in the country)	303	55.19
Continental (in Africa)	169	30.78
International (Out of Africa)	49	8.93
Transfer	550	51.64
Amount of transfer	205	142124.39

Source: Author's field survey

Migration causes

Table 20 reveals the distribution in percentage of the migrants by region of depart and by reason of leaving. The intensity of leaving linked to the different reasons of migration varies from place to place. These factors include economic, social aspect, professional, politic, study and health. From the fourth general population and housing census of 2009, most of the emigrants evoked that the economic reason is the main principal causes of the out-migration in Mali (87.2%). There are other causes reveal by the migrants such as social causes (9%), leave for studying (4.2%) and professional causes (2.4%). In all regions the economic causes is the first cause of migration in 2/3 in case, with the smallest proportion in Bamako (62.3%), the highest proportion was recorded in Kayes' region (92.9%). Household concern are the mostly cited in Gao's region (12.1%), Kidal's region (11.7%) and for the district of Bamako (10.4%). The motive to study is high revealed by Bamako's emigrants (19.6%) and the region of Kidal (10.2%).

Table 20: Sharing (in %) of the emigrants, by region of depart and by motive of migration

Region of depart	Reasons of migrations					
	Econo	Social	Professi	Politic	study	Health
Kayes	92.9	4.1	0.7	0.1	1.9	0.3
Kkoro	90.4	4.4	1.9	0.1	2.7	0.5
Sikso	86.5	8.8	1.7	0.2	2.6	0.3
Ségou	90.4	5.5	1.3	0.1	2.4	0.2
Mopti	92.7	4.7	1.1	0.1	0.9	0.4
Tbctou	89.2	5.5	3.1	0.2	1.1	0.8
Gao	79.4	12.1	2.7	0.1	3.6	2.1
Kidal	69.5	11.7	5.5	0.8	10.2	2.3
Bamko	62.3	10.4	6.5	0.2	19.6	1

Total	87.2	6	2	0.1	4.2	0.5

Source: Author's field research (RGPH 2009)

5.4.4 **Drivers of migration in Mali**

This section analysed the determinants of migration in the study area. From the survey, the push factors that leads to migration were classified under three major factors such as poverty or unemployment, environmental challenges, and others including curiosity, marriage and schooling. These primary and mutually exclusive factors force individuals to migrate to other locations. Therefore, a multinomial logic regression was estimated with the 'other factors' as the reference group. The objective in this section is to identify the socioeconomic characteristics of migrants based on the push factors. For instance, to identify the characteristics of people who migrant due to bad weather or environmental challenges. From the result, the factors that significantly influenced migration were sex, age and age squared, household size, labour constraint, and location. The report of the research is in line with many previous studies on climate change induced such as (IPCC, 2014; Rigaud et al., 2018; Black, Kniveton, & Schmidt-verkerk, 2011)

The effect of sex on migration is positive and significant for migration due to environmental challenges and migration due to poverty or unemployment, similar to the result found by (Adger & al.,2014) in their research on human security in the fifth report of Intergovernmental Panel on Climate Change to contribute to the Working Group II of 2014. This implies that males would migrate due to environmental shocks such as drought or flood than females. In terms of marginal change, relative to other factors, males have a 0.033 probability more of migration if the weather becomes unfavourable revealed also by (Adger & al., 2014) and the production environment becomes unconducive for higher

yield. This is due to the fact that males are most the case the breadwinners of the family in one hand and in other hand surely men are generally additional adventurous than the women (Elijah & al., 2016). Moreover, when the environment is no longer supportive of the farm activities of the household, it still remained the duty of the male to ensure that there is food for household consumption. Therefore, to fulfil their responsibility of breadwinner, they have to migrate to other areas where they environment is good for farm activities or where they can get other non-farm activities to do and earn higher income to meet the primary needs of their households. In addition, because females are child bearers (Elijah & al., 2016), they have limited opportunity to migrate even if they are unemployed or there are environmental shocks. In fact, for a female to migrate, she has to migrate with her children while men often migrate as an individual and leaving the children with their mother. In terms of personals, factors comprise gender and age and also ethnicity, all these factors are able to push people to decide to move or to stay on their origin place (Lee, 1996; Zickgraf, Longueville, & Ozer, 2016)

The effect of age on migration is negative while the effect of age squared is positive. However, the effect is significant for only migration due to environmental challenges. The negative effect of age and positive significant of age-squared means that the younger farmers have a higher probability of migrating to other areas with less environmental challenges than the elderly, this result confirmed what found by Hatton & Williamson, (2003). In fact, in the study area migration is surely driven by their demographic characteristics (age, gender, ethnicity and so on) (Zickgraf & al., 2017). However, in the long run (where environmental challenges persists), the elder would also migrate. The result shows that a unit increase in age leads to 0.01 decrease in the probability of migrating due to environmental factors but in the long run, a unit increase in age would

lead to 0.001 increase in the probability of migrating due to environmental challenges. This is consistent with the expectations of the researcher. Generally, the younger farmers in the rural areas often have the desire for migrating to the cities and other parts of the world for other economic activities. Therefore, with the influence of changes in the environment, these individuals may become more poise for satisfying their desires and hence, migrate, additionally when the situation is unbearable for farmers to stay at their origin place (Awumbila & al., 2015). With a persistent bad environment, their elderly farmers may also migrate because there is nothing they can rely on to provide food and other basic needs for their families.

The effect of household size on migration is negative and significant for migration due to poverty and migration due to environmental challenges. However, the marginal effects for migrating due to poverty (-0.003) is lower than migration due to environmental challenges (-0.002). The negative effect means that farmers with larger family members have a lesser probability of migrating due to poverty and environmental challenge relative to other factors. Thus, with higher family members, the probability for migrating due to factors such as curiosity, marriage and passion is higher than migrating due to poverty and environmental challenges. This is contrary to the research expectations since an increase in household size may have negative implications on the poverty status of the household and household's assets level or distribution, hence should migrate due to poverty or environmental challenges. However, the survey revealed that the social tie among larger households is weak, therefore, they can easily migrate even for passion without its effect on the remaining family.

Labour constraint had positive significant effect on migration due to poverty/unemployment and environmental challenges (Docquier, Ozden, & Peri, 2014). This implies that respondents who indicated lack of agricultural labour perceived that people migrate due to poverty, unemployment or environmental factors, relative to migrating due to other factors. The result revealed that a farmer who lack labour have a probability of 0.055 units more of migrating due to poverty or unemployment and a probability of 0.016 units more of migrating due to environmental challenges, than migrating due to other factors. This implies that lack of labour have a major implication on migration due to poverty or unemployment than migrating due to environmental challenges and other factors. The lack of labour affects the production of crops since the use of mechanised agriculture is low among the farmers. Thus, there is a high reliance on human labour for crop production. Therefore, the lack of labour would lower crop production (de Brauw, 2014) and farmers who rely largely on external labour would be forced out of farming, hence, becoming poor and underemployed. Environmental challenges also requires that more labour is involved in the production of crop since extra farm activities are supposed to be performed by the farmers. It is therefore not surprising that farmers who lack labour for crop production perceived that there is a higher probability of migrating due to poverty and environmental challenges.

The location factors that had significant effect on migration were locating in Yanfolila, Bougouni and Koutiala. All these cercles/departments locations were positive and significant for migration due poverty or unemployment and migration due to environmental challenges. These implies that farmers who are located in these cercles/departments relative to those located in the reference cercles/departments Sikasso, have a higher probability of migrating due to poverty or environmental challenges and no

other push factors. Comparing these cercles to the referring group of Sikasso's cercle, Sikasso has more public infrastructures, more opportunities than all these others cercles. In fact, Sikasso cercle is the main cercle of the region. Regarding Koutiala (called the capital of white gold) such as the main activity in this cercle is the production of the cotton, once there is a climate extreme (drought or flood), which is not good for this crop, farmers have no other choice to fulfil this situation better migration. In case of Yanfolila cercle, as an administrative subdivion of the region of Sikasso, it is a place of gold washing, which instantly increase the price of basics goods to be high to the farmers (the villagers). Bougouni, the administrative centre of the cercle, it is a cercle closed to the cercle of Yanfolila with approximatively the same characteristics. The main activity of this location remains agriculture. Once the environment degradation become worst or there is an event of climate change, farmers have obliged to look for better condition for their livings. This is why most of the studies investigating migration as a strategy to cope with climate variability have principally focused on rural areas (Nawrotzki & al., 2015). Because researches found evidence that the effect of climate change on migration operates principally through employment in the agricultural sector (Nawrotzki & al., 2015).

Table 21 : Multinomial Logistic Regression results

	Poverty/unemployment			Environmental challenges		
Variables	Coeff.	S.E	mfx	Coeff.	S.E	mfx
Sex	2.16***	0.71	0.141	2.26**	0.88	0.033
Age	-0.16	0.11	-0.002	-0.25*	0.14	-0.01
Age squared	0.002	0.001	0.0001	0.002*	0.001	0.001
House size	-0.03*	0.01	-0.0003	-0.04**	0.02	-0.002
Education	0.66	0.06	0.003	0.08	0.72	0.001
Secondary activity	0.02	0.45	0.02	-0.26	0.57	-0.029

Impact income	0.81	0.5	0.057	0.8	0.64	0.007
Migration strategy	-0.13	0.47	-0.047	0.29	0 .63	0.041
Change in village	0.25	0.49	0.052	-0.12	0.65	-0.035
Labour constraint	0.88**	0.44	0.055	0.95*	0.56	0.016
Yanfolila	1.08*	0.61	0.018	2.67***	0.99	0.095
Bougouni	2.89**	1.18	0.024	4.89***	1.43	0.153
Kadiolo	0.36	0.86	0.066	-13.92	1269.63	-0.024
Koutiala	0.11	0.54	-0.273	3.30***	0.91	0.34
Kolondieba	15.98	1901.24	0.067	17.75	1901.24	0.125
Constant						

Significance level ***=1%; **=5%; *=10% (S.E= Standard Error, mfx =Marginal effects)
Source: author's field survey

Notes: change in village = change in the village by migration or not; migration strategy is to adapt or not; impact income= impact of migration on income.

