THE DYNAMICS BETWEEN MIGRATION AND LAND USE AND LAND COVER CHANGE (LULCC) IN BURKINA FASO: A COMPARATIVE CASE STUDY

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ABSTRACT

Elisabeth Kago Nébié: The Dynamics Between Migration and Land Use and Land Cover Change (LULCC) in Burkina Faso: A Comparative Case Study
(Under the direction of Colin Thor West)

In Burkina Faso, population pressure on land cover, fragmenting agricultural units and reduced rainfall have exacerbated land degradation. The long-term failure to balance human interferences and natural degrading processes with natural reproduction and restorative management efforts has initiated Land Use and Land Cover Change (LULCC). In northern Burkina Faso, land degradation has stimulated a large migration toward more fertile areas of the south. While northern provinces such as Bam Province in Burkina Faso are being rehabilitated by Soil and Water Conservation (SWC) projects, southern provinces, such as Sissili Province, considered more "pristine," have been neglected. Recently, researchers have been highlighting the role of demographic pressure and agro-pastoral activities on land degradation in Sissili. However, comparative research between provinces of departure and destination has not yet been undertaken. This paper, informed by regional political ecology, integrates LULCC data with ethnographic and demographic information to compare the dynamics between migration and LULCC trends in Bam and Sissili. This comparison assesses whether these provinces are migration 'sources' or 'sinks.' The results show that migration correlates with LULCC and detect greater LULCC in in-migration areas and little LULCC in areas of out-migration.

I dedicate this work to *Yaba* Adam Kaboré & *Papy* Georges Bamina Nébié

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LIST OF ABBREVIATIONS

AVV	*Aménagement des Bassins de la Volta*
BUNASOLS	*Bureau National des Sols*
BF-WALULCT	Burkina Faso Land Use and Land Cover Maps and Trends
FAO	Food and Agriculture Organization
FEWS	Famine Early Warning System
GIS	Geographic Information Systems
IFAD	International Fund for Agricultural Development
IGB	*Institut Géographique du Burkina*
INSD	*Institut National de la Statistique et de la Démographie*
ISSP	*Institut Supérieur des Sciences de la Population*
LULC	Land Use Land Cover
LULCC	Land Use Land Cover Change
MA	The Drylands Millennium Ecosystem Assessment
OECD	Organization for Economic Cooperation and Development
PASE	Projet d'Accès aux Services Energétiques
PATECORE	Projet Aménagement des Terroirs et Conservation des Ressources
PRRA	Participatory Rapid Rural Appraisal
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
SWC	Soil and Water Conservation
WASCAL	West African Science Service Center on Climate Change and Adapted Land Use

CHAPTER 1: INTRODUCTION

Land degradation is the product of a long-term process. The Drylands Millennium Ecosystem Assessment (MA) defines land degradation as the "reduction or loss of the biological or economic productivity of drylands" (Adeel, et al. 2005:1). Humans have been utilizing and managing land cover to satisfy their needs through hunting, farming, gathering or industrial activities. Land cover is the "observed (bio) physical cover on the earth's surface" (Di Gregorio and Jansen 1998). It does not just refer to soil and surface topography, but also incorporates superficial deposits, climate and water resources, and plant and animal communities (FAO and UNEP 1999). Humans' inputs and arrangements to make a specific land cover type to produce is known as land use. Land use is dictated by diverse socioeconomic factors (Di Gregorio and Jansen 1998). Some of these factors are local culture, land policies, environmental conditions, development programs (Ellis 2013), information and technology availability in specific socio-economic contexts (FAO and UNEP 1997), and global market prospects and constraints (Lambin 2001). Land use modifies land cover and changes in land cover feedback to also transform land use (Ouedraogo 2010). This process is identified as land use and land cover change (LULCC). LULCC is the conversion of a specific land cover class into another class due to human interferences (Turner et al. 1993). Net LULCC is often general and neutral. However, certain specific changes are negative - i.e., farmland to barren soil while others are positive - i.e., barren soil to farmland. One of the negative effects of land use on land cover is known as land degradation.

Blaikie and Brookfield argue that definitions of land degradation are "open to multiple interpretations" based on natural resources users, managers, and other stakeholders (1987:4). This statement indicates that land degradation is a social process with context-specific mechanisms. Any quest for a single definition to capture the entire phenomenon is a complex and delicate task. Consequently, this paper broadly defines land degradation through the following equation: "Net degradation = (natural degrading processes + human interference) – (natural reproduction + restorative management)" (Blaikie and Brookfield 1987:7). Net degradation, which is relative to some specified state or use, is null when the net natural reproduction and restorative action equals that of natural and human degrading processes. In this case, LULCC is minimal. A positive LULCC, that is ideal, implies that abundant rehabilitation efforts stimulate natural reproduction and both processes mitigate degrading interferences. A negative LULCC occurs when human interferences and natural degrading factors exceed natural reproduction and restorative management rates. Here, human and physical processes play complementary roles in degrading, minimizing and/or repairing the land. These processes are "dialectical, for, in the course of reshaping nature, society gradually reshapes itself" (Biersack 1999:9).

In drylands, especially in the Sahel of West Africa, net LULCC is often negative or null. When net LULCC is negative, conservation projects aim to minimize or repair it. In these arid and semi-arid regions, the long-term human and natural failure to balance demand and supply for ecosystem services such as water, food, and forage is known as desertification (UNCCD 1994). Thus, desertification is synonymous with land degradation in these arid and semi-arid areas (Batterbury and Warren 2001). Desertification research in the Sahel has intensively used Burkina Faso (formerly named Upper Volta) as a case study. In the central and northern parts of this

landlocked country, high population density, extensive agriculture, the fragmentation of agricultural units, decreasing land availability, reduced rainfall, and the expansion of gullies in productive valleys have exacerbated land degradation (Critchley 1991; Marchal 1983). In the 1970s and 1980s, after the severe droughts that affected the northern region of Burkina Faso, the government encouraged large migration of Mossi farmers from these semi-arid, densely populated, and degraded areas to wetter, sparsely populated, and more fertile regions of the southern Central Plateau (Gray 1999; Ouedraogo et al. 2010). In response to these droughts and degradation in the area, the northern region has been the site of numerous large-scale Soil and Water Conservation (SWC) development projects (Reij et al. 2005). Considered as a desertification hotspot, the Bam province in northern Burkina Faso, has been studied intensively by international and indigenous environmental researchers (Batterbury 1998). The contribution of these projects on reversing land degradation and their beneficial impact on households and communities are well-documented. In contrast, Southern Burkina, once considered "green" and "pristine," has been neglected by these initiatives. LULCC has been generally attributed to population pressure, increasing consumer demand, land-tenure arrangements, access to financial capital, shifts in international trading patterns, and local inheritance laws and customs (Turner et al. 1993). More specifically, in Sissili, a province in southern Burkina Faso, in-migration has been mentioned as major cause of LULCC (Ouedraogo et al. 2010). However, studies that simultaneously compare LULCC and migration dynamics in both 'sources' (regions of origin) and 'sinks' (destination areas) in Burkina Faso are nonexistent.

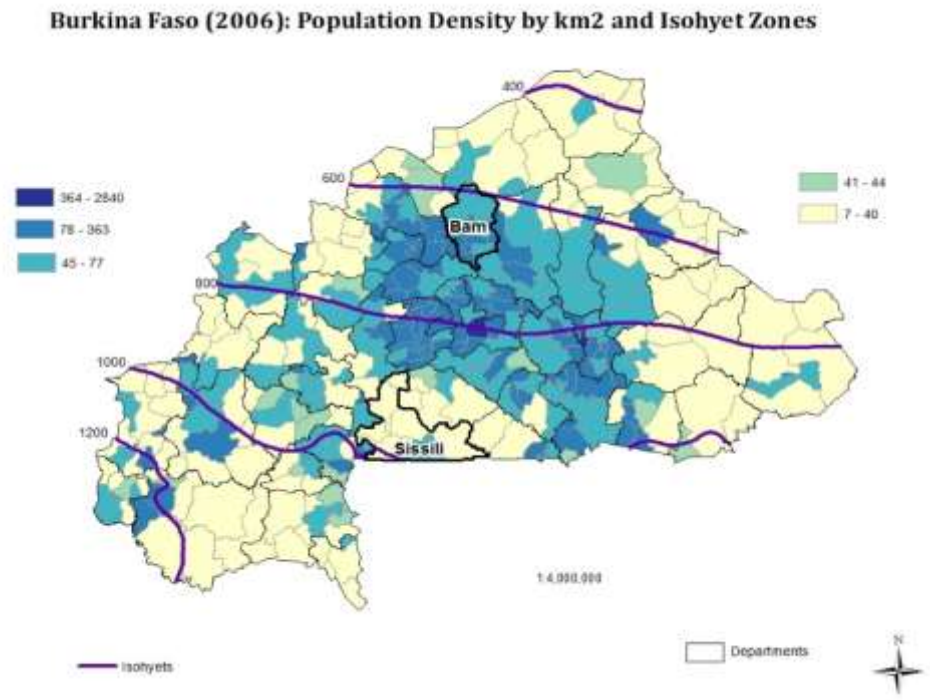
This research addresses this gap through a comparative case study of LULCC and migration dynamics in Bam and Sissili Provinces. Specifically, this study first assesses whether these two provinces are either migration sources or sinks. Census data from 1975 through 2006

are used to establish the number of in-migrants, out-migrants and net migration for each province. Next, this study evaluates the relationship between migration and LULCC. I hypothesize that LULCC is greater in zones of in-migration and lower in zones of out-migration. While land cover can be visually observed on-site or through remote sensing, the use of natural and social scientific methods is essential in examining land use and its changes usually shaped by subsistence systems (Ellis 2013). Consequently, this research uses environmental (LULC GIS data from 1975 and 2000 and 1992 and 2002), demographic (1975, 1985, 1996 and 2006 lifetime migration records), and ethnographic (summer 2014 fieldwork) data to compare the two provinces.

As a unique and multi-scale approach, regional political ecology can shed light on local and non-local historical, cultural, socioeconomic, and political processes operating at different scales and times to shape subsistence relations. Cumulative LULCC, linked to global ecological changes such as climate change, also have local and regional impacts. Hence, examining the proximate causes of LULCC only at the local level is incomplete because the processes involved in LULCC operate across many spatial and temporal scales (Turner et al. 1993). This study addresses the issue of scale by drawing on previous social and ecological research on the Sahel of West Africa in general and Burkina Faso in particular to understand local changes in Bam and Sissili.

