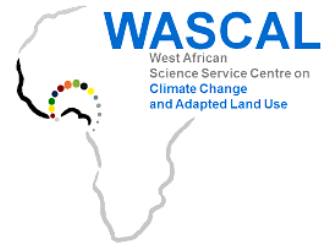




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West African Science Service Centre on
Climate Change and Adapted Land Use

**FACULTY OF ART AND HUMANITIES
DEPARTMENT OF GEOGRAPHY**

MASTER RESEARCH PROGRAM CLIMATE CHANGE AND HUMAN SECURITY

**Assessment of the Adaptation Strategies in the
Pastoral Community of Velingara Ferlo, Senegal in
the Context of Land Dynamic and Drought**

Thesis n°

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DISCLAIMER

This document describes a research work undertaken as part of a programme of study at the University of Lomé, Togo under the auspices of the West African Science Service Center on Climate Change and Adapted Land Use (WASCAL). All views and opinions expressed herein are the responsibility of the author, and do not necessarily represent those of the institutions.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAH	Action Against Hunger
ACTED	Agency for Technical Cooperation and Development
ANACIM	National Agency of Civil Aviation and Meteorology
ANSD	National Agency of Statistics and Demography
ARC	African Risk Capacity
ASUFOR	Association of Drilling Users
AVSF	Agronomes et Vétérinaires Sans Frontières
CECI	Center for International Studies and Cooperation
CLM	Cellule de Lutte contre la Malnutrition
CNSA	Senegalese National Council for Food Security
CSE	Centre de Suivi écologique
ECHO	European Commission for Humanitarian Aid
EGAB	Agreement of Associated Groups for Development at the Base
EFS	Water and Forest Service
EWS	Early Warning System
FAO	Food and Agriculture Organization
IPCC	Inter-governmental Panel for Climate Change
MCA	Millennium Challenge Account
MLAP	Minister of Livestock and Animal Productions
PAPEL	Livestock Support Project
PGIES	Programme de Gestion Intégrée des Ecosystèmes du Sénégal
PRODAM	Projet de Développement Agricole dans la région de Matam
PSE	Plan Sénégal Emergent
SPI:	Standardized Precipitation Index
USGS	United States Geological Survey
WMO	World Meteorological Organization

ABSTRACT

Climate, weather events and land dynamics play a major role in pastoral management. This study examines various adaptation strategies used by herders in the Velingara Ferlo area of Senegal in the face of multiple effects of drought and land dynamics of traditional extensive rearing areas. The approach used for this study range from socio-economic survey of 200 households using questionnaires to Focus Group Discussion (FGD) and interview. All these were combined together to determine the effects of drought, agriculture and settlements expansion on pastoralism and adaptation methods used in the area. The long-term mean annual rainfall data of 2002 to 2017 obtained from the National Agency of Civil Aviation and Meteorology, Senegal was used for the computation of Standardized Precipitation Index (SPI) for the classification of drought intensity and severity. Analyses of land use and land cover maps were carried out with the use of GIS and remote sensing. Semi-supervised classification techniques were applied to evaluate changes that have taken place over 30 years. Outcome of FGD, demography, number of conflicts and bush fire trends were compared to land dynamic in order to appreciate the adaptation strategies of Pastoralists. The results revealed that, droughts are becoming increasingly severe with it attendant negative impacts on the livelihood of pastoralists while agriculture (crop planting) expansion is taken more grazing land areas. Based on the above, herders have resorted to several adaptation strategies ranging from traditional to modern methods. Traditional adaptation methods include mobility for water and pasture, herd and income diversification while the modern adaptations focus on the creation of pastoral structures, the creation of participatory management structure, reorganizing the land use and the production of biogas from animals' excreta. The study recommends that the government should develop a comprehensive and total policy that will encourage pastoralism.

Key Words: Drought, Pastoralism, Adaptation strategies, Land dynamics, Land use and land cover change.

RESUME

Cette étude met en évidence les stratégies utilisées par les éleveurs dans la région de Velingara Ferlo au Sénégal pour s'adapter aux multiples effets de la sécheresse et de la dynamique des terres dans les zones traditionnelles d'élevage extensif. Plusieurs méthodes, allant de l'enquête socio-économique de 200 ménages aux *Focus Group* et aux entretiens, ont été utilisées pour synthétiser les effets des sécheresses, de l'expansion agricole et de l'habitat sur l'élevage ainsi que les méthodes d'adaptation utilisées. La moyenne annuelle des précipitations obtenues de l'Agence Nationale de l'Aviation Civile et de la Météorologie (ANACIM) a fourni l'Indice Normalisé de Précipitations (INP) pour classer l'intensité et la sévérité des sécheresses survenues entre 2002 et 2017. Les cartes d'occupation des sols ont été réalisées grâce à l'utilisation des Systèmes d'information Géographiques (SIG) et de la télédétection. Des techniques de classification semi-supervisées ont été appliquées pour évaluer les changements qui ont eu lieu ces 30 dernières années et pour identifier différentes classes d'occupation des sols. Pour apprécier les stratégies d'adaptation des pasteurs, les informations sur la démographie, le nombre de conflits et feux de brousse ont été comparées aux résultats lors de l'analyse de la dynamique spatiale. Les résultats ont révélé que les sécheresses deviennent de plus en plus graves et ont eu des impacts négatifs sur les moyens de subsistance des pasteurs alors que l'expansion agricole empiète d'avantage sur les espaces d'élevage. Pour s'adapter, les éleveurs ont eu recours à plusieurs stratégies allant de celles traditionnelles aux stratégies modernes. La transhumance à la recherche d'eau et de pâturages, la diversification des espèces animales et des revenus constituent les méthodes traditionnelles d'adaptation tandis que les adaptations modernes se concentrent sur la construction d'infrastructures pastorales, la création de structures avec une gestion participative réorganisant l'utilisation des terres et la production de biogaz. Ces stratégies ont considérablement réduit le nombre de feux de brousse et les conflits sur les ressources. Cependant l'étude donne comme recommandation, la mise en place de politique complète qui donne plus de considération à l'élevage extensif.