Joint probability of push factors

The table 22 shows the estimated probability of migrating due to each of the push factors of migration. From the result, the probability of migrating due to poverty or unemployment is 0.756. Thus, the major push factor for migration is poverty or unemployment. The estimated probability of migrating due to environmental challenges is 0.136 while migrating due to other push factors is 0.106. This result indicates that to address migration among farmers, the major push factor to consider is improving the welfare of the people and move agriculture from the current subsistence status to a commercial status where farmers would see agriculture as a business and engage in large-scale production. However, since environmental challenges can worsen the poverty status of the farmers, it is also crucial that environmental factors are also given a prime attention in addressing migration issues among farmers.

Table 22: Joint probability of push factors

Variable	Mean	St-dev	Min	Max
Poverty/Unemployment	0.756	0.153	0.120	0.982
Environmental challenges	0.136	0.126	8.21^{-9}	0.524
Other push factors	0.106	0.122	2.18^{-9}	0.876

Source: Author's field survey

5.5 Conclusion:

The objective of this research was to identify the socioeconomic characteristics of migrants based on the push factors. For instance, to identify the characteristics of people who migrate due to bad weather or environmental challenges. Cross-sectional data was used for the analysis in this estimation. The use of multinomial logistic regression is the fact migration issue has many causes. From the result, the factors that significantly influenced migration were sex, age, and age squared, household size, labour constraint, and location. The probability of migration due to poverty or unemployment is very high than the other push factors such as environmental challenges. The fact to not overcome the environmental challenges is due to the vulnerability of the population. Therefore, the government should focus its effort on the first point of sustainable development goals that is "no poverty".

CHAPTER SIX

IMPACT OF MIGRATION ON AGRICULTURAL PRODUCTIVITY IN RURAL MALI

6.1 Introduction:

One of the key motivations of this present study raised above is that in order to predict the impact of migration on agricultural productivity in Mali. Migration's impact on agricultural productivity has been a subject that catchs researchers attention in the entire world particularly in the developing countries. The decision of migration of any individual implicates several push factors that force migrant out of rural areas and pull factors that attract migrants to urban centers.

The earlier studies conducted by Todaro (1969) and Harris and Todaro (1970) describing rural-urban migration prove that anticipated wage differential is the main cause of migration from rural to urban. It implies that people will continue migrating from rural to urban centers until the wage in the rural area become equal to the wage in urban area. Therefore, the labour migration from rural area to urban area will involve the decreasing of agricultural workers, which can probably affect the production in the agricultural sector. Which corrobore with the result of McCatty (2004), who argued that as economies continue to develop, the percentage of agricultural workers declines.

Agricultural sector is fragile from the view point of rainfall dependent and price instability. Producers will be consequently affected if there is deterioration in the price of their production. Morever the farming industry offers seasonal employment, so it does not provide suitable revenue to sustain the household over an entire year. Therefore there is a need for the family household to look for an extrat revenue to support the household.

6.2 Sources of data

The data for this chapter was obtained from Enquête Agricole de Conjoncture Intégrée (EACI) done by the Cellule de planification et de Statistiques et le secteur du Développement Rural (CPS/SDR) in collaboration with the national institute of statistics and other services from rural development. In this survey, agricultural exploitation was defined as an economic entity of agricultural production including all the animals in it and all the land that belong, which is wholly in employment or in part and that, directed by the head of household. It is exploited by a household or a group of households independently associated regardless of title of possession, legal status, size and location of the exploitation.

EACI obtained its sample through stratified sampling of two stage with a sample of 2,515 exploitations sharing between 503 enumerations sections. Each section involved 750 persons in rural area and 1100 persons in urban area. At the first stage, exploitations are drawn with the same probability to the level of each stratum, which corresponds to the cercle or department. Cercle/department contains one to three sub-strata based on natural regions. At the second stage, two to five exploitations were drawn within the sample enumeration sections after counting all the exploitations. The survey covered the whole country and it was conducted in all regions apart from Kidal region and Bamako the capital. The survey covered both rural and urban areas. The objectives of this survey included collecting data on the rural sector, the establishment of significant information on the economics characteristics of farms, research of agricultural population statistics and various factors of production (CPS/SDR, 2014/2015). Based on these objectives the data collected included the following:

The characteristics of farm members (sex, age, education level, economic activities, marital status etc), the characteristics of plots and factors of production (area of land, mode of cultivation, seed, fertilizer and pesticide type, labour use), stocks status and off-farm income generating activities. EACI has incorporated, since the general census of agriculture in 2004, a new module on vulnerability, which contains several sections including one related to farm migration. An emigrant was defined by the survey as an individual who has been living outside his/her origin department for at least six months. This module was usually surveyed before the beginning of the crop season or the rainy season while the production was measured at the end of the season. The effect of agricultural production in current year on the decision to migrate was then controlled.

This section provides information on the destination of the migrants, the reason of migration, and the remittances during the last twelve months (description, amount if it is money, level, and their share of food consumption). For 2014/2015 crop year had a complete data and hence was used in this research. After cleaning data, the exploitations with all the information available for the modules were gathered. The survey contains 2 331 exploitations over 474 enumerations sections.

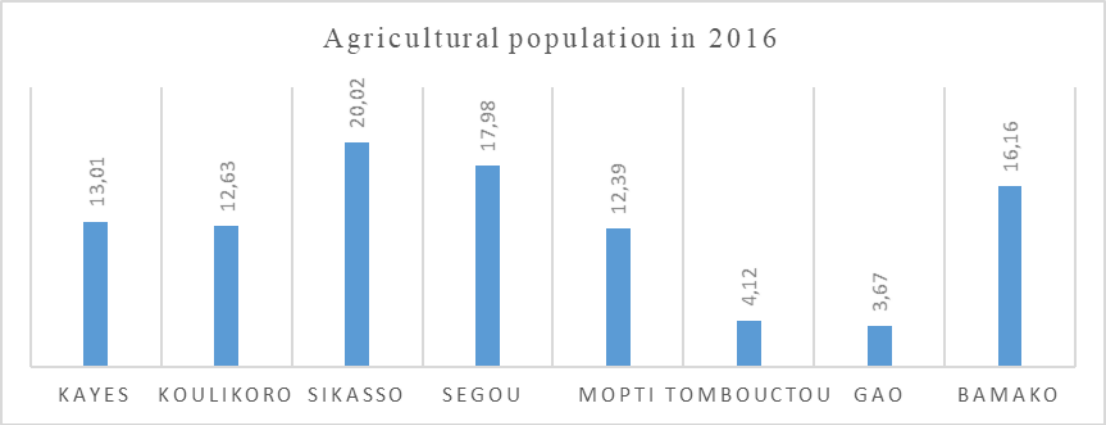
Table 23: The distribution of the sample by region

Region	Number of ES		Number of exploitations		Rate of reply
	number	%			
Kayes	90	19.0	444	19.0	98.7
Koulikoro	72	15.2	359	15.4	99.7
Sikasso	81	17.1	400	17.2	98.8
Segou	80	16.9	394	16.9	98.5
Mopti	99	20.9	487	20.9	98.4
Tombouctou	32	6.8	151	6.5	94.4
Gao	20	4.2	96	4.1	96.0
Total	474	100.0	2331	100.0	98.4

Source: Author's field research

With a very neglet rate of non-reply during the survey, the Malian agricultural population in 2016 was about 14 408 458 individuals. From the figure 17 the distribution of agricultural population by region except Kidal due to the insecurity, showed that more than one-fitfh of the agricultural workers are living in the region of Sikasso (20.02 %). This was followed by the region of Ségou with 17.98% of the agricultural population. The region of Gao reported the lowest rate of agricultural population in Mali.

Figure 21: Agricultural population by region except Kidal.



Source: Author's field research

Table 24: Repartition of the agricultural population by status of residence and by region

Region	Present residents		Absent residents		Total number
	Number	%	Number	%	
Kayes	1 808 656	96.5	65 969	3.5	1 874 625
Koulikoro	1 812 764	99.6	7 950	0.4	1 820 714
Sikasso	2 840 592	98.4	45 092	1.6	2 885 683
Segou	2 559 074	98.8	31 555	1.2	2 590 629
Mopti	1 676 638	93.9	108 726	6.1	1 785 364
Tombouctou	570 214	96.0	23 709	4.0	593 923
Gao	526 919	99.6	2 024	0.4	528 942
Kidal	-	-	-	-	-
Bamako	2 255 866	96.9	73 222	3.1	2 329 088
Total	474	100.0	2331	100.0	98.4

Source: Author's field research

Table 25: Agricultural population by bracket age and by status of residence

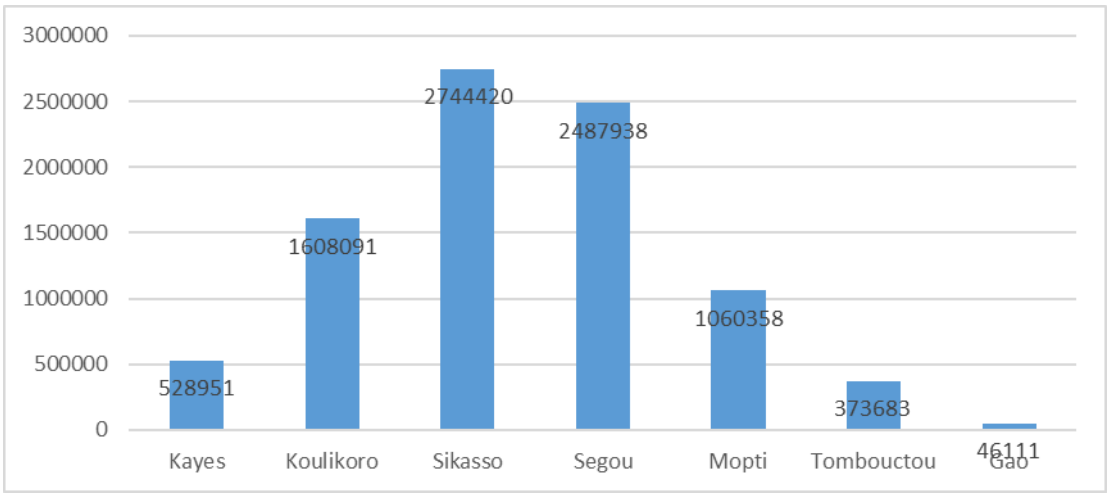
Bracket age	Present residents		Absent residents		Total
	Number	%	Number	%	
0 to 14 years	6 449 928	97.8	145 076	2.2	6 595 004
15 to 29 years	3 653 106	97.0	113 771	3.0	3 766 877
30 to 59 years	3 256 352	97.3	88 900	2.7	3 345 252
60 years and more	690 824	98.5	10 500	1.5	701 325
Total	14 050 201	97.5	358 247	2.5	14 408 458