CHAPTER 2: LITERATURE REVIEW

As a semi-arid country located in Sahelian West Africa, the constraints of its physical environment constitute a major obstacle to the socioeconomic development of Burkina Faso. The Sahel has a semi-arid climate and a rainfall estimated at about 100 mm in the north to 600 to 1000 mm in the south (UNEP 2012). In the 1960s, average rainfall in the Sahel region of Burkina Faso was around 700 mm, but recurrent droughts between 1970 and 1980 decreased average rainfall to 550 mm (Reij et al. 2005). Between 1975 and 2000, savanna, the major land cover type in the country, declined by 13.6% while cultivated areas increased by 50.2% (Tappan 2013). Between 1994 and 2003, rainfall increased, but it was still less than the recorded wetter trends from 1930 to 1965 (Anyamba and Tucker 2005). Emphasizing this natural hardship, popular journalism often portrays Burkina Faso in terms of "low agricultural potential, high risk of destructive topsoil erosion, susceptibility to severe seasonal food shortages, and occasional famine" (Batterbury 1997:8). In the 1970s, highlighting the expansion of barren and denuded land exacerbated by unsustainable extensive agricultural practices and high population densities (50 to 100 people per km^2), Jean-Yves Marchal (1983:54) states that in the northern part of the country, there is "no more space". During this period, the limited availability of cultivable land in this area has not led to a shift to intensive agriculture. Intensification is " an increase in the effort expended per unit area, to increase total output per unit area and over time" (Batterbury 1997:6).



Map 1: Burkina Faso (2006): Population Density by km2 and Isohyet Zones

Consequently, Marchal argues that contrary to what Ester Boserup (1987) predicted, intensification has not been used as a way to adapt to population growth before the 1970s. However, after this period, the transition of Mossi farmers to intensive agriculture actually confirms Boserup's argument. The Mossi, major ethnic group of the country and key migrants to the southern valleys, have continued to practice extensive agriculture using traditional methods such as hand cultivation. Between 1950 and 1980, extensification persisted and animal-drawn ploughs were used to expand cultivated lands rather than being used for agricultural intensification (Reij et al. 2005). The Mossi, as depicted by Marchal, are reluctant to intensify agriculture although they have opportunities to practice it. Migration to Côte d'Ivoire, Ghana, and the southern river valleys of Burkina Faso, free of onchocerciasis (river blindness), have been a preferred strategy to overcome food insecurity in this region.

During the pre- and post-Independence eras, coastal countries such as Ghana and Côte d'Ivoire were used as "reserves" for colonial powers and post-colonial industrialized nations. The development of these "reserves" created a call for free and cheap labor (Meissalloux 1975), siphoning able-bodied young men from drylands such as Burkina Faso, considered as "non-viable peripheries" but rich in manpower (Songré et al. 1974). The Mossi, historically known as "land conquerors" (Marchal 1983), were more inclined to respond to the call for labor in coastal countries because of reduced land availability, declining agricultural productivity, limited off-farm opportunities, high population densities and increased food insecurity in the Mossi plateau. In 1914, Mossi migration to Ghana was not only a "voluntary" strategy to escape military recruitment for World War I and forced labor, but also a way to gain income to pay head taxes to France (Cordell et al. 1996). In contrast, their forced migration towards Côte d'Ivoire was stimulated by the need for labor in cocoa plantations and public works such as transportation systems linking French West African colonies (Songré et al. 1974). In 1946, forced labor was abolished, making migration a "voluntary" choice. However, if it can be "true that migrants vote with their feet, the choice of paths is determined by forces in the larger system beyond their control, and may not be in the interests of their household and communities, or, therefore, in their own long-term interests"(Cleveland 1991:240). Therefore, the paradox is that "voluntary" migration is actually a response to the only viable alternative open to the Mossi in times of environmental hardship.

By the 1980s, these migration have reshaped the economy, demographics, and land use patterns of the center-north and southern provinces. The center-north regions "differed from the rest of the country with relatively low rates of economic activity, lower percentages of males in

the population, a low representation of people aged 15–64, and a high percentage of cultivated area" (Henry et al. 2003: 119). Marchal states:

> "Peasants prefer buying bicycles than plows. They escape […] to come back with motorbikes and leave again after selling them. These people, who claim that they do not have money to invest in agricultural means of production (that would promote their living standards and remain at home) have chosen to either settle somewhere else, or stay at home but by relying on external income. The system works. It is not blocked; it has dilated to cover a wider space" (1983:814).

In order to overcome the environmental, economic and social challenges of the northern regions of the country, the government of Burkina Faso has been promoting internal migration from more degraded and highly populated provinces to less degraded and less populated ones (McMillan 1983). In the 1970s, Della McMillan et al. (1993) explain that the state of Burkina Faso, as the legal proprietor of any "unoccupied", "underpopulated" or "unimproved" land, launched the programs *d'Aménagement des Bassins de la Volta* (Volta Valley Authority or AVV). These programs aimed to voluntarily relocate people from drought affected areas towards southern river valleys which were more productive but underpopulated. Sabine Henry et al. (2003:124) argue that two environmental variables likely to influence migration are "crop yields, as a function of rainfall, and land availability for cultivation". In general, population density in the major river basins of Burkina Faso was very low because of the presence of onchocerciasis. The World Health Organization (2015) defines onchocerciasis as a parasitic disease caused by the repeated bites of *Onchocerca volvulus*, a filarial worm. This worm breeds in remote villages with fertile agricultural land usually along rivers and streams. However, in Sissili (which counted less than 20 inhabitants per km^2 in river valleys), low population density was explained by the fact that rivers served as barriers against external invaders and living far from them was a survival strategy for communities (Duperray 1984).

The AVV project, McMillan (1983) clarifies, has contributed in promoting local, regional, and national development goals. This resettlement program has not only addressed the Central Plateau's pressing economic, environmental, and demographic issues, but also the declining position of Burkina Faso's cotton production and international trade. To overcome this decline in production, the AVV has promoted intensive agriculture in resettlement areas as a way to boost cash crops and move beyond subsistence agriculture in the southern lands. To make these programs viable, actions were taken to eradicate onchocerciasis since it was the major barrier to migration in these river valleys. To integrate the AVV programs, farmers were required to sign an agreement stating their willingness to adopt the following cultivation practices: 1. A delimited total cultivable area per worker to control extensive practices; 2. The assimilation of new production practices such as monocropping and an ox-drawn plow after the second year in the settlement; 3. The utilization of chemical fertilizers and pesticides and the integration of new high yields varieties of seed; 4. The restriction of tree-cutting from AVV land and the promotion of on-farm tree planting and reforestation. McMillan's case study of AVV settlements shows that migrants who integrated the AVV before 1979 had unsecure land tenure in their home village. Borrowed land can become unproductive throughout the years and might be taken away in times of scarcity or famine. Thus, land insecure farmers, who were the most affected by the droughts, welcomed the AVV project because they had few other livelihood strategies but to migrate. In *Settlement and Development in the River Blindness Control Zone: Case Study of Burkina Faso,* McMillan et al. (1993) mapped the AVV planned settlement locations between 1973 and 1984. The map shows that although Sissili has not officially hosted an AVV settlement, the province was surrounded by settlements in Nahouri (another Gurunsi homeland) and Zoundwéogo. The

proximity of Sissili to these settlements could explain intensive migration in the province during the AVV programs.

In the southern river valleys, rapid population growth, land degradation, and vegetation loss followed this migration (Ouedraogo et al. 2010). Substantial changes in these valleys confirms Henry et al.'s argument that "migration driven by rapidly changing environmental factors are likely to be more massive and rapid than migrations driven by slower socio-demographic changes" (2003:117). In the 1985 census, according to Henry et al., population in certain southwestern areas have doubled compared to previous censuses, creating issues related to land and social infrastructure access: the highest rates of in-migrants were recorded in provinces such as Sissili (4.88%), Kadiogo (3.36%), Bam (2.60%), Bazèga (2.53%) and Mouhoun (2.20%) (2003:120). While this migration was taking place toward the south, poor living conditions and land degradation in the north spurred the attention of international organizations and the implementation of dryland soil and water conservation (SWC) projects. Examples of SWC techniques are contour stone bunds (known as '*diguettes*'), semi-permeable dikes, and *zaï* pockets (West et al. 2014). These projects aimed to improve rural livelihoods by "[rehabilitating] the productive capacity of the land through better control of rainfall and runoff, as well as through improved soil fertility management and reforestation" (Reij et al. 2005:643). Will Critchley explains that these projects emerged during the colonization era and continued after the independence in the 1960s:

> "Concern about soil conservation is nothing new in Africa […] In the British-ruled territories soil conservation became a major issue during the 1930s […] But the majority of these schemes were resented by the local people, who were forced to supply labour […] Soil conservation was seen as being a form of colonial oppression. It is not surprising then that independent Governments found it difficult at first to support soil conservation programmes. When conservation projects did begin to reappear, many of the same old mistakes were made again. Until very recently there has been a long list of soil conservation failures"(1991).

Initial SWC projects have failed when local communities were considered as the problem rather than the solution for improved soil conservation. Learning from the failure of such projects, PATECORE (*Projet d'Aménagement des Terroirs et Conservation des Ressources*) successfully built on diverse local knowledge to create sustainable adaptation and mitigation SWC techniques. While farmers were encouraged to improve traditional planting pits or *zaï*, non-governmental organizations' technicians focused on contour stone bunds (Kaboré and Reij 2003). *Zaï,* one of the most successful techniques, are improved traditional pits created on farms at the beginning of the rainy season to store water and organic matter for improved soil fertility (IFAD 2011). Combined, these SWC measures have improved rural livelihoods. Reij et al. (2005) argue that since the mid-1980s, investments in SWC has reversed yields decline and activated agricultural intensification. These projects have become successful and sustainable when they started combining modern conservation techniques with traditional practices.

While soils and vegetation in the north were being restored by SWC, soil and water rehabilitation initiatives were nonexistent in southern areas. As a legacy to the AVV and structural adjustment programs, agricultural entrepreneurship, going from commercial production of cotton to fruit-tree plantation and ranching for global markets, boomed in the Sissili. Consequently, mainly richer farmers could afford costly production inputs. While the practices of both poorer and wealthier farmers influence environmental degradation, Leslie Gray and William Moseley (2004) assert that poverty has been wrongly accused for degrading the environment. According to these authors, wealthier farmers are usually perceived as more engaged in conservation initiatives while poorer farmers do no fallow land or are less involved in conservation techniques on their poor quality lands. However, these differences result from larger unequal land tenure and credit systems in which farmers are less likely to invest in

conservation when land tenure is unsecure. Gray (2005) explains that richer farmers, who can invest in soil quality, are less concerned with tree density than poorer farmers who value tree density as a natural sign of land fertility which requires less investment in soil quality. Soil nutrient analyses indicate that fields with higher levels of animal traction and fertilizer have lower fertility levels than fields without. Nonetheless, while poorer farmers' practices mitigate environmental degradation, their lower participation in intensification has negative subsistence and economic development costs. Sadly, many development and land conservation projects have failed to consider these parameters as well as external factors that influence LULCC. Even though researchers have separately studied the interactions among population density, migration, agro-silvo-pastoral activities and deforestation, this study offers a controlled comparison of two case studies. Marchal (1983) argues that northern territories are in mutation and cannot be analyzed outside of migration flows and destination areas. Since lifetime migrants are individuals who relocated to an administrative entity other than their birth place (Dabiré et al. 2009; Tarver 1992) regions of origin and destination ought to be put in perspective.