Mots Clés: Sécheresse, Pastoralisme, Stratégie d'adaptation, Dynamique foncière, Occupation et couverture du Sol.

CHAPTER ONE: INTRODUCTION

Background of the Study

Pastoralism is generally defined as a system of animal production (Czuba and O'Neill, 2016). In most part of the world, it is done by moving with the cattle from one place to another in search for pasture and water. It is the traditional way of husbandry, compared to the modern one which is more sedentary. According to Rota (2009), pastoralists are defined as people who live in mostly dry, remote area. They inhabit zones where potential raising for crop cultivation is limited due to low and highly variable rain conditions, steep terrain or extreme temperatures. The key word of the system is the mobility either of the animals or the people. Pastoralism is also characterized by three main components: people, livestock and the environment which interact to create a working system of animal production. When one of these components is weakened by any disturbance (either natural or artificial), the whole system is affected. The system supplies food and livelihood to people who depend on the activity all around the world. Extensive pastoral production takes up about 25% of the world's land area and produces about 10% of the meat used for human consumption, while supporting almost 20 million pastoral households (Blench, 2001).

In Africa, it equally plays the same role of food and livelihood supplies. More than 20 million Africans are involved in pastoralism as a means of livelihood; it is done on 50% of the continent's total area (Rota, 2009). In the drier parts of the continent, pastoralists concentrate mainly on camels and goats, while they raise cattle, sheep and goats in higher rainfall lands. The northern part of Senegal, a Sahelian region, is nationally known as the pastoralist zone which provides the whole country with animals and animal products (meat, milk, skins). In this area, extensive livestock farming is the main activity of households and their main source of income. It significantly contributes to their food security, both through the consumption of milk and the selling of animals to buy cereals.

1.1. Problem Statement

The inter-relationship between the three key elements of pastoralism (environment, livestock and people) is affected by climate stress, especially drought. It directly affects the availability of pastures and causes livelihood problems to the community which depends largely on livestock. Consequently, it promotes widespread hunger and poverty in this area. Reports of resilience analysis of FAO, 2016 described the region of Matam—which engages in pastoralism—as one of the poorest regions of Senegal with more than 45 % of the population under the poverty line (ANSD/SRSD, 2015). Also, the Fight against Malnutrition Unit (CLM) finds the region of Matam (Ranerou, Kanel) as the one recording the critical threshold of malnutrition in the country with 15 % (CLM, 2017). However, drought is not a new phenomenon Africa. In the Sahara, droughts led to periods of aridity which lasted for several centuries. In the last 50 years, drought became more frequent in Africa with their extreme records. The most known are the 1972–1973, 1983–1984 and 1991–1992. For Masih et al (2014), severe and prolonged droughts were recorded in the recent past such as the 1999–2002 drought in northwest Africa, 1970s and 1980s droughts in western Africa (Sahel), 2010–2011 drought in eastern Africa (Horn of Africa) and 2001–2003 drought in southern and southeastern Africa.

Pastoral communities in the district of Velingara Ferlo are also facing many other changes brought about by the demography. The last national population census conducted in Senegal indicated that the population of the Matam region was 562,539 with 47.27 % of the population under the age of 15 and the rate of children per woman being 6.3 (ANSD, 2013). With the increasing population, there will be more demand for land to farm and to build houses and consequently the pastoral areas for livestock farming will be reduced. The study of Mbaye and Niang (2013) reported that population growth and the phenomenon of climate change have also led to increasing pressures on increasingly scarce pastoral resources. Consequences of past droughts have oriented development policies of the country toward intensification of farming activities leaving pastoralists behind. Territories are being more and more locked to pastoralism as a result of sedentarization policies. Many pastoralists are becoming increasingly sedentary due to the explicit government policies or by their own will to take advantages of infrastructures and social services. Margin (2011) reported in his study that apart from climate change which is more

visible, mobile livestock farming in Senegal is threatened by agricultural pressures, the extension of protected areas, urbanization and imported consumption patterns that are accompanied by public policies favorable to its intensification and sedentarization. The area formerly dedicated to breeding is progressively transformed into space for agriculture, natural reserves and forests, private domains for ranching, irrigation, bio fuel farming and cereal farming (AVSF 2009). Nevertheless, land use change, as a consequence of drought intensity, population growth and migration has pushed pastoralists of the district of Velingara Ferlo to be more creative and resort to the development of strong adaptation strategies that resist drought intensity.

Nori et al. (2005) stated that where other land use systems have failed or are failing in the face of global climate change, mobile livestock herding is generating national and regional economic and environmental benefits in the drylands. They stated that the strategies are often related to their ability to relocate community members and their livestock to areas unaffected by the crisis they faced at a particular time. In addition to the moderation of the impacts of shocks, such strategies have permitted them to harness climatic variability to deliver high levels of productivity otherwise impossible in their harsh environments (Butt et al., 2009). In the context of frequent drought periods, land use change by population growth and farmlands multiplication, livestock farming activity in the district of Velingara Ferlo is in a critical situation where adaptation becomes difficult and needs to have appropriate solutions.