Source: Author's field research

Some descriptive statistics on the agricultural sector and migration:

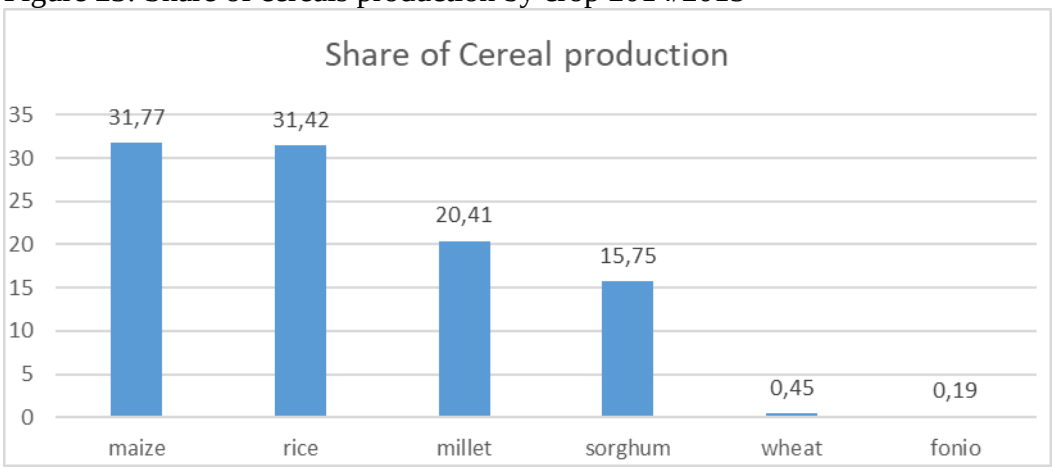
The 2014/2015 crop year recorded an estimated of 8,849,551 tons of cereals production (rain season and dry season crop). In this quantity produced are including 2,811,385 tons of maize, 2,780,905 tons of rice, 1,806,559 tons of millet, 1,393,826 tons of sorghum, 40,137 tons of wheat and 16,740 tons of fonio. The quantity of cereals produced varies largely from region to another region in Mali. Sikasso first comes and follow by Segou. In terms of cereals production the regions of Gao and Kayes produce less cereals compare to other regions.

Figure 22: Cerarls production per region (2014/2015 rainy season)



Source: Author's field research

Figure 23: Share of cereals production by crop 2014/2015



Source: Author's field research

Malian's agriculture remains dominated by the traditional subsistence sector. In fact, farms are generally small in terms of size. The average area cultivated is about hectare (ha) per farm. Three over ten farms (28.3%) have less than two hectares of cultivated area while only three over twenty (14.6%) cultivate more than 10 hectares. Agricultural mechanisation in Mali is quite widespread. The expansion of mechanisation is more linked to the possession of equipment such as plough availability from seven over ten farms.

Animals like donkeys, camels, horses, sheep and goats are used as milking animals in some places in the country.

An agricultural worker is a member of the farm who is six years old or older, involving in the agricultural activities i.e. participating in at least one of the following activities: soil preparation, seeding or transplanting, weeding, spreading, crop treatment, harvesting and transportation. Across the whole country, farms have nine people as average of member of the household. This number is significant higher in exploitation lead by man than to the one head by woman. On gender basis, thedata showed that females were engaged in farming as the males. This shows that women's involvement in agricultural activities is high in the county.

In addition to these farm assets, exploitations may use the service of others to help perform with certain stages of farming activity for cash or in kind compensation. This is what is chosen by the agricultural labour as defined by the EACI. It can be temporary or permanent. In 2016, four of every then farms used temporary labour while only one over ten used permanent labour.

On migration in the EACI survey, this phenomenon was measured by asking farmers if they have one or more family members living and working outside their community of origin. From their responses, the list of emigrants was then established and information is provided on each respondent.

6.3 Technique of production and migration

Table 27 displays a correlation analysis between the participation in migration and the ownership of certain agricultural equipments. The proportion of exploitation (household)

with a hoe, a plough, and a cart is higher in the exploitations involved in migration than farm households with not migrants. Thus, 5.6% for household with internal migrant, 8.3% for household with international migrant and 4.3% for household without migrant. It is the same for the proportion of household owing a hoe plus cart and oxen this is also relatively higher in household involved in migration than those without migrant (23.2% for household with internal migrant, 27.9% for household with international migrant and 19.5% for household without migrant). . In addition, farmers owing only a hoe, an ox of tillage and a plough are higher than exploitation not involved in migration. In fact, the proportion of household with multiple equipment is higher among those participating in the migration than those who do not participate. However, looking well at the situation, the observed difference is not generally significant, especifically with respect to the possession of complete a hoe plus plough and seeder. Less than 5% of exploitations of the whole country owing the complete combination of equipment. These results show that except a relative mechanization of exploitation production, the equipment is still incomplete for most of the majority of the exploitation according to their participation in migration (their migratory status).

Average expenditures of hired labour was almost twice high in exploitation with member(s) participating in international migration than other group of farmers. From Table 27, farmers with international migrant had an average hired labour expenditure of 52,343 Francs CFA 29,316 Francs CFA for household involved in internal migration and 23,626 Francs CFA for household who do not participating in migration. Therefore, the observed differences are considerably high. However, in terms of exploitation usage of fertilizer those involved in international migration spend less on fertilizer. Among the

inputs, is the expenditure on fertilizer was higher than the other inputs regardless of the migratory status of the exploitation.

The average cultivated areas and the number of plots are larger for the household participating in migration. In addition to this, improved seeds usage was more prevalent within the exploitations groups with internal migrant while it is roughly equal among those with no-migrant households and those participating in international migration.

Table 26 : Cross tabulation of agricultural equipements by migration status

Characteristics	Household with internal migrant	Household with international migrant	Household without migrant
% of exploitation using equipment			
Cart	22.6	38.8	24.9
Ox of tillage	68.7	69.0	59.7
Plough	74.2	81.4	66.9
Seeder	20.3	24.8	25.6
Hoes	17.9	28.5	16.7
Combinaison of equipment			
Hoe + plough + cart	5.6	8.3	4.3
Hoe + plough + seeder	8.2	11.4	10.9
Hoe + plough + ox	23.2	27.9	19.5
Superficie			
Average cultivated area	6.7	6.9	5.1
Average number of plot by expolitation	6.7	6.8	4.2
Plot with improved seed	21.9	15.0	16.1
Plot with fertilizers	26.0	19.3	24.8
Average expenditures			
Hired labour	29,316	52,343	23,626
Fertilizers	80 607	128 668	86 691

Source: Author's field research

In the country as a whole, average production varies between 1,900 tons for maize and 3,259 tons for rice. However, the major staple crops in the country are rice, millet, sorghum and maize while cotton is the only cash crop. Except for cotton, the average production of the staple crops was higher for farming households participating in migration. On the other hand, yields per hectare are lower for farmers with a member involved in migration, especially international migration. These results suggested that production is higher because farmers exploits larger areas, which is in line with the Malian family farming based on agricultural extension. The availability of equipment and the use

of new farming practices do not favour an increase in agricultural yields. Udry (1995) shown that several factors may explain this situation. In fact, the soils of the plots exploited by migrant families may be of a lower quality than those of non-migrants, which could be the cause of the departure to the migration of certain members of the household. In addition, the activities and types of crops chosen may be different depending on the migratory status. Morever, the misuse of newly acquired equipment by exploitation participating in migration may result in lower yields. Finally, the imperfections of the labour and capital markets can lead to a difference in the opportunity costs of the factors of production according to the migratory status. Gubert (2000) has also made similar arguments on the relationship between migration and yield. The explanation is that, the existence of a behavior of collection of rent (rent - seeking behavior) made possible by migrant remittances that make it less imperative to balance production and food needs. The technical inefficiency of household participating in the migration, ie their inability to reach the highest possible level of production with a certain amount of factor, can be explained by this "opportunistic behavior (Delvine 1994) ".

Table 27 : Production and average yield of the crops by migration status

Characteristics	Household with internal migrant	Household with international migrant	Household without migrant
Average yield (kg/hectare)			
Rice	2 398,6	1 908,4	2 051,5
Millet	814,8	715,0	804,2
Maize	1 678,3	1 423,5	1 615,6
Sorghum	934,0	890,6	956,6
Cotton	1 061,6	1 077,9	1 052,4
Average yield (kg)			
Rice	3 108.9	6 833.1	3 028.3

Millet	2 962.1	2 734.9	2 598.8
Maize	1 605.9	1 993.4	1 975.4
Sorghum	2 430.2	2 220.2	2 167.1
Cotton	2 126.8	3 159.0	3 189.8

Source: Author's field research

6.4 Data analysis

6.4.1 **Theoritical model**

According to Gubert (2000), migration of a family member and its financial after-effects meet two essential purposes: firstly, the migration might contribute to ease the constraint of credit and risk constraints faced by rural household and facilitate technological change through remittances (Collier et Lal, 1984; Stark, 1991). Finally, migration can be seen as part of a diversification strategy, aimed at protecting households from production failure or income risk in agricultural sector. Therefore, migration as a strategy means that remittances from migrant labours respond to shocks affecting the recipient families in origin countries (Stark, 1991). In some cases, moral hazard is probable to appear as shocks like climatic issue, which are not directly observable by the migrants in his own place. This situation can be analysed in a consistent theoretical framework used by Gubert (2000).