CHAPTER 3: DESCRIPTION OF SITES AND COMMUNITIES

A. Bam

Covering an area of 4 064 km² (Lopez-Escartin 1992) in the Center-North Region of Burkina Faso, the Bam province records between 500 mm and 700 mm of annual rainfall. Its Sudano-Sahelian landscape is characterized by steppe, savanna, agricultural lands, and bare soil. Lake Bam, from which the province owes its name, is the largest natural lake in the country. Millet and sorghum are the principal crops and animal husbandry is practiced by wealthier households. Like other provinces in northern Burkina Faso, Colin Thor West (2013) explains that Bam is identified by the Famine Early Warning System (FEWS) as one of the most food insecure areas of the country. FEWS classifies the severity of food insecurity from Minimal, Stressed, Crisis, Emergency to Famine. This classification is based on poor food production and households' reliance and vulnerability to market prices. This awareness explains the intensive presence of non-governmental organizations (NGOs) dedicated to SWC and food security projects in the capital, Kongoussi. The *Marché de Kongoussi*, interconnected to Ouagadougou by improved dirt roads, facilitate flows of livestock from northern areas to southern urban areas and neighboring countries such as Côte d'Ivoire and crops circulation from southern valleys to drought prone areas of the north. This province is one of the homelands of the Mossi and listed among the most degraded Sudano-Sahelian provinces of the country.

B. Sissili

Occupying an area of 7111 km² (Pare, et al. 2009) in southern[1] Burkina Faso, the Sissili recorded an annual rainfall mean of 883 mm between 1975 and 2007 (Ouedraogo 2010) and 648 mm to 1382 mm between 1920 and 1971(Duperray 1984). This amount is among the highest in the country. The major LULC classes of Sissili are savanna, agricultural land, and gallery forest. Soils in the Sissili are ferruginous on sandy clay materials sensitive to erosion, but more humid and fertile for agriculture than those of Bam. Sissili features three rivers: the Mouhoun (*Volta Noire*), the Nazinon (*Volta Rouge*) and the Sissili River, to which the province owes its name. Off-farm activities vary among formal employment, trade, handicraft and arts, and fisheries. A major paved road links its capital Léo to Ouagadougou. The *Marché de Léo*, close to the borders with Ghana, is one of the major commercial centers between Ghanaian and Burkinabè traders. The major crops are yam, cassava, sweet potatoes, corn, sorghum, rice, cotton, niébé (variety of black-eyed peas), peanuts, voandzou, and sesame. There are several ethnic groups, which include the Nuni and Sissala, known as Gurunsi and considered as autochthonous of the Sissili, share their homeland with the Mossi and Fulani.

C. The Mossi and the Gurunsi: past and present bonds

Though some Mossi migrants have relocated to the Sissili following the AVV projects, Mossi presence dates from the colonization era when Mossi kingdoms raided and invaded Sissili for slaves and space (Duperray 1984). As a legacy to these invasions, in Sissili, certain *chefs de terre* (or "earth priests," usually descending from the first occupant of a village and who handle land tenure issues) are Mossi. Since the 15th century, the expansion of Mossi kingdoms, known as

[1] Sissili, located south of Ouagadougou, is currently part of the Center-West region. This has not always been the case. To avoid any confusion related to the changing administrative organization of Burkina Faso, this paper simply refers to Sissili as a southern province.

'mossification", consisted in "annexing other, often stateless, peoples at the edges of Mossi polities" (Finnegan 1996). Although the term "Gurunsi" is commonly used to refer to the inhabitants of Sissili as one ethnicity, Louis Tauxier (1924) argues that the term "Gurunsi" was used by the Mossi, in *Mooré* (the language of the Mossi), to refer to neighboring autochthonous, acephalous and homogenous communities fully or partially dominated by the Mossi. This term was also used by the Mossi to define their neighbors at the west of the Nazinon as primitive and barbarous. The Nuni and Sissila of Sissili, the Kasséna of Pô and Tiébélé, the Léla of Réo, Ténado, Didyr, among others, fall within the category of Gurunsi. The Mossi, Anne-Marie Duperray explains, still pejoratively use the word "Gurunsi" to define an individual as "primitive", "savage", "non-civilized", or worse, a "thief" (1984:26). However, since national independence, the government has been using this name to refer to the autochthonous communities of Sissili, Réo, and Pô, as one single, coherent and independent ethnic group similar to the Mossi.

CHAPTER 4: DATA AND METHODS

A. Census data

The National Institute of Statistics and Demography (INSD) collected lifetime net migration data from 1975, 1985, 1996 and 2006 for Bam and Sissili during national censuses. Time spent out of one's birth place determines migrant status. INSD defines a person as a migrant when this person's place of residence (household location or "concession") differs from his or her place of birth. A lifetime migrant is an individual who relocated to an administrative unit other than their birth place (Dabiré et al. 2009; Tarver 1992). Lifetime migration data was used instead of short-term migration because short-term migration is more seasonal, difficult to track and its long-term impacts on LULCC might be lower compared to lifetime migration. Net migration is the difference between in-migration and out-migration (net migration = number of in-migrants – number of out migrants) of a given population at a specific moment in time (INSD 2013). Net migration is negative when the number of out-migrants exceeds the number of in-migrants (OECD 2005) and positive when the number of in-migrants exceeds the number of out-migrants.

In the 1975 census (1978:100), to identify migration status, surveyors inquired about people's place of birth as well as their actual residency status and whether or not they spent more than six months abroad in the five years preceding the census. However, in the 2006 census, Dabiré et al. (2009) explain that people were asked for their residency information in the twelve months before the census. In addition, in order to obtain out-migration data from a province, surveyors questioned the residents of this specific province about the residence status of their closest

relatives. Yet, collecting data from a third party has not always been inaccurate in tracking out-migrants' departure dates and destinations. Indeed, it is only the out-migrant himself who knows his final destination. While certain family members failed to declare some of their relatives, others were declared more than once. In some cases, the undeclared people were either missing or forgotten during the surveys. In other cases, they were intentionally unaccounted for when they committed criminal offenses and are hiding from justice. Therefore, INSD recognizes that this situation negatively influenced out-migration data quality.

In the INSD censuses, residency status is defined at all geographical scales while birth place is defined by "prefecture". In the 1975 census, people were asked to list their birth place by "prefecture", but data was analyzed based on departments. A "prefecture" in Burkina Faso is considered as one of the most stable and familiar administrative units in the country. In the 2006 census, Dabiré et al. (2009:28) highlight that the major change has been the use of "commune", instead of "prefecture," as the smallest unit in identifying birth place. However, considering the high number of "prefectures" and "communes" (more than 300 "communes" in 2006), data was analyzed by INSD based on "departments" in 1975 (there were 10 departments in 1975), provinces in 1985, 1996 and 2006 (there were 30 provinces in 1984 and 45 provinces in 1997) (29-30). In Table 2, the author used this migration data by province in 1985, 1996, and 2006 to calculate percentages of in-migrant from Bam and Sissili in major destination areas such as Kadiogo, Houet, Kossi, Sissili, and Mouhoun. The author also calculated percentage of out-migrants from Bam and Sissili going to these major destinations compared to total out-migrants from Bam and Sissili. Nonetheless, in 1975, net migration data was aggregated by administrative region (as shown in Table 1) with no discrete dataset for the Sissili and Bam provinces. Consequently for the 1975

data, for analytical purposes, the author used migration information for Kongoussi and Léo departments, currently capitals of Bam and Sissili respectively.

One of the challenges to gathering information on migrants' place of origin and residency, Dabiré et al. point out, is that respondents (concerned individuals and third persons) might know the name of their village of birth or residency, without knowing the name of the former or newer higher administrative unit linked to that specific village. These issues are exacerbated by high illiteracy rates in rural areas. In order to complement the limitations of the migration data, the author incorporated remote sensing and GIS data.

Table 1: Administrative regions of 1975

Administrative regions	**Center-West**	**Center-North**
Departments	Koudougou, Kindi, Kokologho, Nanoro, Sabou, **Léo**, Fara, Réo, Didyr, Ténado, Pouni, Yako, Arbollé, Bagaré, Samba.	Barsalogho, Boulsa, Tougouri, Kaya, Boussouma, Korsimoro, Mané, Téma, **Kongoussi**, Tikaré, Pissila.

Source: (INSD 1978)

B. Geographic Information Systems (GIS) data

1. Land Use and Land Cover (raster): 1975 and 2000

Remote sensing specialists of West Africa collected and analyzed the Burkina Faso Land Use and Land Cover Maps and Trends dataset (BF-WALULCT) as part of a comprehensive satellite data archive of West Africa Land Use and Land Cover Trends for AGRHYMET (Tappan 2013). This BF-WALULCT raster data was run into ArcGIS 10.2, projected to Abidjan 1987 UTM Zone 30N and clipped to the boundaries of Bam and Sissili. The author tabulated and summarized area statistics of each land cover class in each province in 1975 and 2000 and created LULCC charts based on the following legend: forest, savanna, wetland, steppe, plantation, agriculture, water bodies, rocky land, bare soil, settlements, irrigated agriculture, and gallery forest.

2. Land Use and Land Cover (vector): 1992 and 2002

The *Institut Géographique du Burkina* (IGB) developed a vector-based dataset on land use and land cover (BDOT) for 1992 and 2002 based on satellite imagery. This dataset is formally called *Guide Technique de la Nomenclature BDOT: Burkina Faso* with 44 LULC classes, an effective resolution of 1/200,000 and a smallest spatial unit that varies between 5 and 25 hectares (IGB 2005). The collection for IGB's LULC data was inspired by the methodology of the European Coordination of Information on the Environment (CORINE) Land Cover guide. This methodology uses common spatial data collection and analysis techniques among regions to make comparison consistent. IGB's data was aggregated into fewer classes in ArcGIS to match BF-WALULCT's data and enable direct comparison between 1975-2000 and 1992-2002 results. Every map was projected to Abidjan 1987 UTM Zone 30N; area statistics for each land cover class was summarized for each province in 1992 and 2002; and LULCC charts were created.

C. Ethnographic fieldwork

Local ethnographies and ecological fieldwork offer a powerful complementary lens for understanding local human-environment complex interactions behind the pixels (Jiang 2003). Ground truthing, more specifically through a modified Participatory Rapid Rural Appraisal (PRRA) method, provides insights from local people about local conditions (Chambers 1994). This approach provides important contextual information on ecological conditions and human-environment interactions in a timely manner. In order to ground truth the LULCC data for Bam and Sissili, the author travelled to Burkina Faso from July to August 2014 with her advisor Colin Thor West. Fieldwork entailed meeting with experts in environment, food security, and demography from FEWS, INSD, the West African Science Service Center on Climate Change and Adapted Land Use (WASCAL), National Population Sciences Institute (ISSP), Access to Energy

Services Project (PASE), and *Bureau National des Sols* (BUNASOLS) in Ouagadougou. In Kongoussi and Loulouka, four interviews were conducted with a farmer, a town elder (who provided an historical view of LULCC) and two experts in land conservation. In Léo, two farmers, a water and forest agent at the provincial ministry of the environment, a government official, a land tenure specialist, and a coordinator at the ministry of agriculture were interviewed.