The periods of the Tabaski are crucial for the government to meet the national demand in sheep, goats and cattle. Most of the animal products which are consumed in Dakar come from the sylvo-pastoral zone. Also, Senegal has many other religious festivals with a high demand in animal products (meat especially) to be met. Pastoralism in the northern Senegal is at the crossroad of many challenges, with drought being the hindrance to its development. Pastoral communities have to face many transformations (spatial, economic and social) in their activities. The first step toward assessing the effects of adaptation strategies when drought strikes is to know the changes that have been taking place in the previous decades.

Many studies in climate-related hazards have been conducted, especially in the adaptation strategies pastoralists (Lekapana, 2013). However, few studies have been conducted regarding

the assessment of these adaptation strategies using the Pastoral Units (PU) scale. Population has been adapting to drought by using many methods (AVSF, 2010). Understanding their adaptation strategies in the context of population growth and sedentarization policies is essential for the development of strong policy. Strengthening and rebuilding these adaptation strategies, therefore, need to be emphasized. Such knowledge can be very useful at the local level in reducing the adverse effects of drought and land dynamic by bringing new adaptation strategies and preventing food crises. This study will help the government to formulate appropriate policies to address drought-related problems both at the national and regional levels.

1.2. Research Questions

This research seeks to address the following questions:

1. what are the characteristics of droughts and land use/land cover in the district of Velingara?
2. what are the effects of drought land dynamic on the pastoralists?
3. what are the existing adaptation strategies of the community and the ones provided by the national authorities and NGOs.

1.3. Research objectives

The main objective of the study is to assess how a northern Senegal pastoral community is adapting to the combined effects of land dynamic and drought.

Specifically, this study seeks to;

1. analyze the characteristics of land dynamic and drought in the district of Velingara Ferlo;
2. assess the effects of land dynamic and drought on the pastoralists;
3. assess the existing adaptation strategies that the community, the national authorities and NGOs have developed.

1.4. Research Hypothesis

The research states the following hypothesis

H 1: Drought and land dynamic are not severe and expanding.

H 2: Drought and land dynamic have no negative effects on the pastoralists.

H 3: Pastoralists are not well adapting to drought land use and land cover change.

1.5. Thesis structure

The first chapter of the thesis includes the problem statement, research objectives, research questions and hypothesis. Chapter two provides the review of conceptual basis for the research. Chapter Three deals with materials and methods and presents the study area. Chapter four presents the results and discusses the findings.

CHAPTER TWO: LITERATURE REVIEW

2.1 Drylands and Drought

2.1.1 Drylands

Drylands are observed in many places in the world. Worldwide, they occupy over forty one percent (41%) of the earth's land surface and are occupied by over two billion people (2 billion), and often experience a crisis (Birch and Grahn, 2007). Economically, drylands support forty four percent (44%) of the world's food production systems and fifty percent (50%) of the world's livestock. They are home to one-third of global population. The main characteristic of drylands is the fragility of the ecosystem, the degraded soil, the amount of rain fall and high evaporation rate. The situation of dry lands is more complicated by climate change and its rainfall decrease in the concerned regions.

The West African Sahel and Dry Savannah stretch from Mauritania in the west through southern Mali, northern Ghana, Burkina Faso, southern Niger, and northern Nigeria to Chad in the east. It is a vast region characterized by frequent droughts and the increasing use of the marginal lands, degraded soil, poverty and increasing population according to CGIAR (2016). In the southern part, agricultural support services and access to markets tend to be better than in the north, the challenge is to sustainably intensify agricultural production.

The District of Ranerou Ferlo, Senegal, which is part of the northern West African Sahel, is between the desert and the savannah. It is characterized by land degradation and lack of water during the dry season. The rainfall amount varies from 300 to 600 mm per year, with the main activity being the pastoralism occupying eighty percent (80%) of the population in the department of Ranerou, according to the Millenium Challenge Account (MCA) report (2009).

2.1.2 Drought

Wilhite (2002) described drought as a normal, recurring phenomenon of climate that practically occurs in all regions of the world. Drought is a reduction of the rainfall amount over a long period of time. Morton and Meadows (2000) provide a comprehensive definition of drought: it is a temporary reduction in water or moisture availability significantly below the normal or expected amount (norm) for a specified period. Lekapana (2013), citing Byun and Wilhite (1999), thinks that the severity of drought is aggravated by high temperatures, high winds and low relative humidity. However, drought is not a new phenomenon in the African Continent.

Drought differs from the other types of hazards that exist, according to many scientists. First, its effects are slow accumulations over a long period of time and can last many years after the event. That is why the onset and cessation of drought are difficult to determine (Tannehill, 1947; Wilhite, 2000).

The operational definition of drought helps people to identify the onset, cessation, and degree of severity of a drought. It is usually reached by comparing the current situation to the historical average, often based on a 30-year period of record, according to World Meteorological Organization recommendations in 2005. Operational definitions attempt to identify the precise characteristics and thresholds that define the onset, continuation, and termination of drought episodes as well as their severity (Wilhite, 2000). Several terms and definitions for drought include:

- Meteorological drought is usually defined on the basis of the degree of dryness (in comparison to some “normal” or average amount) and the duration of the dry period. Meteorological drought must be considered as specific to a region since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region (WMO, 2005);
- Agricultural drought focuses on factors such as differences between actual and potential evapo-transpiration and soil-water deficits;
- Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (i.e., streamflow, reservoir and lake levels, groundwater).