Assume that, given the production technology and the state of nature, the agricultural household can produce either Y_h with probability $p(le)$ of Y_l with probability $1-p(le)$.

Where, l designs the amount of labour input and e is the average level of effort applied to these units of labour (le is labour in efficiency units). Therefore, $p'>0 \quad and \quad p''<0.$

The probable production level is then given as

$$E(Y) = p(le)Y_h + [1 - p(le)]Y_l$$

(1)

In such net income of the farm production is given by:

$$\Pi = Y - x \quad (2)$$

In this second equation x represents the amount of material other than labour. Output and input prices have been normalised to one, since we are going to use only cross-sectional data in the empirical application.

Considering that $v(le)$ is the non-use of labour for the household, with $v(0) = 0,\ v' > 0 \ \ and \ \ v'' > 0.$

Under the assumption of risk neutrality, expected utility when the household works le in efficiency units follows as:

$$EU = E(C) - v(le) \quad (3)$$

C is the agricultural household's level of consumption.

The expected utility of the household is maximised subject to the following cash-revenue and time constraints:

$$C = \Pi + R + \overline{Y} \quad (4)$$

$$1 - l = loisir \quad (5)$$

Where, R is the remittances from internal and international migrants, $\overline{Y}$ is exogenous income like pension, rental income, and l is the total (normalised) time endowment. However, assume that the levels of output are as follow:

$$\begin{cases} Y_h > Y_l \\ \Pi_h + \overline{Y} \geq \overline{C} \\ \Pi_l + \overline{Y} < \overline{C} \end{cases}$$

Where $\Pi_h\,(\Pi_l)$ denotes net income from farm production when output level is $Y_h\,(Y_l)$, and $\overline{C}$ can be interpreted as the level of consumption such as the basic needs are satisfied.

Assume that, remittances be part of an implicit contract between migrants and their recipient origin families (exploitations), it is an informal arrangement, which rest on a sense of distributive justice. Concerning the justice involves that the migrants have the duty to satisfy the basic needs of their families whenever they are not able to do it themselves (i.e whenever C fails below $\overline{C}$).

In particular, a clause in the contract binds the migrants to send funds (or consumer goods) each time their families cannot establish entitlement over an adequate amount of food through purchase or through food production. Such a transfer of general purchasing power from the migrants to their families may be viewed as an informal tax aimed at re-allocating incomes between the modern capitalist sector, located either in Mali or abroad, and the subsistence farming sector. This family solidarity serves as a substitute for the welfare state of industrialised societies and, by guaranteeing subsistence, provides what may be called a poverty insurance. The implementation of distributive justice as described above is not Pareto efficient, however, if we assume that the household's effort level is

unobservable by the migrant. Imperfect monitoring of effort implies that the migrant cannot ascertain whether low yields in his family's fields are due to his relatives' idleness or to unfavourable weather conditions (or any other unfavourable state of nature). It may thus induce the household to shirk and to rely on the migrant for her subsistence.

Following Fafchamps (1992), an effective way to prevent the occurrence of moral hazard is to use punishment strategies. The migrant may, for example, threaten his family to break the contractual arrangement by suspending remittances. Since the loss of the migrant's financial support is very costly in intertemporal utility terms, the family has a strong incentive not to shirk. This implies, however, that the migrant is able to check his family's work performance. A comparison of family output with that of others can serve as an indicator of effort. Such a scheme is often referred to as "yardstick competition" in industrial or labour economics (Shleifer, 1985, Lazear et Rosen, 1981). Though compensation schemes based on relative performance may provide an efficient mechanism for monitoring productivity, collusive manipulation by participating firms or workers is often an important limitation of yardstick competition (Shleifer, 1985). In the particular case of the Kayes area, some scope for collusion is undeniably present. Agricultural households may for example collude in order to send false signals to the migrants. Acts of collusion, such as the announcement of fictitious natural disasters, were actually observed in the area. Moreover, peer pressure could make family output an unreliable signal, for "zealous" families (i.e. those that do not take advantage of their informational rent) could well be constrained by others to reduce their labour effort. Ex- ante financial support is, according to Fafchamps (op.cit.), another way to prevent opportunistic behaviour. In the case of the Kayes area, survey data suggest that even if the bulk of remittances occurs

after the harvest has been realised, the migrants supply some liquid assets prior to the crop season so that their families may have access to key factors of production.

So far, our theoretical discussion has not taken into account the presence of another informational asymmetry, which would this time be beneficial to the migrant. Indeed, the migrant freely decides whether he sends funds or not. If he decides not to, his family cannot ascertain whether this decision is due to temporary money troubles or to his intentional derogation of the contract. Various elements, among which directly moral motivations or migrants' concern about other persons' opinions of them, induce us to believe that the migrants do not take advantage of this informational asymmetry and that the implicit agreement to assist others is enforced by social pressure. Yet, the possible occurrence of money troubles is introduced in the model since it alters the reliability of the poverty insurance mechanism. Let Ψ the probability that the migrant financially supports the family be:

$$\Psi = h\left(\frac{N_m}{N}\right)$$

(6)

Ψ is assumed to be positively correlated with the number of family emigrants N_m divided by the number of family members residing in the country of origin N. The higher the ratio, the smaller the number of individuals being financially supported by each emigrant and the more the insurance mechanism.

Insurance mechanism reliability and level of effort:

The presence of a relationship contractual between emigrants and their families of origin imply that when families suffering a shortfall in income receive an amount of remittances R in such a way that $R \geq \overline{C} - \Pi - \overline{Y}$ with probability Ψ and $R < \overline{C} - \Pi - \overline{Y}$ with $(1 - \Psi)$. For simplifying the model, we can assume that the migrants send either an amount strictly equals to the deficit of consumption $(R = \overline{C} - \Pi - \overline{Y})$ with probability Ψ or no remittances at all $(R = 0)$ with probability $(1 - \Psi)$, whenever, $Y = Y_l$

Under these assumptions, the expected value of remittances is written as follow:

$$E(R) = \Psi[1 - p(le)](\overline{C} - \Pi_l - \overline{Y}) \quad (7)$$

The optimisation facing each household is to choose a level of labour effort that maximises expected utility, where expected utility is given by:

$$EU = E(\Pi) + E(R) + \overline{Y} - v(le) \quad (8)$$

$$\Leftrightarrow EU = (1-\Psi)(\Pi_l + \overline{Y}) + \Psi\overline{C} + p(le)\left[(\Pi_h - \Pi_l) + \Psi(\Pi_l + \overline{Y} - \overline{C}\right] - v(le)$$

This first-order condition is

$$\frac{v'(le)}{p'(le)} = (\Pi_h - \Pi_l) + \Psi(\Pi_l + \overline{Y} - \overline{C} \quad (9)$$

Starting from equation (9), the effect of increasing Ψ on optimal le can be derived from differentiating the first-order condition. The resulting expression can be written as:

$$\left[\frac{v''(le)\,p'(le)-v'(le)\,p''(le)}{[p'(le)]^2}\right]dle = d\Delta\Pi + (\Pi_l + \overline{Y} - \overline{C})d\Psi + \Psi d\Pi_l + \Psi d\overline{Y} - \Psi d\overline{C}$$

(10)

(+) (–) (+) (+) (–)

Where $\Delta\Pi = \Pi_h - \Pi_l$

The result of the comparative experiments on the level of effort derived from the model may be summarised as:

$$le^* = le^*(\Delta\Pi, -\Psi, +\Pi_l, +\overline{Y}, -\overline{C})$$

(11)

The model predicts a negative relationship between the Ψ, which is an indicator of the reliability of the insurance mechanism, and the labour in efficiency units in a context of informational asymmetry. This prediction cannot be directly tested due to lack of data. Formally it is possible to show the presence of a negative relationship between the degree of reliability of insurance mechanism and technical efficiency of the exploitation in the case where the hypothesis moral hazard is pertinent.

From the literature, technical efficiency is defined as follows:

$$TE = \frac{realised\ \ output}{Maximum\ ouput}$$

The maximum output in the model above Y_h corresponds to a level of effort $\overline{le}$, such that $p(\overline{le}) = 1$. Technical efficiency may then be written as:

$$TE = \frac{E(Y)}{Y_h} = \frac{p(le)(Y_h - Y_l) + Y_l}{Y_h} \quad (12)$$

It follows that:

$$TE^{'}(le) = \frac{p'(le)(Y_h - Y_l)}{Y_h} > 0 \quad (13)$$

The key prediction of the model thus becomes: the more reliable the income-smoothing mechanism, the higher the incentive to shirk, the lower the technical efficiency.

Extension of the model: adversion of the risk hypothesis

The hypothesis of the neutrality towards the risk can be modified by the spefication of the expected utility of the exploitation as follow:

$$EU = \log(C) - v(le)$$

(3bis)

So it becomes possible to show that :

$$EU = p(le).\left\{\log(\Pi_h + \overline{Y}) - \log(\Pi_l + \overline{Y}) + \Psi\left[\log(\Pi_l + \overline{Y}) - \log\overline{C}\right]\right\} + \Psi \log\overline{C} + (1 - \Psi)\log(\Pi_l + \overline{Y}) - v(le) \quad (8bis)$$

Which gives the first order condition

$$\frac{v'(le)}{p'(le)} = \log(\Pi_h + \bar{Y}) + \Psi\left[\log(\Pi_l + \bar{Y}) - \log\bar{C}\right] \quad (9bis)$$

This last equation shows that the prediction of the model does not change nothing if we introduce the adversion hypothesis towards risk. Nous found a negative relationship between $le and \Psi$ en estimating the total difference of the expression (9bis). I search, in the following, to size the opportunist behaviour of the exploitations by analysing the technical efficiency. I propose frontier estimation of the production function using the fixed effects method to show that the offered guarantee linking the migrants to their orgin exploitations are a determinant factor of the inefficeiency.