In these institutions, the team solicited responses to aerial and satellite photos from 1982 to 2006. During the interviews with the farmers, we experimented with an interactive participatory approach using printed maps and Google Earth imagery on tablet device and a computer. At the beginning of the exercise, the participants were trained to recognize major roads and buildings on the map. Then, they were asked to locate specific farming, barren and rehabilitated lands as well as water bodies and forests in the province. Lastly, the farmers were asked to explain LULCC trends on these specific lands throughout time from their own frame of reference. Information about rainfall changes, food insecurity, land tenure, determinants of on-farm tree planting, and migration were collected. Interviews were conducted in Mooré and French and notes were written in a notebook. These notes were then transcribed.

CHAPTER 5: RESULTS

A. Census

Figure 1 below suggests that net migration is positive in Sissili. Yet, this trend has decreased drastically and steadily from 1985 to 2006. For Bam, on the other hand, net migration was negative between 1985 and 1996 and positive between 1996 and 2006. In 1985, the large majority of the migrants to Sissili came from Boulkiemdé, Kadiogo, Oubritenga and Passoré (Drabo et al. 2003:61). The same year, Table 2 illustrates that Sissili was the primary destination of people migrating out of Bam (16.34%), followed by Kossi, Houet, Kadiogo and Mouhoun. During this period, out-migration increased slightly in Bam and the province recorded its highest out-migration rates in 1985 and 1996. In terms of total in-migrant population within each province, Kossi counts more people coming from Bam (7.37%) than Sissili where people coming from Bam constitute 6.87% of the total in-migrant community. Based on this analysis, Bam has been a net migration source and Sissili a sink. This is particularly true in the 1985 and 1996 censuses. In 1985, more precisely, Sissili was a prominent destination for migrants from Bam, but information on migration flows is not available in other censuses. The 2006 census data shows evidence that changing patterns in migration flows is underway for both provinces. In fact, Table 3 displays that between 1996 and 2006, Bam (and also its surroundings) dramatically shifted from a negative to a positive net migration. But how does this migration pattern correlate with LULCC trends?

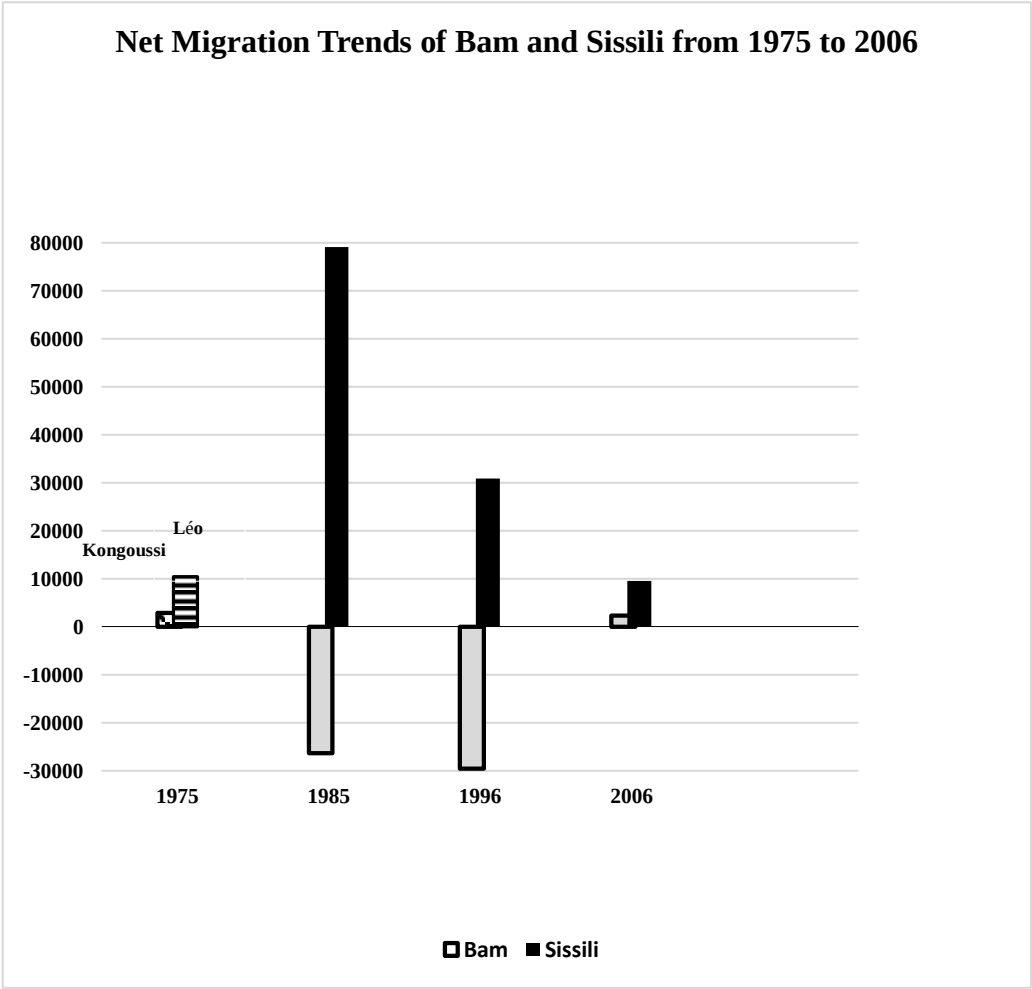


Figure 1: Net Migration Trends of Bam and Sissili provinces from 1975 to 2006

Data Source : (INSD 1978:Tableau 46); (Drabo et al. 2003:60&62); (Dabiré et al. 2009:118)

Table 2: Origin and destination of lifetime in-migrants by province in 1985

Origin	Destination					*Total out-migrants*
	Kadiogo	Houet	Kossi	Sissili	Mouhoun	
Bam	3311	5368	5499	6212	1878	*37998*
Percent to total in-migrants	**1.81%**	**3.01%**	**7.37%**	**6.87%**	**2.78%**	
Percent to total out-migrants	***8.71%***	***14.12%***	***14.47%***	***16.34%***	***4.94%***	
Sissili	3376	1297	62	N/A	851	*11577*
Percent to total in-migrants	**1.85%**	**0.72%**	**0.08%**	**N/A**	**1.25%**	
Percent to total out-migrants	***29.16%***	***11.20%***	***0.53%***	***N/A***	***7.35%***	
Total in-migrants per province	182,068	177,873	74,544	90,687	67,545	

Data Source: (Drabo et al. 2003: 61)

Table 3: Lifetime Net Migration in Bam and its Surrounding Provinces in 1985, 1996 and 2006

Census period	**1985**	**1996**	**2006**
Bam	-26325	-29549	2312
Namentenga	-6373	-11450	3299
Sanmentenga	-73275	-64032	-5611
Yatenga	-153089	-91889	-249

Data Source : (Drabo et al. 2003:60&62) and (Dabiré et al. 2009:118).

B. Geographic Information Systems (GIS) maps and graphs

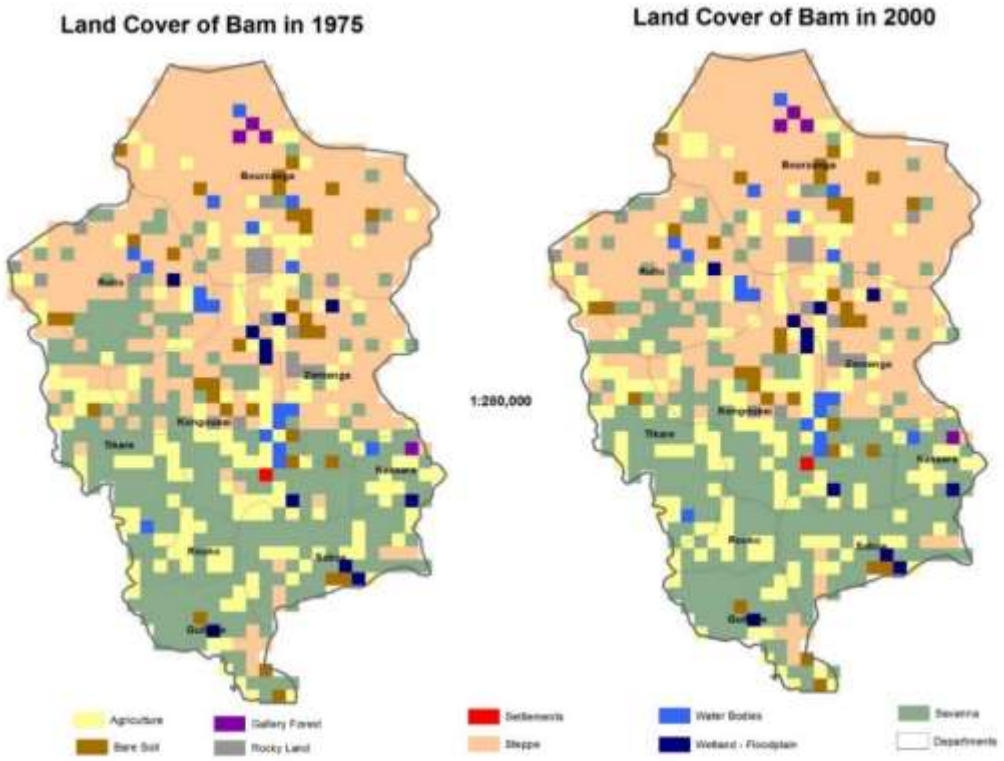
Even though land degradation has driven severe migration out of Bam until the 1990s, in Sissili, in-migration has often been listed as one of the major causes of negative net LULCC (Ouedraogo, et al. 2010). Since land cover conversion from one class to another is the product of long-term processes, any LULCC analysis needs to incorporate and compare short and long term change dynamics. Consequently, this paper compares LULCC data over 10-year and 25-year

periods. These two datasets roughly correspond to periods in the census on migration. Overall, maps 2, 3, 4 and 5 and figures 2, 3, 4 and 5 illustrate that from 1975 to 2002, Burkina Faso has experienced dramatic LULCC, especially increasing agricultural land. The expansion of agricultural land and steppe in the Central Plateau and the north is "modest" and stable compared to other areas (Tappan 2013).

LULCC over a longer period of time: 1975 to 2000

a) Bam

Map 2 and Figure 2 illustrate that between 1975 and 2000, in Bam, steppe and savanna decreased by 1.4% and 0.6% respectively while agricultural land and bare soil increased by 1.8% and 0.2%. Other LULC classes such as water bodies, wetland, gallery forest and settlements remained unchanged.