2.2 Pastoralism in the Senegalese Context

Pastoralism is a very important activity in Senegal. It is mostly done in the north eastern part of the country which has been dedicated to the livestock farming since the colonial period because of the dry characteristic of the region. It is mostly done in the Ferlo where it occupies 1/3 of the Senegalese territory (Wane, 2006). For a long time, the sector was ignored in the development policies of the country. The activity is now drawing the attention of the authorities because of the income it generates. The Ferlo is an area of extensive pastoralism both regionally and nationally because of the availability of pasture there. The department has 49,995 cows and 90,331 sheep

(ANSD, 2013) and more than 80% of the population of the region of Matam rely on pastoralism (MCA Matam, 2009).

2.2.1 The Pastoral Units

A Pastoral Unit (PU) is made up of "the space and all the resources polarized by a pastoral drilling" (Faye, 2001). It is an area where people live and share the water resources of the drill for pastoral or farming purposes. For Wane (2006), citing the Livestock Support Program (PAPEL, 2005), communities living on the same PU have priority rights to exploit resources at the level of their land but also responsibilities towards these resources. The main aim of the Pastoral Unit is to well organize and modernize the extensive pastoralism with a limitation of the transhumance and management of the resources.

The Pastoral Units in Ferlo appeared in the 1980s due to the high competition over land and water resources between pastoralists and farming areas. They have been re-actualized in Ferlo by the Livestock Support Project (PAPEL) and adopted by other projects such as the Agricultural Development Project in the Matam department (PRODAM) and the Integrated Ecosystem Management Program of Senegal (PGIES). In the implementation phase, the PAPEL was ordered to build hydraulic infrastructures and provide appropriate training to the communities for the management and maintenance of the infrastructures. Because the population lacks competences in management, many of the structures failed. After the first implementation phase, many other facilities were put in place with a focus on the training of the population. The department of Velingara Ferlo is currently divided into many Pastoral Units (PU) and the management of its resources is executed by local population through the supervision of NGOs such as Agronomes et Veterinaires Sans Frontières (AVSF). AVSF had identified five pastoral units in the commune in 2013.

2.3 Pastoralism-Drought nexus

Linking drought and pastoralism is possible because of two main things: the reliance of the community on the only activity—which is raising animals in hostile areas—and the nature of the drought with its impacts and severity. Citing Oba and Lusigi, Lepakana (2013) explained that drought occurrence among the pastoral communities is not new. In the past, pastoral communities have suffered numerous drought events. These have led to human, economic and

environmental costs, which are mostly borne by pastoral communities who exclusively depend on livestock for their survival and livelihood.

2.3.1. Impacts of drought on pastoralism

Drought impacts on the pastoral communities are well known the literature.(Odhiambo and Env, 2011). Masih et al (2014) reported that drought impacts affect numerous people causing loss of life, crop failures, food shortages which may lead to famine, malnutrition, health issues and mass migration in many regions. It also causes huge damages to the environment through land degradation, aridity and desertification. Speaking about its geographical scale, they predicted that individual families or communities may lose their livelihoods and source of water, subject to acute food shortages and health issues that may severely impact countries' economy. During the period 1900-2013, there were 642 drought events reported across the world, resulting in a huge toll to humanity, killing about 12 million people and affecting over 2 billion (EM-DAT, 2014). The financial damages were also estimated at USD135 billion.

The department of Ranerou where the district of Ranerou Ferlo is located has the highest poverty rate in Senegal (FAO, 2016). That is the reason why many NGOs are working with local people there. Matam is one of the poorest regions in the country with a high rate of malnutrition (FAO, 2016). Drought is identified here as the main cause which exacerbates the food production, distribution and access within an already difficult environment of fragile ecosystems, poor economic performance and governance.

The first impact of drought on the pastoral communities is associated with the depletion of water resources and reduction of vegetation quality and quantity (Sommer, 1998). The lack of water and pasture affects the livestock in their productivity of milk, and by implication the livelihood of the community. Frequent droughts are associated with the deterioration of livestock condition, increased frequencies of certain diseases and livestock deaths, altered herd structure, and a collapse of livestock markets (Speranza, 2010). The second impact is the weaknesses of their purchasing power resulting from the food shortage which pushes them to rely on weak animals. Animals lose their real monetary value during drought. Livestock prices decrease drastically, while prices of grains and other food crops rise sharply, reducing the purchasing power of pastoral communities. The decline in purchasing power is a major cause of famine (Speranza, 2006). For example, it was not food production shortfalls that caused the scarcity of food during

the 1984 drought, as is often believed in famine relief circles (Speranza, 2010): it was the failure of livestock and food markets (Speranza, 2006).

Pastoralists are usually faced with food shortage during droughts because there are changes in terms of trade that adversely affect the purchasing power represented by their herds. Drought leads to famine but this is not the only danger associated with drought: another major danger in the long-term is destitution (Sommer, 1998). Famine is the first and immediate risk, but the long-term risk is destitution of pastoralists. Once pastoralists become destitute, food insecurity becomes a chronic — longer — rather than temporary— problem because economic opportunities in pastoral areas outside the pastoralist sector are generally rare.