The econometric model:

Here is the function of the production technology on each plot

$$g(X_{ih}, W_i, G_{ih}, \mu_h, \theta_{ih}), \quad (14.a)$$

Where i is the index plots of land and h is the index of the household $(i = l, \ldots\ldots p, \quad h = 1\ldots\ldots\ldots\ldots, H)$; X_{ih} represents a vector of physical inputs on plot i, W_i represents a vector of observable plot characteristics, G_{ih} stands for a vector of characteristics of the individual who controls the plot; μ_h represents a disturbance term that recapitulates the effects of unobserved plot quality variables and plot-specific production shocks.

Considering that $g(X_{ih}, W_i, G_{ih}, \mu_h, \theta_{ih}) = g(X_{ih}, W_i, G_{ih})\exp(\mu_h + \theta_{ih})$

In fact, the logarithms are taken on both sides, the production function is specified as:

$$\ln Y_{ih} = \ln g(X_{ih}, W_i, G_{ih}) + \mu_h + \theta_{ih} \quad (14.b)$$

According to Greene (2012) the term μ_h can be considered as: a fixed effect where it represents a specific constant to each exploitation; it is about the estimator *within*, the statistics properties have been clarified by a relative study on panel data (Mundlack, 1978).On the other hand, a random effect where, it is included in the residual where the distribution is not explicit specified. The generalised least squares GLS, which brings unbiased estimators and convergent can be used to estimate the model.

While it is possible to argue for one or the other model, unobserved heterogeneity and embodied in the error component μ_h are the key problem with the random effects approach, therefore may be correlated with observed inputs. In the presence of such correlation, generalised least squares and least squares yield biased and inconsistent estimates of the parameters. The traditional technique to beat this problem is to exploit a fixed effects procedure, i.e. to remove the household-specific effect μ_h by transforming the data into deviations from household means (Hausman and Taylor, 1981). In that case, sufficient conditions for the OLS estimates from the transformed variables to be unbiased and consistent is that the elements X and W are uncorrelated with the classical disturbance term Θ .

Hausman (1978) proposed a test for orthogonality of the random effects and the regressors. It is based on the thought that under the hypothesis of no correlation. The random effects and the fixed effects estimates should not differ systematically. The basic

idea of the test is that, under the hypothesis of independence, the estimators within and Generalized Least Squares are not significantly different.

Two main limits are observed for this method. First, the regressors' specific to every exploitation and invariants according to the plots of land, are excluded by the within transformation, which consists in expressing variables according to their gap to the individual mean. Finally, the efficiency and the convergence of the within estimators are bound to the acceptance of the hypothesis of exogneity of the independent variables with the term of classic error.

The use of the method of fixed effects is legal because the specification of the model does not contain invariant regressors according to the plots of land. However, without instruments, it was not possible to correct the estimated coefficients of biases introduced by a possible correlation between the explanatory and Θ variables. After the estimation of equation $14b$, we test the hypothesis of a negative relationship between the reliability of the insurance mechanism (ψ in the theoretical model) and the technical efficiency (not observed) of the holdings, measured by μ_h. It will be a matter of simply regressing μ_h on a set of variables representing the characteristics of the exploitation with a proxy of ψ.

6.4.2 **Specification of the model:**

Before estimating the model, we have to choose the specific functional form $g(X_{ih}, W_i G_{ih})$. For that, we assume that the process of the production on a plot i from an exploitation h determined by Cobb-Douglas production function. In this case, we estimate:

$$\ln y_{ih} = \alpha + \beta_x \ln X_{ih} + \beta_k W_i + \beta_N G_{ih} + \mu_h \quad (15)$$

Where,

y_{ih}, represents the yield on plot i from an exploitation $\boldsymbol{h}$;

X_{ih}, denotes the vector of tradionnal factors of agricultural production (superficie, labour, and capital);

W_i, is the vector of the plot characteristics (include the characteristics of the responsible of the plot himself “sex, age, education);

G_{ih}, is the representing certain variables exogenous uncontrollable by the farmers (like precipitation and regions’ fixe effects);

The specification has an advantage to be simple and provide the estimators without bias. The estimation of this function gives a measure of technical efficiency that is regressed using certain characteristics of the exploitation and the locality of residence.

$$\hat{\mu}_h = \beta_{\grave{a}} + \beta_k Z_h + \varepsilon$$

Where, Z_h is a vector of the charcteristics of the exploitation like participation in migration, le sex, education level, and ethnic of the head of explotation, the proportion of plot with improved seed and the variables of localisation as region of residence.

6.4.3 **Dependent variables:**

The dependent variable for the first model is logarithm of the yield on each plot. The agricultural survey of economic conditions makes it possible to obtain the yield of all the crops on all the plots of the sample from the survey on the yield squares (carré de rendement) on 1/3 of the plot and the farmer declarations on the others. The regression on the production of the different plots of the holding provides a measure of technical efficiency, which is the dependent variables for the second model.

6.4.4 **Explanatory variables:**

The explanatory variables used in the regression are:

- Area: The Malian's agriculture remains extensive. The increase of agricultural output remains linked to the expansion of the cultivated areas. All the plots of land of the exploitations samples are measured during the first move of the survey. When several speculations are cultivated on the same plot of land, is made an evaluation of the proportion occupied by each of them;
- The variables of input: the work is measured by the number of the agricultural assets (active persons) having worked on the plot. When family can not handle all the work, the exploitations can turn to hired labour in certain periods of the cultural calendar, the use of this outside work is taken into account through the cost made for this service. Fertilizers and improved seeds are taken into account through the introduction of dummy variables, take value 1 if the input is used on the plot and 0 otherwise;
- The characteristics of the plot: the quality of the soil is measured by dummy variables that reflect it use or not during the previous season and it weeding for the current season;

- Farming techniques such as the use of complete equipment, the practice of monoculture or the type of cereals grown are introduced in the regression. The method of exploitation of the plot (collective or individual) is also integrated into the model;
- The individual characteristics of the person responsible for the plot are taken into account through sex and schooling.

For the technical efficiency regression, the explanatory variables are:

- The reliability of the insurance mechanism is measured by the ration of migration, calculated by the number of migrants over the number of members of the exploitation. This ration is calculated separately for each type of migration to distinguish their effects. To show the existence of moral hazard, the coefficient associated with each ration must have negative sign;
- Characteristics of the household head: the household head is the main decision maker at the production unit level. Its ability to make good decisions and ensure better execution is important for the proper running of the exploitation. Despite the theoretical and even empirical controversy surrounding the role of education on agricultural productivity, we expect that it will have a positive impact in the sense that it is important to us to strengthen its capacity to absorb new farming practices. In a society, still marked by cultural heaviness, it is thought that men are better equipped to better manage a unit of production and consumption. Therefore, a negative sign of the sex variable of the farm manager is expected, which takes the value of 1 if woman and 0 if not. The manager's ethnicity is also integrated into the model;

- Other variables such as the proportion of plots grown with improved seeds and locality characteristics across the region of residence are also introduced in the model.

6.5 Results and discussions

This section presents the results on the impact of migration influence on agricultural productivity in fact, on the productivity of growing crops in Mali. Primarily, the study supposed to estimate the impact of each type of migration (internal and external), unfortunaly the secondary data used from national survey was cross sectional data so the international migrants were not enough to make our regression.

Descriptives statistics of the variables used in the model:

Table 29 reveals the descriptive statistics of the variables used in the present study. The data employed in the estimation includes 37175 individuals sharing between 2331 farm households (13.82 individuals' in average per household with a sdandard deviation of 9.06) through the 9 regions of Mali except Kidal because of the insecurity of this region. This data is a representative survey of 2331 households statiscally distributed in the country. Children represente 33.99 % aged less or equal to 14 years old of the sampled individuals and the work-force age going from 15 to 65 years old acounted for 60.28 %, while the retired orthe elders above 65 years represented 5.80 %. Males represent 53.0 % of the sampled individuals of the whole sample and the remaining 47.0% were females. The educational level from the sample showed that 72.38% had no formal educational, 17.47% had primary while only 9.46% had education upto secondary or professional educational level. For the university level the percentage is very low in the agricultural production sector.

The Malian farming remains dominated by the traditional practice (see the table 29), it is up to now family production scale with small cultivated area. In the survey, they used GPS

to measure the cultivated area and the yield square to measure the output of the crop production. More than 51% of the farmers do not use the manure or fertilizer and the mode of cropping by the majority (91.45%) was mostly pure cultivation (one plot one crop), a system known as monocropping. On average, the production in kg is 113.59 for all the staple crop together '(millet, sorghum, rice and maize) with a standard deviation of 206.81. It can said that there is a high variability of the cultivated area of crop in the agricultural production in Mali. The average cultivated area averages 6.85 hectare with standard deviation of 20.61, which simply show that there is a big differenc between the sizes cultivated.

The proportion of young population in the population in Mali is very considerable, and this is evident in the sampled population.The average age is about 29.32 years old with 21.64 as standard deviation. This situation is associated with our variable of interest, migration, which is very widespreaded in the Sahel especially in Mali our study area. Indeed, the phenomena of migration in Mali is the consequency of unemployment and the difficults economics conditions of the country, which push the population to emigrate. Regarding to our sampled population, there is an average emigrant of 0.40 by household.