Map 2: LULC maps of Bam in 1975 and 2000

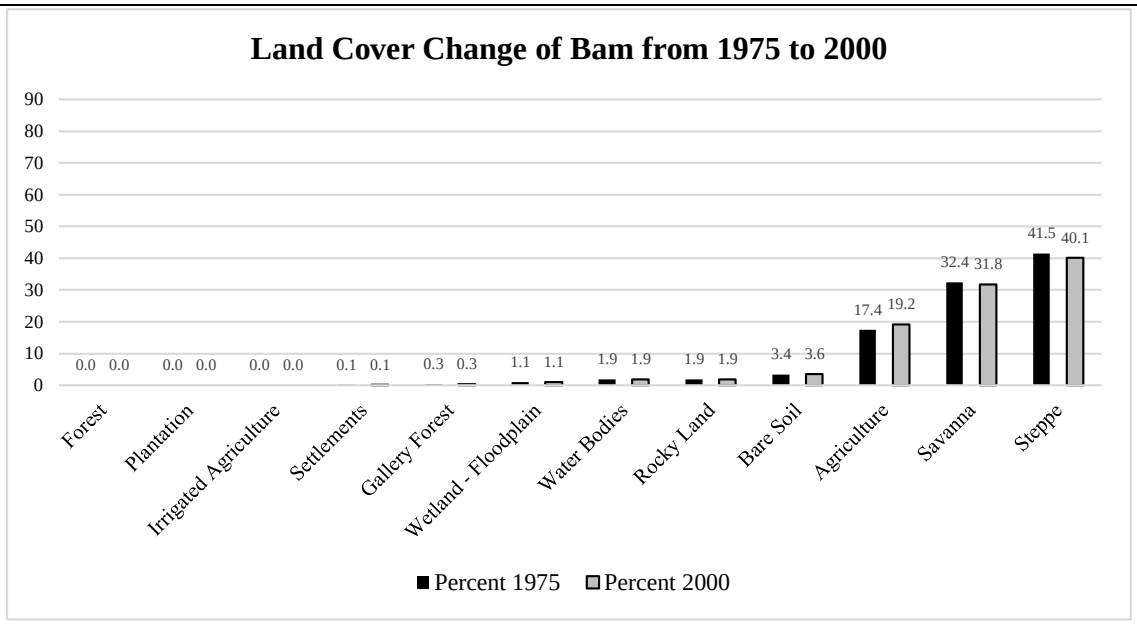
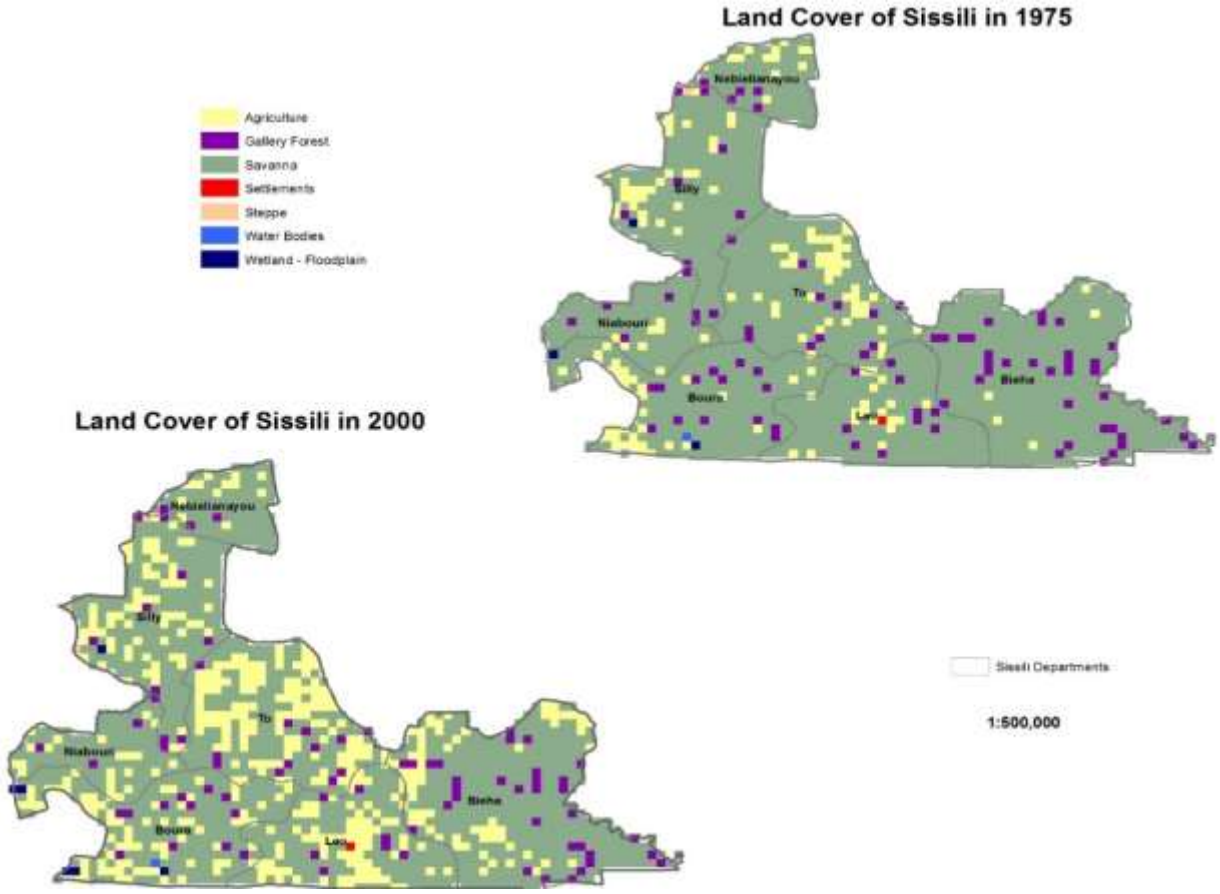


Figure 2: LULCC chart of Bam from 1975 to 2000

b) Sissili

Map 3 and Figure 3 demonstrate that between 1975 and 2000, in Sissili, while savanna and gallery forest decreased by 15.9% and 0.6% respectively, agriculture increased by 16.3%. Other LULC types such as steppe, water bodies, and settlements remained unchanged but wetland increased by only 0.1%. Figure 4 and 6 show that in Sissili, LULCC over a long period of time is more significant compared to LULCC over a short period of time.



Map 3: LULC maps of Sissili in 1975 and 2000

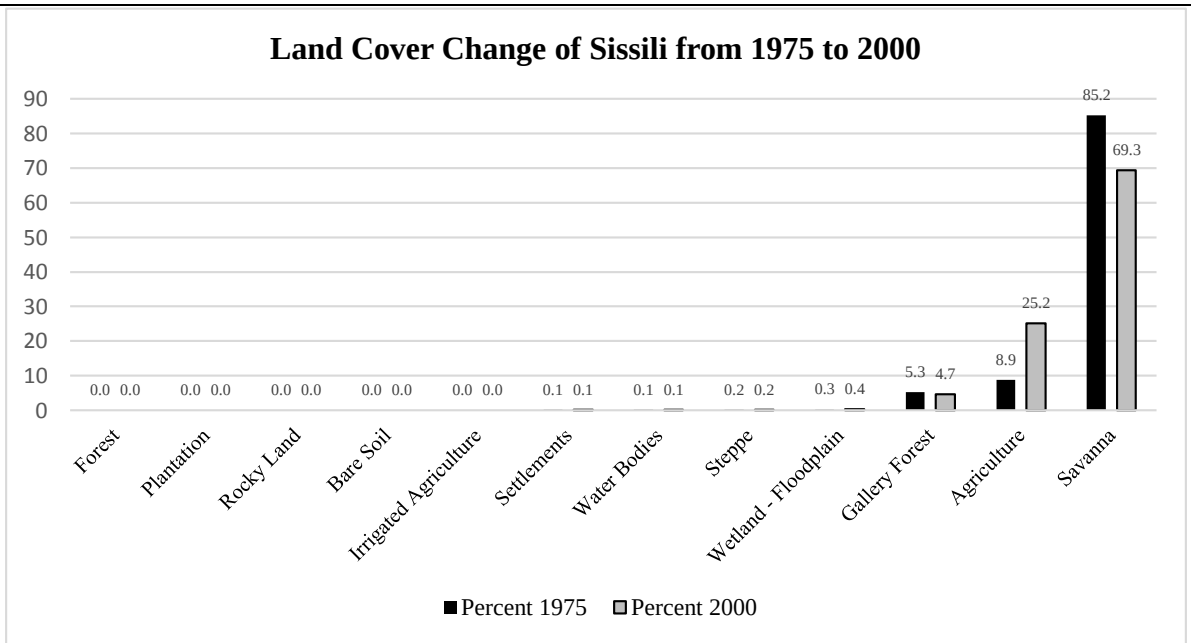
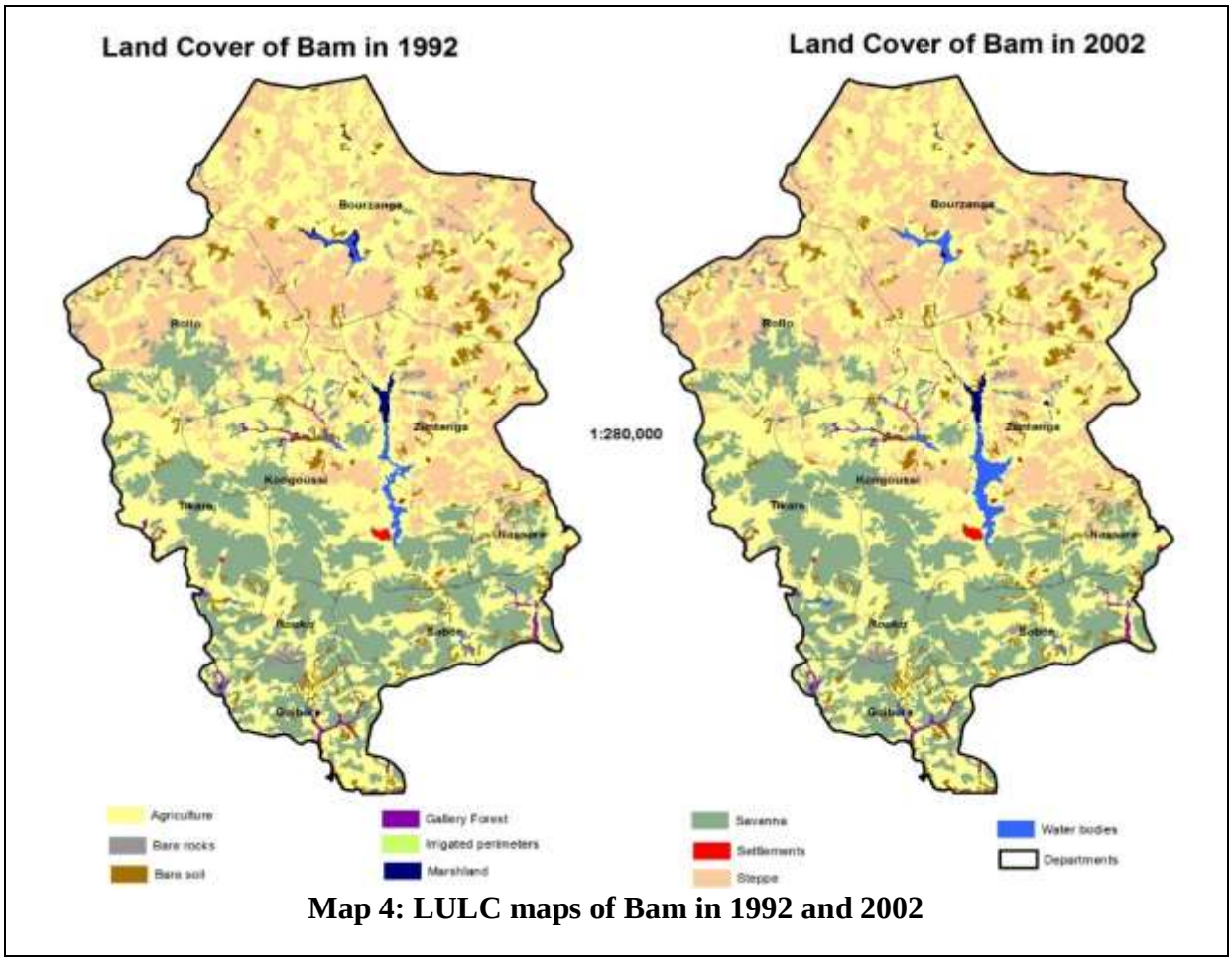