2.3.2. Mutation

To some extent, impacts of drought are very severe in the pastoralist communities and can bring new changes in the spatial, social and economic domains. In Senegal, pastoralism has been relegated to second plan of the development policies, though it brings more income to the national economy after the agriculture sector. This policy is due to the fact that the livestock system was considered as a difficult activity to control by the power in terms of tax payments. In fact, the problem of the durability of the agro-sylvo-pastoral system was not at the center of the political debates as the State targeted other areas which can generate more incomes. Drought does not only create human loss, hunger and diseases. In addition, it transforms the habitat of pastoral communities (Tsegaye, Moe, Vedeld, and Aynekulu, 2010) In the District of Velingara Ferlo, due to drought, land use has been changed over the years (AVSF 2012). Freudenberger (1993) noted it by stating that land use patterns under Senegal's Sahelian zones are undergoing significant and rapid changes. One particularly alarming aspect of this transformation is the unrelenting compression of at once dynamic agro-pastoral system into an ever more circumscribed space.

Frequent occurrences of droughts have triggered a change in the policy-makers' orientation, giving priority to agriculture than to livestock farming. In fact, the changes undergone by livestock farming over the years are attributed to the droughts of the 1970s and 1980s (Wane, 2006). The consequences of these droughts on the whole country were devastating in terms of livelihoods and food security. The lessons learnt from these droughts shaped and oriented the development policies of the country regarding food security and livelihoods, giving strong

concentration in the agriculture sector. Since then, policies in food sufficiency favored the development of farming activities to the pastoral areas during the same time. These policies were also strengthened by laws which came with them. The state law favored more farmers than pastoralists. Shettima (2008), underlining the background conflicts between farmers and pastoralists, underscored the power of farmers and the powerlessness of pastoralists. It is in this context that we understand mutations that go with the land use change.

However, mutations are not only analyzed in the land use and land cover change. They can also be measured in the social behavior of the population. The most visible social mutation is the abandonment of the livestock farming for another activity due to the huge number of animals which die from the hazard. When they leave pastoralism, they migrate to secondary cities of the country in the first place; thereafter, they go to the capital city where they can find job. The drought of the 1980s has pushed many pastoralists to Dakar.

2.4 Adaptation strategies of pastoralists in Senegal

Pastoral communities in Senegal have a long tradition of adapting themselves to drought impacts. Strategies are numerous and changing over time due to the severity of the hazard added to spatial, demographic and economic changes. Transhumance is being practiced since the beginning of pastoralism. Transhumance done horizontally is sometimes the most adopted strategy to alter the lack of pasture and water. People migrate with the livestock from site to site in search of abundant pasture. In the case of the Sahel Senegal, pastoralists move during the dry season to the south where there is green pasture and water. But this practice is gradually replaced by the sedentarization with the building of drills and management of livestock in Pastoral Units (PU). The objective of the sedentarization was, at the beginning, to fix the nomads by providing them with water. Later, it became an adaptation strategy to mobility. For Toure (1997), one of the major consequences of the change in exploitation conditions in the region was the gradual decline of large seasonal transhumance. With the reduction of the mobility, another way to adapt appeared: pastoralists' communities started to diversify their food availability by adopting agro-pastoralism.

Agro-pastoralism is the way of developing farmlands associated with cattle raising activities (Huho, Ngaira, and Ogindo, 2010). Pastoralists, who used to face extreme conditions of rainfall,

have found in this association a way to be entirely independent from livestock incomes for their livelihoods. While livestock is still valued property, their herds are on average smaller than other pastoral systems, possibly because they no longer solely rely on livestock and depend on a finite grazing area around their villages which can be reached within a day (Blench, 2001). Pastoralists have also a long tradition of raising herds which can well cope with the drought. Mixing the composition of the herd is a well known practice in drought areas. Diversification of herd composition and species are key strategies that have enabled pastoralists to thrive in a harsh environment for centuries (Speranza, 2010). In northern Senegal, livestock type is composed of goats, cattle and mostly sheep. Goats and sheep are perceived to be more resistant to drought. Households involved in diversification of herd composition and species have a higher off-take and thereby improved access to food during drought (Opiyo, 2015).

The availability of weekly market is another important adaptation during the dry season. It allows pastoralists to sell some animals to take care of the rest. It equally provides them with incomes for the remaining months of the dry season. The adaptation strategies can be more understood if they are supported by efficient drought management policies.

2.5 Drought management by pastoral communities

Besides the pastoralists' own adaptation strategies, the resistance to drought is better understood when it is strengthened by external actors such as the government and organizations which are present in the area. These external entities define the adaptation strategies to drought from preparedness to mitigation (Swift, Barton, and Morton, 2001). Citing Barton et al (2001), Lekapana (2013) argues that drought early warning system, drought contingency planning and policies to support pastoral communities' resilience to drought are key components for drought management policy for pastoral areas. For Ahmed (2002), the roles of external agents in the post-drought recovery period include instituting effective early warning systems, promotion of development activities suitable in recovery phase, and assisting households who should migrate out of the system and accommodate in other sectors. The figure 2.1 presents the drought management.