Table 28 : Descriptives stattistics of the variables used in the models

Variable		**Number**	**Mean**	**Std. Dev.**
Production (in Kg)		8477	113.59	206.81
Area (in hectare)		8477	6.85	20.61
Number of migrant by household		8477	0.40	1.16
Average age		8477	29.32	21.64
Household size		8477	13.82	9.06
Variables	**Modality**		**Number**	**Frequency**
Age of the household member	Children (<=14 years)		2876	33.93
	Working age (15-65 years)		5110	60.28
	Vieux (>65 years)		491	5.79

Sex of the household member	Male	4493	53
	Female	3984	47
Level of education of the household member	Non educated	6136	72.38
	Primary school	1481	17.47
	Secondary & professional	802	9.46
	University level	58	0.68
Mode of plot's ploughing	No ploughing	719	8.48
	Manual	961	11.34
	plough	464	54.74
	Manual et plough	1957	23.09
	Mechanic	159	1.88
	Manual et mechanic	26	0.31
	plough et mechanic	15	0.18
Use of manure and fertilizer	None	4346	51.27
	Manure or fertilizer	318	37.51
	Manure and fertilizer	951	11.22
Mode of cropping	Pure	7752	91.45
	Association of crops	725	8.55

Source: Author's field research

Estimates of production function

The econometric results is presented in table 30. A multiple regression was estimated for the main staple crops in the country (millet, sorghum, rice, maize and bean) jointly and seperately. It gives the elasticities of production in relation to the different factors used such as input (fertilizer and manure). The Adjusted R square shows that 62.5% of the variability of the plot production is explained by the explanatory variables used in the model. Seed is an important factor that influences the yield in terms of quantity and in terms of the quality of the seed used for the production. From the results it was observed that the quantity of seed is positively significant in explaining the output of farmers. The use of improved seed other than local seeds for the first year was statistically significant but negative in explaining the yield of farmers. However, improved seed for the third year had a positive sign and significant. The area coefficient is positive and significant at 10%;

this situation indicates that the marginal yield of the area is not zero. First, this result is coherent with the theory and it confirms the extensive nature of agriculture in Mali. The results show that the number of agricultural workers (family labour and hired labour) significantly influence the production on the plots. Therefore, it can be argued that the coefficient associated with the logarithm of the number of both workers on the plot are significant. This suggests that the constant of the production function varies according to the number of agricultural assets. This circumstance indicates that the potential of these factors of production are still to be exploited. Consequently, it confirms the hypothesis that, there is a surplus of workers in farms production in developing countries, which reinforced Lewis' model done in 1954: "labour can move from the traditional sector to the modern sector without loss of production in the traditional sector" (Lewis, 1954). In this case, the departure of one or more members in migration should not negatively influence agricultural work because, as Sen (1966) argued, migration takes workers but not work, hence, "the effort of those who remain adjusts". Once the use of the hired labour is positive and significantly different from zero, it indicate that farms could compensate for the departure of agricultural assets by using additional labour. The mechanization of the production system can also help reduce the need for agricultural assets. The use of fertilizers and manure have a positive influence on the level of production. Production is higher for newly developed plots according to the farmers. Probably because these plots are more fertile. As expected, pure cultivation (a single crop on the plot) favours increased production compared to the crop association. Production is higher in plots where the plot was managed by a man than managed or owned by a woman. This situation is in line with several studies done on measuring men and women’s agricultural output(Quisumbing et al., 2014).

Regarding the labour force, the working population is not significant, however, the category elder's population is statistically significant at 10% and affects negatively the production. This situation can be explained as the fact that the elder's population do not have the work force to work decently in the farm. In terms of gender issue, the result showed that the plot controlled by women are less productive than the one controlled by men which is similar with the results Udry et al (1995) found. Explaining this outcome, women in rural area in Mali mostly use most of their time working for men instead of working for themselves and also, this can due to the limited resources by rural women. In fact, reffering to the Food and Agriculture Organization of the United Nations (FAO), in underdeveloped nations, rural women act as a keystone of family agriculture that is small-scale production and daily household subsistence.

Migration variable is statistically significant and held a negative sign that means it has a negative impact on the output of the several crops used in the model. Our finding is related to the results of Zahonogo, (2011); Imran, Bakhsh, & Hassan, (2016). Migration plays important role in time of food shortage in the rural area in Mali (Findley, 1994). Especially through the remittances send by migrnats to their respective family members behind. Migration contributes also to diversify the sources of earnings, which allows the household to overcome the weaknesses of market in the rural area and also restrainst of credit and insurance.

Table 29 : Jointly modelling of the production function of the growing staple crops in Mali

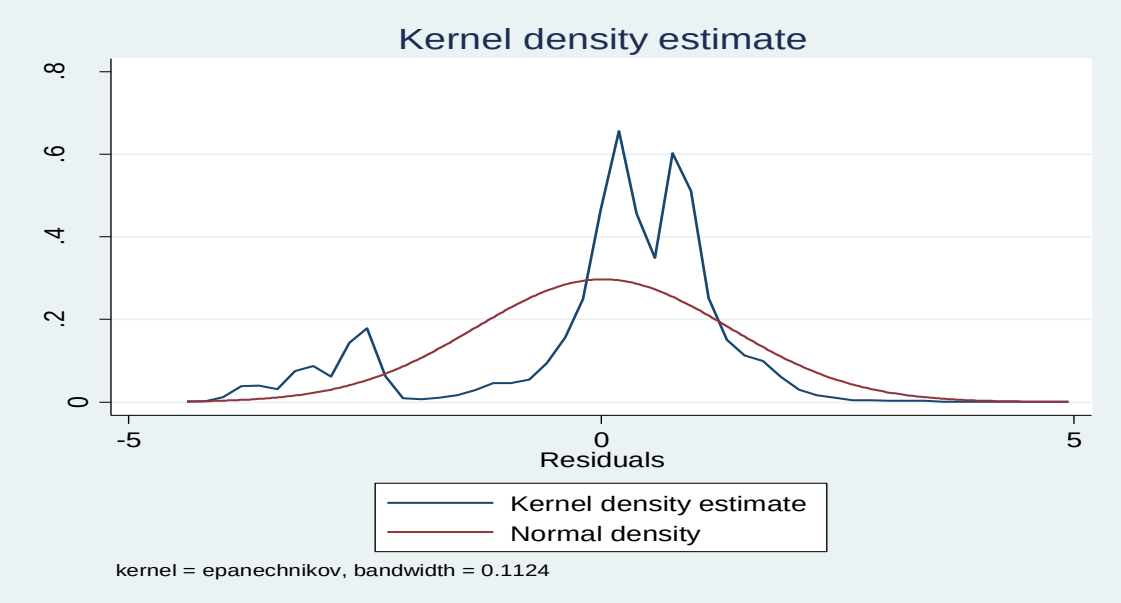
Log (production)	**Coefficient**	**S. Error**	**t**	**P>t**	[95% Conf.	Interval]
Constant	3.61***	0.05	68.33	0.00	3.51	3.71
Seed [Ref. Local seed]						

Improved seed for first year	-0.36***	0.07	-5.23	0.00	-0.50	-0.23
Improved seed for 2^{d} year	0.12	0.10	1.26	0.207	-0.07	0.31
Improved seed for third year	0.32***	0.11	2.98	0.003	0.11	0.53
Improved seed unknown year	-0.17**	0.07	-2.53	0.011	-0.31	-0.04
Quantity of seed used/plot	0.02**	0.01	2.23	0.026	0.00	0.04
Log (Area)	0.02*	0.01	1.70	0.09	0.00	0.05
Log (Hired labour)	0.03**	0.01	2.69	0.01	0.01	0.06
Log (Family labour**)**	0.10***	0.02	4.77	0.00	0.06	0.15
Input [Ref. No use of manure and fertilizer]						
Manure or Fertilizer	0.58***	0.03	18.44	0.00	0.52	0.64
Manure and Fertilizer	0.77***	0.05	16.81	0.00	0.68	0.86
Mode of Cropping [Ref. Monoculture]						
Association de cultures	-0.21***	0.06	-3.49	0.00	-0.33	-0.09
Level of schooling [Ref. Non educated]						
Primary school	0.14***	0.04	3.77	0.00	0.07	0.21
Secondary& professional	0.13***	0.05	2.87	0.00	0.04	0.22
University level	0.23	0.18	1.30	0.19	-0.12	0.58
Age [Ref. (<=14 years)]						
Working age (15-65 years)	-0.04	0.03	-1.41	0.16	-0.10	0.02
Elders (>65 years)	-0.12*	0.06	-1.35	0.06	-0.19	0.006
Sex [Ref. Male]						
Female	-0.04	0.03	-1.42	0.15	-0.10	0.02
Migration (0=No, 1=Yes)	-0.10*	0.04	-2.43	0.02	-0.18	-0.01

***p<0.001 indicates significance at 1%, **p<0.05 indicates significance at 5%, *p<0.01 indicates significance at 10%.

Source: author's field research

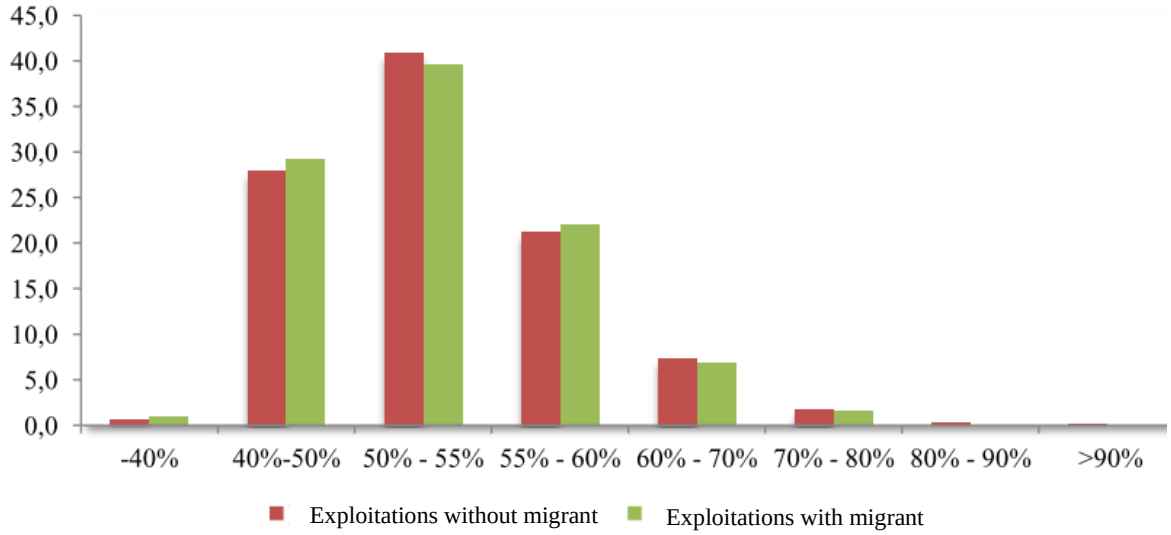
Figure 24 : Sharing of fixed effects



Source: Author's field research

Once technical efficiency's estimation of agricultural unit is available. We are now checking whether it is a decreasing function of the reliability of the insurance mechanism. Therefore we estimated an equation of the predicted value of the fixed effect as a function of a vector of observable characteristics of the operation and the insurance mechanism measured by Ψ . Due to the aspect of data (cross sectional) we ran only one model with internal migration (rural to urban migration) because the data did not contain much exploitations involved in international migration. The results of technical efficiency regressions are presented in table 31. The coefficient associated with the rate of migration is significant and held a negative sign. This means that the null hypothesis of moral hazard is not rejected. The presence of opportunistic behaviour might well be facilitated by the existence of an implicit contract between migrants and their families behind.