Figure 3: LULCC chart of Sissili from 1975 to 2000

1. LULCC over a short period of time: 1992 to 2002

a) Bam

Map 4 and Figure 4 show that between 1992 and 2002, in Bam, steppe decreased by 1.4% while agriculture land and water bodies respectively increased by 0.8% and 0.4%. Savanna, bare soil and bare rocks slightly increased by 0.1% and marshland declined by 0.1%. Settlements and gallery forest did not change.



Map 4: LULC maps of Bam in 1992 and 2002

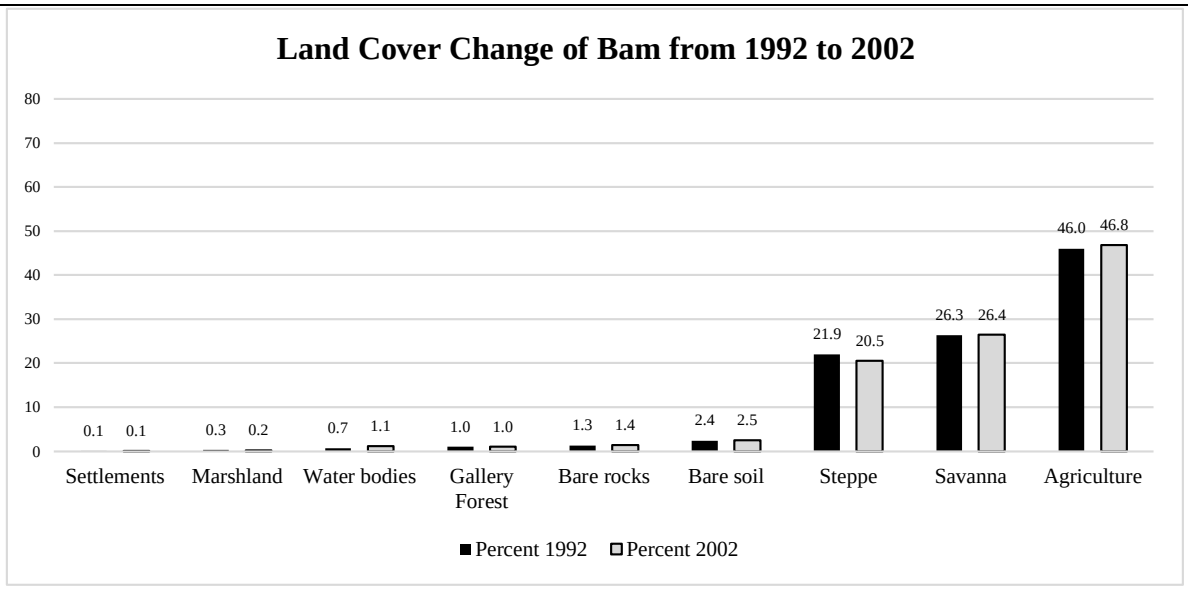
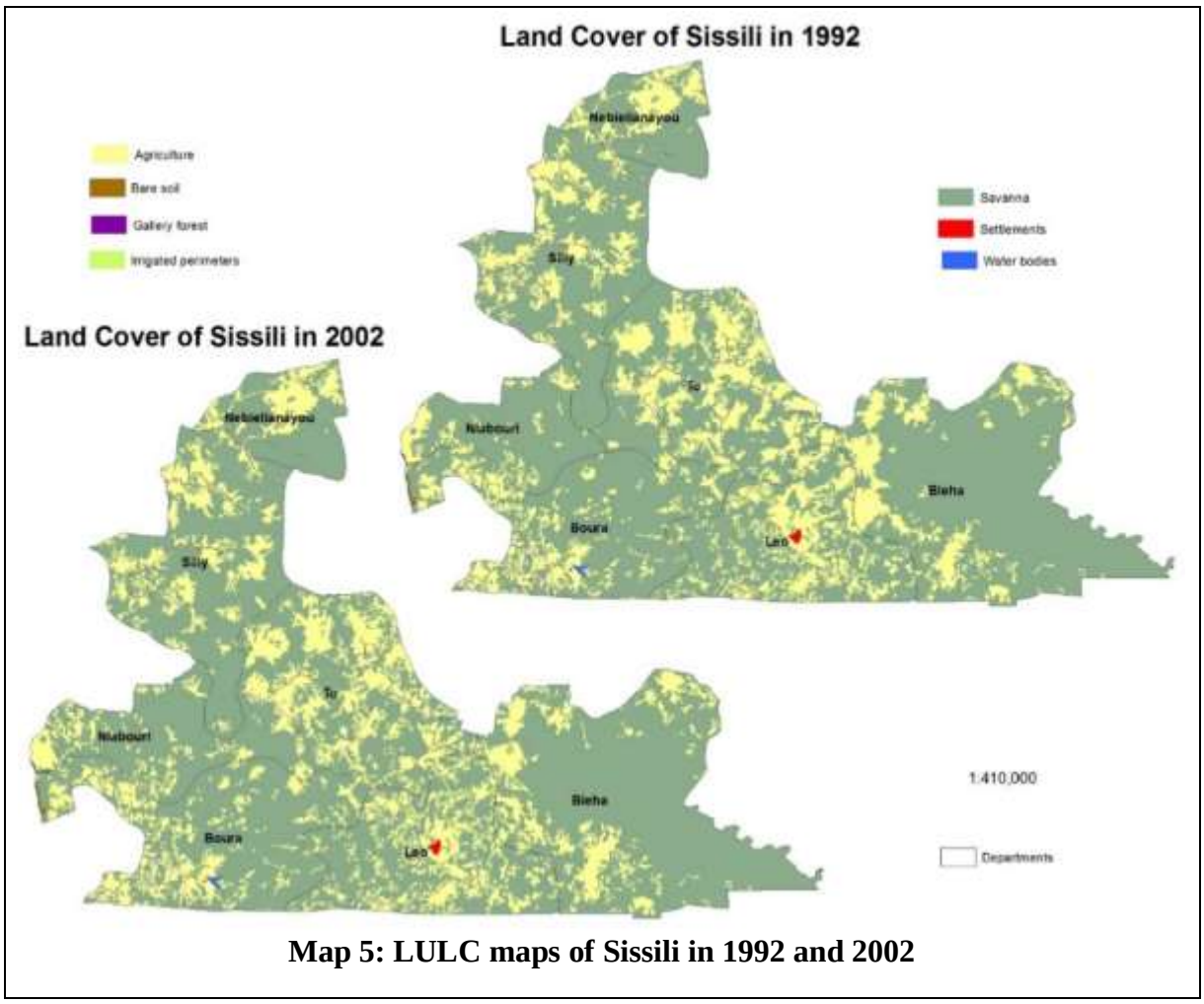


Figure 4: LULCC chart of Bam from 1992 to 2002

b) Sissili

Map 5 and Figure 5 indicate that between 1992 and 2002, in Sissili, savanna decreased by 1% while agricultural land and forest increased by 0.9% and 0.1%. The other LULC classes remained unchanged.



Map 5: LULC maps of Sissili in 1992 and 2002

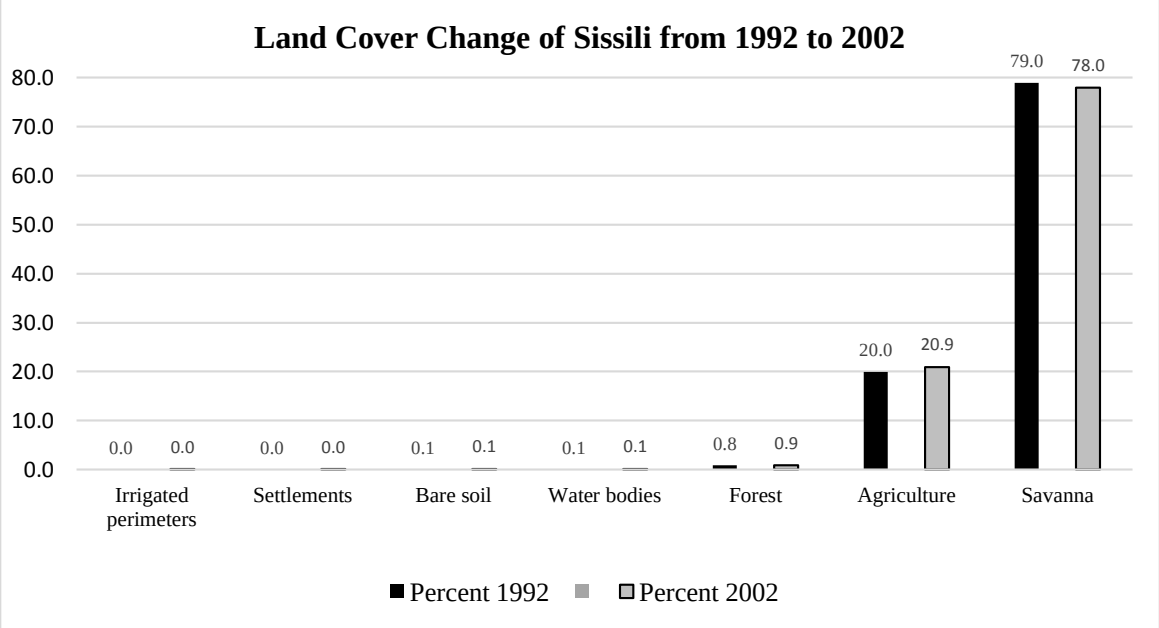


Figure 5: LULCC chart of Sissili from 1992 to 2002

As a summary, figures 2, 3, 4 and 5 show that LULC differences between a long (1975-2000) and shorter time (1992-2002) frame is not significant in Bam. However, these figures demonstrate that changes in agricultural land is higher over a longer time frame compared to a shorter one in this province. Between 1975 and 2000, in Sissili, LULCC is characterized by the intense loss of savanna and the extension of agricultural land. However, between 1992 and 2002, the province only recorded a slight decline of savanna and minimal increase in agricultural land. The ethnographic data provides some local explanations for these LULCC trends.