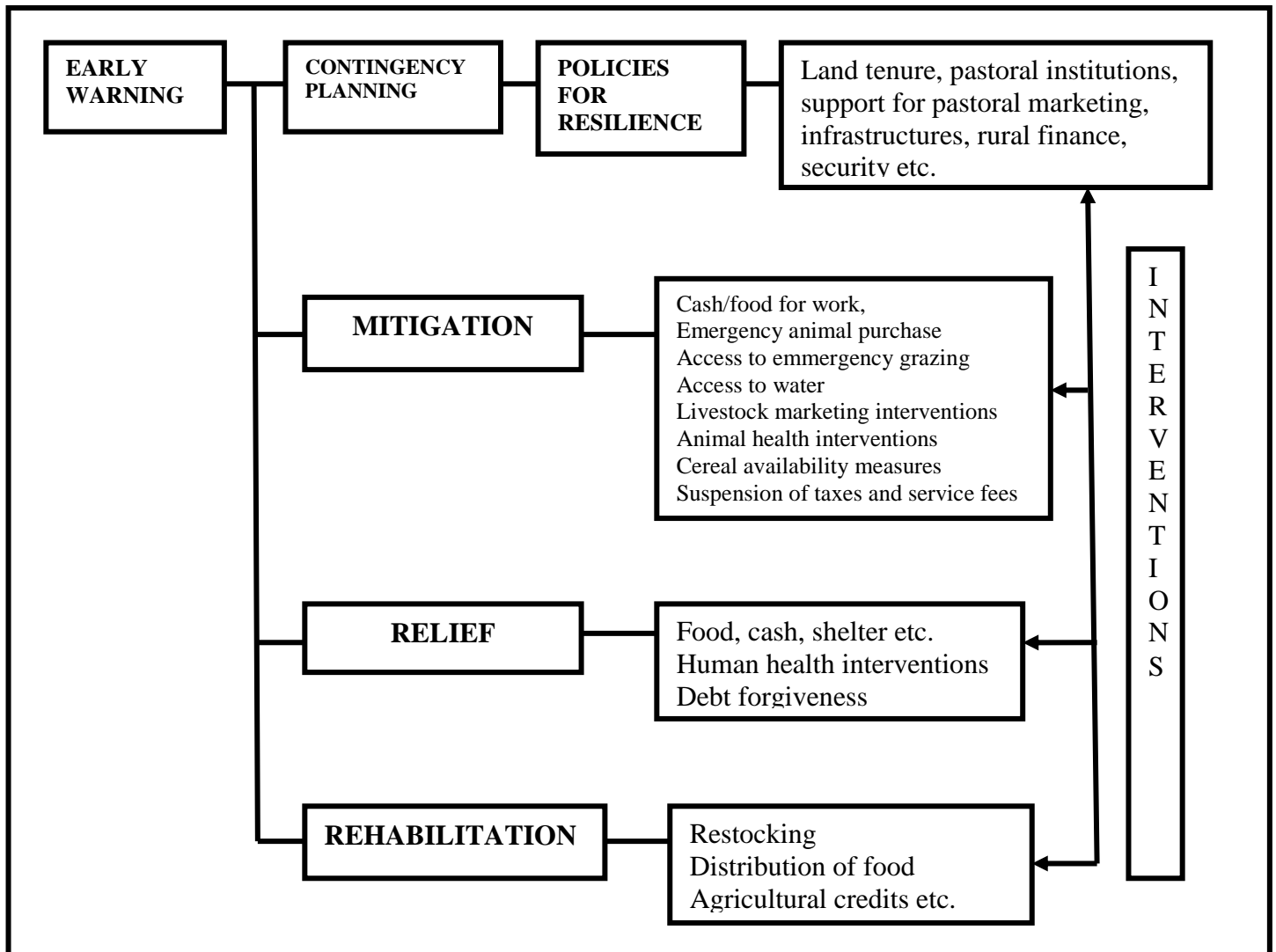


Figure 2.1: Drought management

Source: (Swift, Barton, and Morton, 2001)

The first major impetus to establish early warning systems (EWS) in Africa came after the famines of the early 1970s in the Sahel, which the international community failed to recognize in time (Ahmed, 2002). In fact, it evolved over time with a small interest given to production

determinants of the pastoral economy. The main focus was on rainfall and crop production monitoring., Citing Buchanan-Smith et al. (1991), Sommer (1998) argues an Early Warning System (EWS) is a system of data collection to monitor pastoralists' determinants of entitlements in order to provide timely notice when drought stress occurs and thus to elicit an appropriate response. EWS is not only about the relief of goods and services but it also manages resources which can improve the livelihood of the pastoral community. In this way, EWS is not only warning the population about famine but is equally assessing how the community is pursuing its livelihoods rather than on how it fails to do so (Sommer, 1998).

Many indicators are used to do Livestock Early Warning System. Sommer (1998) classified them into the following three categories:

- Monitoring of Endowments: this step takes into account the rainfall data, the crop production, the forage production, and the water sources;
- Monitoring Determinants of Entitlements: it includes the indicators on market, the assets, the rights over endowments, and the changing livelihoods; and
- The Monitoring of well-being: the most popular indicator for well-being is to measure the nutritional status.

Many mitigation strategies have been experimented in the Ferlo when drought occurred (AVSF, 2012). They have been evolving over the years to better fit the need of the pastoral communities and the goals of the international organizations which are generally implementing them. In other contexts of pastoral drought, for example, these mitigations are in the form of marketing, water and veterinary services. In the Ferlo, in general, and in the District of Velingara Ferlo, in particular, mitigation is mainly done in the form of food security, cash transfer and nutritional elements organized by international organizations such as Action Against Hunger (AAH), Agency for Technical Cooperation and Development (ACTED), Center for International Studies and Cooperation (CECI) under the supervision of the European Commission for Humanitarian Aid (ECHO). The national government under the umbrella of the Senegalese National Council for Food Security (CNSA) supervises all interventions related to food security in the region.