Figure 25 : Ditribution of the exploitations according to the technical efficiency by migration status



Source: author's field research

Production function ran separately for each crop:

The regression ran separately, the results changed from one crop to another crop. Our interested variable that is migration has an impact at 10% only on the yield of maize. That effect is statistically significant and negative, which is beyong our expectation. Maize and groundnut production demand labor intensive for its practices. The labour both hired labour and family labour are statisticllay significant and positive for these crops. The variable area is significant and positive for maize and groundnut cultivation, this situation is understandable because Malian agricultural is based on extensive agriculture. The input fertilizer and manure and the labour both hired labour and family labour are statisticllay significant and positive for the crops (millet, sorghum, maize and peanut). Association of crops is negative for the maize crop such as more number of plants in one acre and also due to less sunlight can make difficult crop to grow effortlessly or easily.

Production function ran for each crop separately

Variables	Millet	Sorghum	Rice	Maize	Peanut
Log (production)	Coef/SE.	Coef/SE.	Coef/SE.	Coef/SE.	Coef/SE.
Constant	3.96***/0.13	3.80/0.15	4.40***/0.07	3.09***/0.12	3.25***/0.11
Log (Area)	0.03/0.04	-0.05/0.04	-0.01/0.01	0.07*/0.04	0.09**/0.04
Log (Hired labour)	0.12***/0.04	0.03/0.04	0.00/0.02	0.05*/0.03	0.17***/0.03
Log (Family labour**)**	0.12**/0.06	0.06/0.06	-0.03/0.03	0.14***/0.05	0.11**/0.05
Input [Ref. No use of manure and fertilizer]					
Manure or Fertilizer	0.21***/0.07	0.65***/0.08	0.04/0.05	1.36***/0.09	0.56***/0.07
Manure and Fertilizer	0.76***/0.10	0.92***/0.13	0.04/0.07	1.38***/0.10	0.36**/0.17
Mode of Cropping [Ref. Monoculture]					
Association of cultures	0.13/0.11	-0.26/0.14	-0.05/0.09	-0.54***/0.16	0.20/0.16
Level of schooling [Ref. Non educated]					
Primary school	0.06/0.08	0.30***/0.09	0.01/0.04	0.08/0.07	0.42***/0.08
Secondary& professional	0.29***/0.09	0.18/0.13	0.08/0.09	-0.09/0.10	0.41***/0.09
University level	-0.05/0.74	0.24/0.22	-0.08/0.05	0.26/0.25	0.81***/0.13
Age [Ref. (<=14 years)]					
Working age (15-65 years)	0.19***/0.07	0.19**/0.08	0.05/0.05	0.04/0.07	-0.04/0.07
Elders (>65 years)	0.49***/0.16	0.31**/0.15	0.18/0.07	-0.05/0.15	0.21/0.26
Sex [Ref. Male]					
Female	0.10***/0.06	-0.07/0.08	-0.10**/0.05	-0.06/0.06	0.08/0.07
Migration (0=No, 1=Yes)	-0.29/0.23	-0.23/0.18	0.05/0.06	-0.11*/0.06	-0.07/0.05
Number of observation	1917	1538	1019	1340	1493

Standard error after /. *Source: author's field research*

6.6 Conclusion

The principal component of this objective was to highlight the existence of a moral hazard phenomenon that would be the cause of poor agricultural output obtained by exploitations with at least one member living outside their locality. A remark, most of the researches

have been focused on the international migration, but the present study mostly focused on the impact of internal migration on agricultural productivity. Because more than 95% of the whole migrants move inside the country. The theoretical model used in this research, proposed by Gubert (2000), shows that the farmers exercise lower average level of effort in doing farm activities once they are insured by receiving transfer from migrants. The forecast of the theoretical model was tested using the estimation by the fixed effects method of a production frontier. The indicator of the reliability of the insurance mechanism, measured by the ration of migration (ration of migration is to the number of migrants over the size of the exploitation) seems determine the technical inefficiency of agricultural exploitations. Gubert (2000) obtained this conclusion with regard to the Kayes region (international migration). Although some previos studies conducted regional analysis, this present study was estimated based on national impact and have also concentrated on the impact of internal migration which is the most dominant migration type in Mali.

CHAPTER SEVEN

GENERAL CONCLUSION, POLICY IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH

7.1 General summary and conclusions

Migration especially in the Sahara region is a concern to many international developers. The trend and intensity is worsening due to the impacts of the changing climatic conditions over the years. As a result, this study examined the rate of migration in response to climate change and its effect on agricultural productivity in rural in Mali. More specifically, three hypotheses were tested and these were:

Hypothesis 1: climate extremes have no significant effects on migration;

Hypothesis 2: Socioeconomic factors do not have significant effect on migration in Mali;

Hypothesis 3: there is no statistically significant effect of migration on agricultural productivity in rural Mali.

The literature review revealed that the underlying motives for migration are varied and migration is often a voluntary decision that goes beyond risk prevention and adaptation to environmental stress. Better income opportunities (based on wage differential), society (migration is a way of life for West African people), and the the desire for progress, prosperity and a different lifestyle are major reasons for migration. Similarly, the prestige and economic achievements of previous migrants also motivates other people's decision towards economic migration. The literature on the relationship between environment and migration is ambiguous. However, the findings turns around three relevant aspects for the research on environment and migration, particularly in West Africa. Firstly, changes in environmental changes favour temporal migration, secondly, migration is a well-

established activity to diversify revenue and thirdly, migration is as a result of multi-causal factors.

In chapter four, I tried to assess the impats of climate change on migration. Fromprevious studies, several methods were used to analyse this kind of economic relation and this includes ecological inference based on area characteristics, sample surveys, times series, multilevel analysis, and agent-based modelling (ABM). The choice of approach was based on the focus of the researcher and the availability of data. As a result, this study used time series method to carry out the impacts of climate change on migration. Climate change was proxied withtemperature and rainfall in Mali. The result has shown that beside the unfavourable economic conditions of the country, climate change impacts negatively out-migration from Mali directly and indirectly. Directly, the vulnerability of the Malian population to climate change easily forced them to move during climate extreme events or shocks. Indirectly, through the most vulnerable sector to climate change, which is agricultural sector that employs more than 75% of its population, any shock to agriculture production due to climate conditions may push individuals or household to migrate in order to secure food and other basic needs. Besides, bad governance, civil war and political instability also play a significant role in pushing people to migrate from their current location to outside Mali.

In assessing objective two addressed in chapter five, the descriptives statistics show that the migration phenomenon is very considerable in Sikasso region of Mali. In fact, among the 300 households surveyed in the region, there is an average number of 2 migrants per household. The survey revealed that over 66% of the households were involved in agriculture, both crop production and animal breeding. Over half of the migrants were married and were young people. This section also underlined the perceptions and the

sociocharacteristics of the population that motivate them to migrate when they are facing environmental challenges. The analysis established that poverty, unemployment, bad weather and bad crop season were the major reasons for migration among households. This was relied upon to estimate a MLN regression. The result showed that the factors that significantly influenced migration were sex, age and age squared, household size, labour constraint, and location. Talking about the hypothesis 2, the results have shown that the MLN regression, which used primary data, the level of perception and the causes of migration have been perceived by study area population.

The third objective of this study convered the effect of migration on agricultural productivity. Shown by the descriptive statistics, agricultural activities are still the major activity of the population of Mali. About one of every five agricultural population of Mali reside in Sikasso region. Among several growing cereals in Mali such as maize, millet, rice, sorghum etc the result showed that there is an increasing production of maize over other cereal crops. The ownership of agricultural equipments by migration status showed that the households with international migrant most of the cases owned more equipments than the households with internal migrants and households without migrants. In terms of productivity, the households without internal migrants have high productivity than those with international migrant, however, in terms of average yield housedolds with international migrants had higher yields than those with internal migrants. Using a Cobb Douglas production function, it was established that migration has a negative impact on productivity of agriculture. As such the last hypothesis that migration have no significant effect on agricultural productivity was rejected. Going far the mechanism insurance between migrants and his/her behind family, strong the reliability of the insurance mechanism is, the least the average technical is.