C. Ethnography

1. Participants focused on regions of degradation and greening

The author and her advisor talked to experts in Burkina Faso about national trends. These experts perceived land degradation as localized. During the interviews, our participants tended to list the causes of land degradation by regions within Burkina Faso. Within Burkina Faso, the underlying and proximate causes of LULCC differ from one area to another and its patterns and amplitude also vary. While experts described northern Burkina Faso as "browner" migration sources with lower land availability, southern and western provinces were considered as "greener", but degrading migration sinks. An expert asserts:

> "The Sahel is invaded by agricultural lands making it difficult to find pasture for cattle … In the South West, mine workers, who came from the North, are degrading the soils…In the West, forest cover is declining but plantations are increasing to preserve soils [and] secure land tenure". -**A FEWSNET expert**

2. Participants used local explanations

However, in order to understand LULCC patterns and coping strategies in micro-environments such as Bam and Sissili, one needs to incorporate indigenous knowledge into research. The intention of this research is "not to replace one version of truth with another, but rather to add the version that people, whose livelihoods are directly affected by these changes,

themselves contribute to the scholarly debate" (West and Vásquez-León 2008:381). Local rural producers explain LULCC trends in terms of land tenure systems, migration trends, population density, rainfall, and specific agricultural and forest land use practices to clarify the causes of observed LULCC.

a) Bam

In Bam, more precisely Loulouka and Kongoussi, our participants attribute current LULCC to SWC projects, rainfall recovery, land tenure systems and reforestation. They also highlight the role of population pressure and drought on LULCC in the 1970s-80s. One of the participants, who is a farmer in Loulouka, argues that "demography has changed and is different from the past". Out-migration, according to him, was much stronger during the major droughts, but population has been increasing back in the area due to the SWC projects. Consequently, population growth has stimulated the expansion of agricultural land, even on bare soil:

> **"***Zipélé* [bare soil] is now occupied and cultivated. There is no more *zipélé* here because of demographic pressure and there is also no more space to cultivate because there are too many people. Nowadays, *zaï* is still practiced, but now on *zipélé* which has been rehabilitated and produces better than non-*zipélé* and *bas-fonds* [low-lying areas]. Even if you can't do *zaï* every year, you can use the one from the previous year because dry stems can replace and reinforce your *zaï*." – **PZ, a farmer in Loulouka**

While this farmer perceives bare soil as decreasing in the area, our data shows slight increases in bare soil by 0.2% between 1975 and 2000 and 0.1% between 1992 and 2002 for the entire Bam province. The changes highlighted by this farmer are localized and specific to Loulouka.

The lack of land in the neighborhood has created new types of complex negotiations and land tenure arrangements among ethnic groups, especially between farmers and pastoralists. Our participant, who accesses several spatially dispersed agricultural fields, indicated a farmland on the map that he borrowed from a pastoralist (whom he referred to as *Silmiga*, which means Fulani). After harvesting, he gives *Silmiga* "something", most often a bag of millet. Other farmers have

also borrowed land from this *Silmiga* and follow the same principle. No monetary transaction is involved, but there is a requirement to give "something" in exchange. This exchange system is a livelihood strategy for pastoralists, but also farmers. *Silmiga*'s land, he argues, is virgin, rich, sandy and surrounded by tall trees. Hence, there is no need for soil improvement on this specific land. The remote location of this field from Loulouka and the fact that it has never been cultivated in the past suggest that agricultural land is increasing and encroaching on steppe, but very incrementally.

When asked if he planted trees on his farm land, our participant replied that he planted trees at the border of his *diguettes* (contour stone bunds). In addition, while he was clearing the land, he intentionally left a few trees as sun shade around the field. However, although farmers conserve and plant trees in their fields, reforestation is dispersed and there is no formation of "forests". Indeed, "space to plant trees is hard to find because we need fields to grow subsistence crops. Thus, when there are many trees being planted, people think that they will lose the opportunity to grow crops." – **PZ, a farmer in Loulouka**. In the 1970s-80s, experts described deforestation and the lack of trees as one of the causes of the severe famines in the Sahel. Remembering this period, an elderly participant in Kongoussi provided an historical perspective on how rainfall relates to tree cover, agricultural production, food insecurity, and migration in Bam. He stated: "This is unforgettable. It wasn't raining and experts said there wasn't enough trees… two to five days without eating. The lack of rain was the main cause of this hunger." – **LS, a town elder in Kongoussi**. According to our participant, overcoming hunger was a "household to household matter". While the poorest families depended on food aid, he says, some bought food on the market or other chose to migrate:

> "Many people migrated south. This is where they can get better lands and rains to grow crops…On average in one single village in the Bam, about one to three families left with

> all their family members and children. Moving entire families is rare but when older family members leave, they encourage other members to come when it's good. Those who left were not rich; they left because of hunger and could barely manage to get transportation without any money in their pockets. When a migrant arrives, his acquaintances or relatives feed him by solidarity until he gets something since he came with nothing. Young people are the ones who usually migrate because they are stronger to travel and go work hard in agricultural fields and harvest. They can even bring food back to their family. Then, they prepare their younger brother to come help…Out-migration has decreased since the big hunger. A small number of migrants came back but most of them stayed there." – **LS**, **a town elder in Kongoussi**

Migration and food exchanges have connected rural livelihoods between Bam and Sissili. LS continues:

> "When there is a lot of food here in Kongoussi and no food in Léo, we can also send them food…in the past you had to send food through transportation or delegate someone to bring it. Nowadays, it is easier. You can send money with new technologies such as Western Union." – **LS**, **a town elder in Kongoussi**

Sharing a personal story, he explains how Bam migrants remain attached to traditional customs in their homeland while residing in Sissili:

> "My brother's family settled in Léo, but his children come back to visit. They consider Léo as their second home, but don't forget their homeland of Kongoussi. They just went to Léo to ask for land and cultivate but they were born in Kongoussi. They don't forget to come back to check on us. When they go there, they are far from their traditions but they come back to their *Bayiri* [homeland] for wedding and funeral rituals." – **LS**, **a town elder in Kongoussi**

This attachment to their natal village demonstrates the need to study migrants' destination areas in perspective with their region of origin.

b) Sissili

In Sissili, especially in Léo and Biéha, participants recognized decreased rainfall, population pressure and the commodification of agricultural land as the primary causes of LULCC. Aware of environmental changes in the province, farmers compare current drier seasons to the much rainier past: "In the past, it used to rain from May to October. But nowadays … we have four months or sometimes four months and half of rain." – **KM**, **a farmer and trainer in Léo**. **AN**, **a farmer and town official in Léo** describes these rains as heavy and destroying about 10 %

of trees. He explains: "people know that things are not like they were in the past. However, they do not talk about climate change since they don't know this term. They don't know scientific causes, but know that it's not like in the past." AN adds that the lack of SWC and reforestation projects in the area was seen as a major weakness: "Here, people do not work on restoring soils and they do not like using it as much fertilizer as elsewhere…there are no reforestation programs in Léo apart from the few trees that people plant on their farm land. This is a weakness." In Sissili, instead of developing SWC projects to overcome the new environmental challenges, farmers have been trained to plant improved short cycle crops, especially genetically-modified (GM) maize such as *Barka, SR21, FBC 6, Kamboinsé Précoce Jaune* (KPJ), *and Kamboinsé Précoce Blanc* (KPB). Local farmers' associations such as *Fédération Nean-Zwe* (meaning "hunger is over") created in 1998, have been implementing farming and adaptation strategies to combat food insecurity in the area. However, they do not specialize in reforestation initiatives. A participant clarified: "The only SWC project, implemented with the support of the Netherlands, was in Tô which is the most affected area in terms of degradation in the Sissili. Experts from the Netherlands introduced organic manure and reforestation in the area." – **KM**, **a farmer and trainer in Léo.**

According to the participants, certain areas such as Kounou, located at the eastern part of Sissili, are greener than other areas because of the presence of protected forests and very low population density. One of them explained that "Kounou is closer to Ghana and not too many people migrate there because of poor roads' conditions and the forest makes it hard to access … There are also less bush fires since the zone is protected." – **AN**, **a farmer and municipal advisor in Léo**. This statement infers a relationship between human settlement and local LULCC processes. Participants claim that in certain villages of Sissili, such as Yale, Mossi migrants

outnumber autochthonous populations and farming land is scarce and unproductive. One of them states:

> "Many migrants moved in Yale because our parents accepted and integrated migrants comparatively to other areas where they are rejected...In 1992, I visited Yale which had at that time about one hundred households. At that point, migrants constituted about one tenth of the autochthonous in Yale. Nowadays, the number of migrants in Yale is three times the number of autochthonous inhabitants." – **KM**, **a farmer and trainer in Léo**

Increasing land scarcity and the commodification of agricultural land has exacerbated conflicts between and among indigenous and migrants. Two participants assert:

> "There are many conflicts. Many! …Many migrants settled here, but the land doesn't extend to keep up with increasing population growth. Land is becoming scarce and when autochthonous communities want to take back the plot of land that a migrant exploited for years, it doesn't go without conflicts." **– HY, a government official in Léo**

> "We are afraid that this zone becomes a '*poudrière* (battle field) because there are sales and double-sales of the same plots of land." **–ZI, a local historian in Léo**

A secure land tenure stimulates peaceful relationships between migrants and autochthonous communities. Contrary to the Mossi, who have a hierarchical political and familial organization, the Gurunsi have an acephalous and decentralized one with the elders and the *chef de terre* as the most important leaders. In the southern river basins, McMillan et al. (1993) describes three major types of customary land tenure systems: lineage tenure (based on a common ancestor); extended kin group rights to specific lands (usually managed by the *chef de terre*); and individual land use rights (based on patrilineal or matrilineal descent). All these systems value collective land ownership. Migrants are given access to the land as a "loan" while indigenous communities receive the land as an inheritance. However, a "loaned" land that is passed from migrant parents to their children gives these children individual use rights and this land cannot be reclaimed as a loan. In most villages of Sissili, one of our participants, who is a land tenure specialist of Sissili, explains that the "*chef de terre*" controls land distribution. However, the land is managed by the "*chef de lignage*" (lineage chief) in certain areas. Every migrant who arrives in

a village has a "*gaang-soba*" (host) who introduces him to the community as a member of his lineage (fictive kinship). Thus, the "*chef de lignage*" informs the "*chef de terre*" of his willingness to "give" him a plot of land. After receiving permission from the "*chef de terre*", the migrant can start using the land for "free".