2.6. Conceptual Framework

This study will be based on the Sustainable Livelihood Approach (SLA) as defined by Ashley and Carney (1999). The aim is to increase the livelihoods of people by taking advantages of the surrounding resources to reduce poverty. Chambers (1987) stated that the SLA promotes the bottom-up approach instead of top-down one because it begins with real livelihood strategies of people looking at their areas and situations, what they have, and what their needs and interests are. According to Ellis (2000) and Lakapana (2013), the SLA considers two main aspects: environmental and social aspects. The environmental aspect deals with sustainability, while the social dimension looks at the livelihood adaptation, the vulnerability, resilience and the ability of livelihood to cope with and recover from shocks and stresses. These shocks, as explained by the framework (Figure 1), include drought which increases the vulnerability of the pastoralist community by weakening their livelihood assets (human, social, natural, physical and financial capitals). In the case of drought, impacts bring spatial and social mutations inside the area. Transformations should come from the external factors such as the governments and NGOs implementing policies in order to generate livelihood outcomes in the form of income and food security increases. These outcomes will directly affect the livelihood assets while the transforming structures will impact the vulnerability as shown in the figure 2.2.

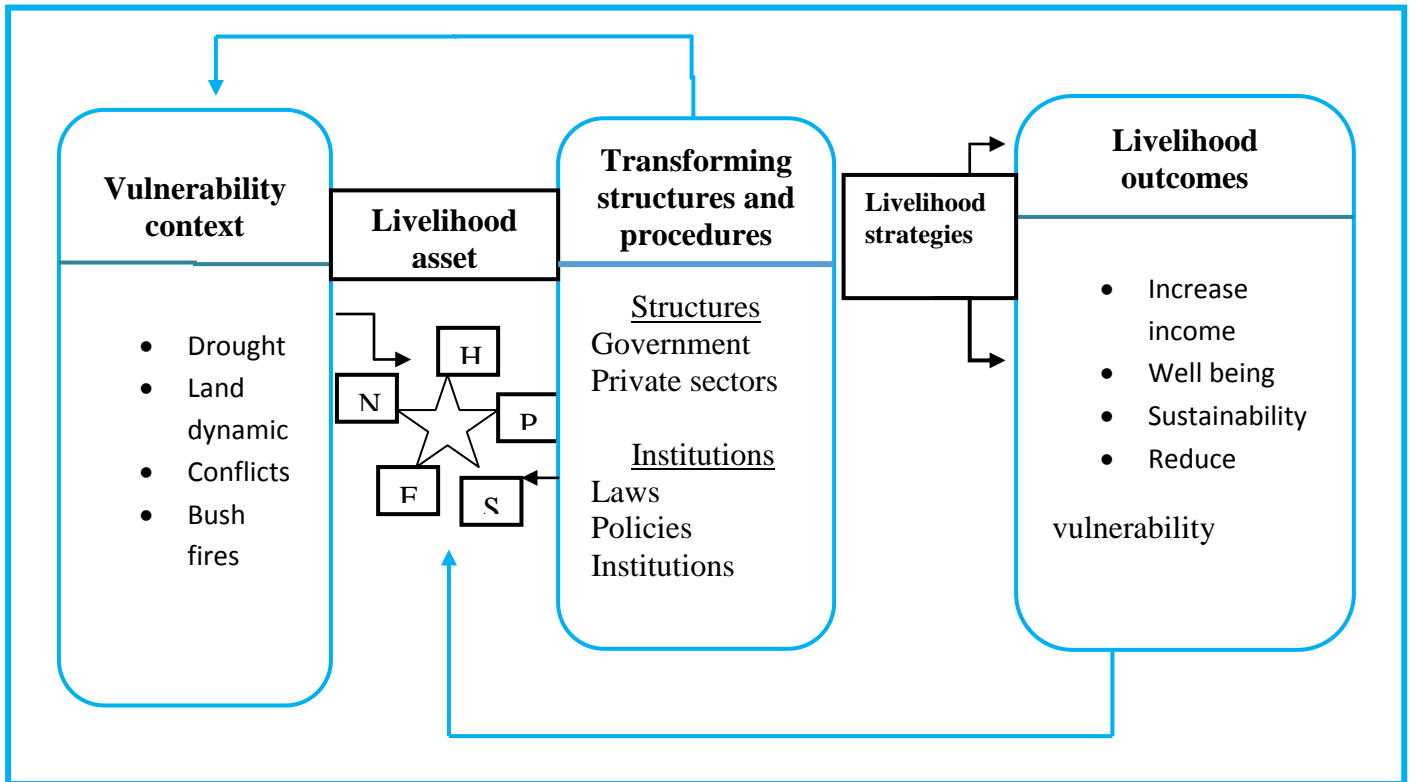


Figure 2.2: Sustainable Livelihood Framework (adapted from Ashley and Carney, 1999)

Five livelihood assets are identified. They are the Natural capital (soil, water, air, genetic resources etc.), Human capital (skills, knowledge, and labour), Social capital (networks, social claims, social relations, affiliations, and associations), Physical capital (infrastructure), and Economic capital (cash, credits, and savings). In this study, the context of vulnerability are drought and land dynamic resulting in scarcity of water and pasture, conflicts and destruction of the ecosystem of forest. To come with a sustainable adaptation of pastoralists and increase income and well-being, a set of indicators are used. Conflicts trend and bush fires in drought periods over the years will be used to assess the adaptation. To reduce the negative effects of these phenomena on resources and finance, the indicator of structures such as the government and NGOs will be assessed. The question of the organization of the area between different actors will be raised. How is the area organized and who are the actors engaged in the management of resources? What are the laws of land use in the area? It will shed light on institutions and laws that are put in place to act on livelihood asset and transform the vulnerability context into opportunities of sustainable management of resources.