7.2 Policy implications

Following the conclusions drawn in the proceeding section, a number of policy implications were drawn and recommendations made, primarily, to avoid force migration due to climate extremes of rural people in Mali and to ensure that migration does not lead to a decline in agricultural productivity. In Mali, climate change is mainly manifested by events. These include significant increases in temperatures and desertification, which can itself lead to flooding. However, this study found that unexpected events such as…are the major factors that drive people to migrate for survival. This form of environmental migration, although little observed in Mali, is also characterized by the modification of usual migratory trajectories as part of an urgent strategy to manage food insecurity. It can be seen that droughts in Mali have caused people to migrate south temporarily and/or permanently at a given time. By degrading pastures, the drying up of water points and the reduction of livestock, drought and all climatic events are altering the migratory trajectory of nomadic peoples and contributing to the disappearance of a very traditional way of life. Floods, on the other hand, mainly affect material goods and infrastructure, sometimes plunging people into absolute precariousness.

Therefore, the main objective of the government should be first of all to avoid forced migration, but facilitating positive impacts of voluntary migration. In fact policies must contribute to livelihood sutainability and well-being irrespective of whether predictions of climate change materialize.

It is recognized that the rural people of Mali, their livelihoods are mainly based on subsistence agriculture, which depends on rainfall, therefore, policy should make livelihoods less dependant on rainfall, and also by promoting non-farm activies. In

addition, put environmental policies to combat erosion, land degradation and deforestation, but respecting the interests of rural farmers.

Farmers may not easely change their behaviour but respond to external motivations that would lead to a rise in agricultural production. It is therefore, recommended that government should direct attention towards skills training, raising the educational standard.

Through remittances, migrants are able to help their respective families.Nonetheless, the results of this research showed that remittances leads to technical inefficiency of the members of the families behind. Moreover, it is recognized that 95% of the received remittances go to the daily comsumption. Policy makers should encourage emigrants to direct their savings to Mali for investment. Also policy should create more opportunities such as modest jobs in the country's main emigration areas in order to settle populations in their home territory.

7.3 Limitations and future research

As frequently executed in many empirical researches, the present study used rainfall and temperature to decipher climate change conditions in the study area Mali. This approach of measuring climate change, however, is limited in the sense that rainfall and temperature remain simply proxies and do not represent a complete index of climate change.

Although climate change and migration research have recently been gaining attention, in the case of this study, time and data constraints did not allow for the

estiamation of climate change effects on migration at regional level in Mali using longitudinal data. Morever, it will be better to see the subject at farm household level maybe using the dataset EMOP. Future researchers who are interested in analysing this subject should focus more on the fact that poverty and unemployment are the relevant factors driving migration. The environmental challenges also fairly affect migration directly and indirectly. As a result, future research should try to well understand population vulnerability to climate change.

In addition, the study carried out here is constrained by cross-sectional data indeed a single time period, and also the fact that the assessing of climate effects on migration has been done at national level. The current study could not well model the farmers' performance change at different points in the time according to the reliability of the insurance mechanism. A longitudinal research design might have facilitated a better analysis and understanding of farmers behaviour in receiveing transfers from their respectively migrants. It would be interesting if future research could explicate farmers' behaviour by engaging in longitudinal reserah.

Finally, based on the explanatory variables used in this study to analyse migration and agricultural productivity in Mali, future researches ar encouraged to build on these variables to further analyse the migration-agriculture nexus.

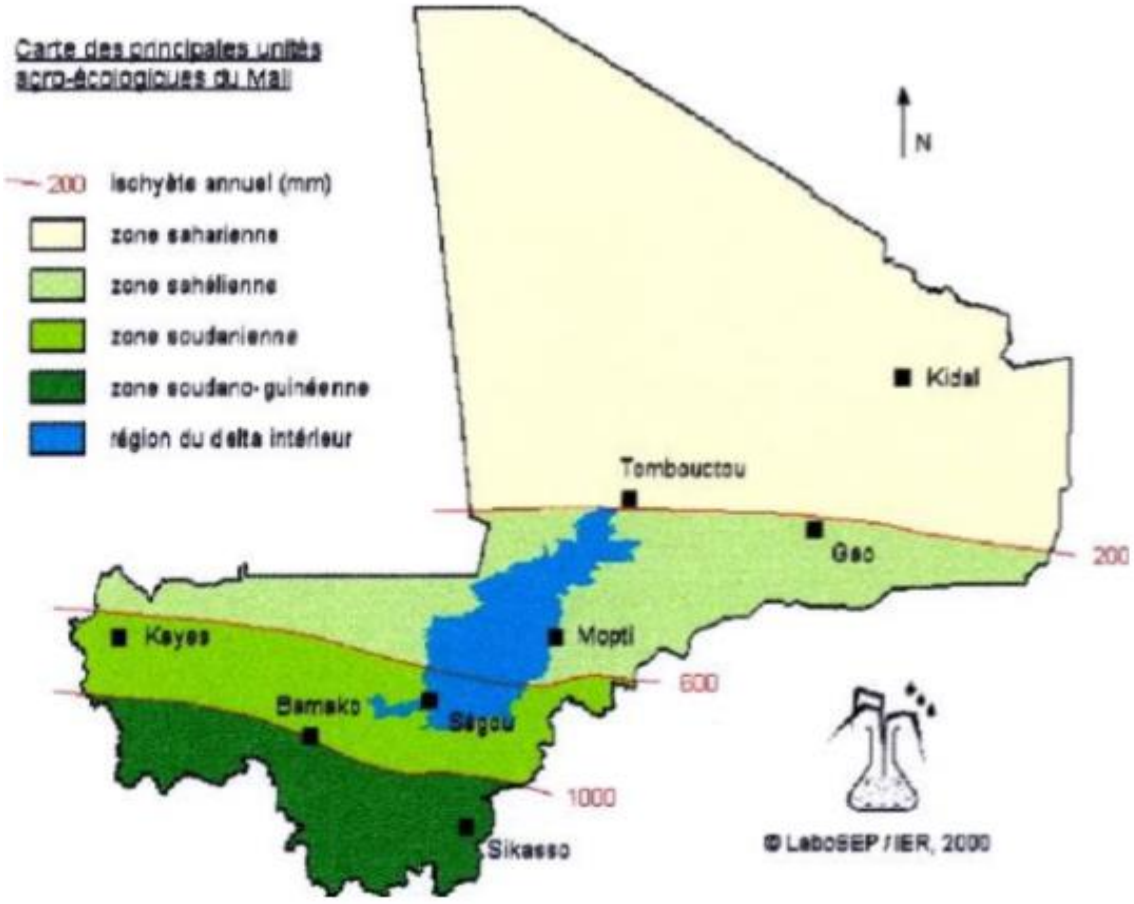
APPENDIX

Table 30A: Variance decomposition of out_migration using cholesky (d.f. adusted) Factors

Period	S.E.	D_OUT_MIGRATE	D_RAIN	D_UNEMPLRATE	D_GDPCAP	D_ANTEM	D_AGRI_GDP
1	0.192839	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
		(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
2	0.259478	91.39942	6.756818	0.134109	0.802714	0.695629	0.211309
		(7.04227)	(6.01813)	(1.77467)	(3.01344)	(1.93596)	(2.23326)
3	0.323131	78.45532	10.83021	6.394680	0.624372	3.000730	0.694684
		(10.8995)	(8.26971)	(5.36300)	(3.24217)	(3.93898)	(3.26977)
4	0.353135	76.21175	9.868880	8.220796	0.599868	4.513320	0.585384
		(12.4467)	(8.29233)	(6.46176)	(3.96216)	(4.85262)	(3.79466)
5	0.377088	73.61411	10.30911	9.249529	0.879531	5.342665	0.605051
		(13.9566)	(8.85667)	(7.20785)	(4.51568)	(5.04624)	(4.27837)
6	0.392946	72.21482	10.87531	9.500570	0.810581	5.969059	0.629658
		(14.7623)	(9.19455)	(7.65255)	(4.67898)	(5.38640)	(4.74278)
7	0.404499	70.91263	11.28308	10.07429	0.801213	6.258403	0.670387
		(15.3788)	(9.36827)	(7.95689)	(4.93036)	(5.58570)	(4.89701)
8	0.411938	70.31812	11.40387	10.33679	0.783600	6.469547	0.688070
		(15.7228)	(9.46823)	(8.05414)	(5.03660)	(5.78463)	(5.20095)
9	0.417355	69.84152	11.51364	10.52792	0.781074	6.630489	0.705361
		(16.0532)	(9.56772)	(8.14636)	(5.18716)	(5.91137)	(5.39748)
10	0.421067	69.51718	11.60588	10.65753	0.771146	6.732309	0.715958
		(16.2575)	(9.69651)	(8.23500)	(5.23816)	(6.01608)	(5.50694)

Cholesky Ordering: D_OUT_MIGRATE D_RAIN D_UNEMPLRATE D_GDPCAP D_ANTEM D_AGRI_GDP
Standard Errors: Monte Carlo (100 repetitions)

Figure 26 : Card of the principal agro-ecologic in Mali



Technical efficiency

Variables	Coefficient	Sdt.Error	t
Constant	-0.57***	0.060	-8.83
Rate of migration	-0.120***	0.036	-3.23
Household size	-0.003**	0.002	-2.33
Age	0.001**	0.001	2.22
Sex [Ref. Male]			
Female	0.017	0.028	0.64
Ethnic of the plot manager [Ref. Bambara]			
Peulh/foulani	-0.230***	0.046	-5.02
Sonhrai	-.187	0.053	-1.26
Sarakolé	-0.483***	0.053	-9.12
Kassonké	-0.808***	0.108	-7.47
Sénoufo/Minianka	0.033	0.045	0.72
Dogon	0.075	0.083	0.91
Tamacheq	-0.482**	0.219	-2.19
Bobo/Dafing/Samogo	-0.037	0.064	-0.58
Level of schooling [Ref. Non educated]			
Primary school	-0.146***	0.036	-4.05
Secondary& professional	-0.064	0.044	-1.46
University level	-0.243	0.127	-1.92
Region [Ref. Kayes]			
Koulikoro	0.915***	0.053	17.03
Sikasso	0.953***	0.057	16.64
Ségou	0.917***	0.054	16.90
Mopti	0.383***	0.079	4.83
Tombouctou	0.886***	0.167	5.31

Gao	1.480***	0.195	7.58

Source: author's field research

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