Changing social organizations, such as fragmentation of production units, have decreased land availability and stimulated intensification and LULCC in migration sinks and sources. In a study of the determinants of intensification among the Bwa of southwestern Burkina Faso, Gray (2005) explains that kinship groups known as "houses" are no more the major and sole agricultural production units. In order to adapt to the changing environment, the Mossi of Kongoussi, for example, have valued the extension and/or fragmentation of extended households into smaller units of production based on the viability of each of these systems at a point in time (West 2010). However, at the present time, individual nuclear households control most of the agricultural production, especially in migrants' region of destination. The fragmentation of production units and the introduction of plough, which makes farming possible on soils previously too heavy for hand cultivation, have increased total production area. A farmer describes:

> "In the past, 5 hectares of agricultural land was enough to feed 10 people in a family but, nowadays, with the use of herbicides and animals (draft animals), every person wants 5 ha to exploit alone. Now, one person does what many used to do. In addition, the size of agricultural lands has grown bigger." – **KM**, **a farmer and trainer in Léo**

In these individualistic production units, decisions that were once made by the elder or chief of a group are now made individually by each migrant. To explain local perceptions of land use patterns by ethnic group, an expert from ISSP shares that one of his professors used to claim that "*Après les Mossi, c'est le désert*" ["After the Mossi, comes the desert!"]. Leaving a place to conquer another one, has described Mossi chiefdoms since the 15th century. In migration waves, the Mossi

have abandoned the 'old' Yatenga[2] to go and create new Yatengas elsewhere (Marchal 1983). However, these "new lands may have been underpopulated, but they were never unclaimed" (McMillan et al. 1993:38). Consequently, participants listed land sales as one of the major source of conflicts in the area. In Bam, land is not sold; it is used for subsistence, rather than an essential economic resource. Indeed:

> "There were no recorded cases of land being sold; land is seen more as a family heritage than a commodity (see Barrière et al., 2003). The purchasability of land in Burkina Faso is a hotly debated issue our observations were confirmed by a recent field study in south-western Burkina Faso, which is seen as the centre of these financial transactions (Pickardt, 2003)"(Stamm, et al. 2003:9).

Growing land scarcity and the fear of losing loaned land has stimulated a prohibition of long-term investment such as on-farm tree planting on borrowed lands. A participant explains: "Mango trees take a long time to grow. If I gave you a land to cultivate and I find out that you are planting many mango trees on it, I will start thinking that you want to keep the land. So I will make sure that you give me back my land." **–ZI, a local historian in Léo**. In their study areas of southern Burkina Faso, Stamm et al. found out that "92% and 98% of interviewees in all three villages think that farmers are free to manage and develop the land they work, particularly in terms of short and medium-term measures. However, they were more reticent about long-term undertakings, such as tree planting" (2003:13). This unsecure land tenure system is a threat for reforestation initiatives undertaken by migrants. However, in the 1980s-90s, McMillan et al. (1993) argue that most migrants have valued local customs and seek land use permission from local authorities. They clarify:

> "The land is subject to supernatural forces with which it is necessary to remain in accord. In cases where this authorization is refused, they preferred to move elsewhere …By following these traditional methods, the settlers' gets a 'loaned' land but also a friend. This

[2] Province of northern Burkina Faso similar to Bam in terms of landscape and population. Marchal, who studies the mossi of Yatenga, argues that there is no more space in the province because of extensive agriculture, leading to migration.

> ‘loan’ is “usually a straight grant, with little expectation that it will ever be reclaimed. By giving a new settler land and, perhaps, extra food, an indigenous farmer makes a social investment. He creates indebtedness and gains a friend and political ally … in passing through the customary channels to acquire land, the borrower acknowledges the lineage and village leaders’ right to control the use of the village land in service to community life” (1993:40).

The recognition and respect of local customs mitigate tensions, but lately, the non-respect of these norms has been stimulating conflicts between migrants and autochthonous peoples.

CHAPTER 6: DISCUSSION

A. Sissili has been a migration sink: LULCC is dramatic

As a fertile valley, Sissili has been a migration sink since the development of the AVV programs in the 1970s. McMillan et al. (1993) predicted the increasing settlement and demographic growth in the southern valleys during the crisis of the cocoa market in Côte d'Ivoire and returning migrants based on the 1985 migration trends. They argue that it would be "naïve to think that many of these immigrants, especially those who remained for long periods of time in Côte d'Ivoire, would go back to the impoverished Mossi Plateau" (11). Between 1975 and 1996, Sissili has been one of the preferred destinations for migrants. This period of in-migration, characterized by the expansion of fragmented agricultural fields, decreased savanna and incipient land degradation, correlates with increased population density (as shown in Table 4) and high LULCC.

Between 1996 and 2006, Sissili received the lowest number of in-migrants since the implementation of the AVV programs. This period corresponds to lower LULCC. The lack of SWC projects to revitalize soils in the Sissili and the developing opportunities created by these projects in northern Burkina Faso can explain these trends. Decreasing net migration advises that as population has grown in Sissili, farming land has become scarcer and less productive. Yet, LULCC findings show that although savanna and forest land have decreased and agricultural land have expanded, there is still available space for agriculture in the Sissili province. However, based on the ethnographic data, the author proposes that currently in the Sissili, decreased

migration can be explained by deteriorating relationships between migrants and autochthonous communities due to reduced land availability and land tenure challenges. This scenario suggests that the current persistent migration is mainly motivated by non-farm income generating opportunities such as commercial activities (McMillan et al. 1993:11). Farmers' decision to migrate is highly dictated by the lack of economic opportunities in their region of origin. The goal of SWC programs has been to alleviate these disparities between river valleys and settlers' regions of origin.

Table 4: Evolution of the population densities in Sissili Province

Table 4. Evolution of the population densities in Sissili Province

	Population density (inhab km^{-2})			
District	1986	1992	2002	2006
Bieha	8.81	9.34	11.76	17.02
Boura	14.35	16.76	22.76	21.77
Leo	27.78	31.57	42.01	52.53
Nebiel	10.93	12.30	16.24	18.82
Niabouri	12.54	16.33	23.79	36.31
Silly	17.80	20.06	26.51	29.54
To	24.84	27.38	35.59	39.60
Total	16.78	18.96	25.11	29.90

Data source: (Ouedraogo 2010:45)

B. Bam has been a migration source: LULCC is minimal

Before the 1980s, the saturation of land coupled with frequent droughts and fewer off-farm income opportunities have pushed many people to migrate out of Bam. During this intensive migration era, Bam has been a migration source with little LULCC from 1975 to 2000. These insignificant changes were potentially stimulated by decreased land availability and productivity and high out-migration of young mossi farmers toward Ivory Coast, Ghana, and the southern

regions of Burkina Faso. Although people migrated for better opportunities, bare soil persisted in the area. The SWC projects were introduced to repair and stabilize land degradation, revive bare soil, and make it more productive. Between the 1996 and 2006 censuses, the stable LULCC and shift from a negative to a positive net migration in Bam (and throughout the northern Central Plateau) suggests that the combined SWC improvements have potentially rehabilitated soils to the point where out-migration has dramatically decreased. Our ethnographic data proposes that population is increasing back again in Bam and land is getting scarce again. Luckily, SWC programs and the stronger compliance to intensive agriculture in Bam made it possible to practice *zaï* on the same plot of land recurrently.

Higher LULCC between 1975 and 2000 compared to 1996 and 2006 suggest that before the development of the SWC and adherence to AVV programs, higher population densities in Bam have stimulated more LULCC. However, since the 1990s the development of SWC might have repaired the soils and mitigated land degradation. Indeed, following the SWC projects, tree density has increased on cultivated lands (Sawadogo et al. 2001). Cultivated area remained stable and farmers improved soil fertility management through mixed farming and livestock systems. Many farmers involved in *zaï* say that their investment in livestock has increased because of the growing availability of fodder. These farmers argue that they have become less poor and less vulnerable to drought. According to them, "famines are [now] a thing of the past" because improved agricultural techniques and investment in livestock have helped them adapt to drought (West et al. 2014). In the Central Plateau of Burkina Faso, SWC projects stimulated the "rehabilitation of 200,000 to 300,000 hectares of land and the production of an additional 80,000 tons of food per year" (IFAD 2011:3). Although some households still remain vulnerable to food insecurity due to skyrocketing global market prices, in times of food scarcity, they engage in non-farming activities such as trade

and handicraft. In addition, they count on remittances sent from migrant relatives to buy grains on the market or depend on food aid programs.

In this part of the country, rainfall recovery might also explain lower vulnerability to drought throughout the region. Looking at a period of 30 years, researchers argue for a rainfall recovery in the overall West African Sahel. Sharon Nicholson (2005) claims that this pattern is more visible in the Western part of the Sahel. She adds that the trend is also weaker in August, the wettest month in the area. Hermann et al. (2005), examined rainfall recovery patterns at an 8 kilometers coarse spatial resolution and found long term residuals in their study of the relationship between rainfall and vegetation greenness. These residuals mean that other factors, not only rainfall, contribute to vegetation greenness. Therefore, they argue that there might be a weaker causative association factoring in long-term greening. Since the Sahel is a cultural landscape populated by human beings who interact with their environment, this weaker cause could be restorative initiatives such as reforestation and massive SWC projects.

CHAPTER 7: CONCLUSION

In the Bam and Sissili provinces of Burkina Faso, LULCC correlates with migration trends. While land degradation stimulates intensive out-migration from a province, soil rehabilitation can help decrease out-migration and/or increase in-migration toward a province. In the 1970s, land degradation in Bam led to intensive out-migration, making Bam a migration source. In order to overcome land degradation, SWC projects were introduced in this province. The introduction of the SWC projects and rainfall recovery have stabilized LULCC in Bam, transforming the negative net migration of the province into a positive net migration. This positive net migration suggests more in-migration or less out-migration from Bam. These migration trends do not only confirm the success of long term SWC investments, but also dwindling opportunities elsewhere. In Sissili, which used to be one of the preferred destinations for Bam's migrants in the 1970s-80s, a severe loss in savanna and forest and a dramatic increase in agricultural land followed intensive in-migration. Increased population, reduced land availability, and the development of commercial agriculture have degraded the land cover and social relationships. After 1985, and more specifically since 1996, in-migration to Sissili have drastically decreased. Declining migration toward Sissili and brewing land tenure conflicts between migrants and autochthonous communities call for controlled LULCC and conservation programs. As intensive out-migration promoted the introduction of SWC in regions of departure, massive in-migration must also inform conservation measures in order "to take care of what is left-over" (Marchal 1983) in destination areas.

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