CHAPTER THREE: MATERIALS AND METHODS

3.1 The study area

The District of Velingara Ferlo is part of the three departments which form the region of Matam. It is located in the north eastern part of the region and falls within the large pastoralist area in Senegal called the Ferlo. It covers 1/4 of the Senegalese area (15° N and 14.68° and 14° West). There are three main reasons guiding the choice of the study area. The first reason is the large proportion that the livestock farming activity occupies in the livelihood of the households of the study area. At the regional level, livestock and its derivatives contribute significantly to the economy. According to the ANSD (2013), the largest percentage of sheep in the region of Matam is found in the department of Ranérou-Ferlo. It further stated that about 90 % of the populations in the Regional Direction of the Rural Water Supply are involved in the livestock farming activity and it covers an area of 1,740 km² for pasture in the District of Velingara Ferlo.

The second reason is based on the drought impacts and adaptation strategies in the District. Droughts are recurrent events in this commune with a high number of impacted households. The community is always adapting itself to drought, recovering from it every time without changing its activity. The Matam region remains the most resilient region of the country according to FAO analysis of resilience (FAO, 2016) despite its backwardness in human development indicators in comparison to other Senegalese regions. This result may be typically linked to the high levels of adaptive, transformative and coping capacities. Analyzing the adaptation strategies that are being used in the District of Velingara Ferlo is our central focus because it can reveal new adaptation strategies that can be shared and replicated elsewhere.

Third, the choice of this study area is dictated by adaptation strategies that were being opted some years ago in Senegal in order to control and well manage the pastoral activities and the resources (water and pastures) by the creation of Pastoral Units. Five (5) of these PU are currently identified in the District of Velingara Ferlo (see figure 3.1). Assessing this division of the pastoral area can reveal spatial, social and economic mutations in the community.

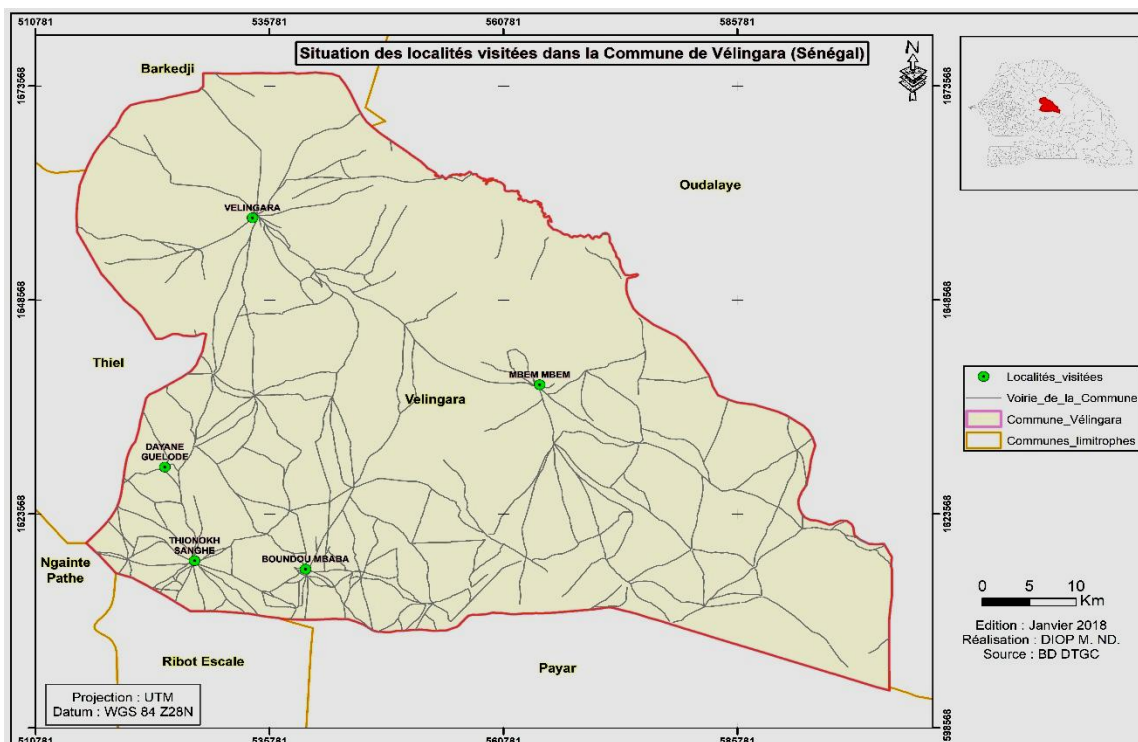


Figure 3.1: District of Velingara Ferlo

Source: DTGC, 2017

The District of Velingara Ferlo covers an area of 2,611.7 km². It is located in the south-western part of the department of Ranérou-Ferlo in the region of Matam. It is bounded in the north by the rural community of Barkédji (department of Linguère), in the South by the rural community of Kouthiaba (department of Tambacounda), in the South East by the community of Ribot Escale (department of Kaffrine), in the East by the rural community of Oudallaye (department of Ranérou) and in the West by Thieul (department of Linguère).

Like most of the Sahelian region, the District of Velingara Ferlo is an arid zone which registers one rainy season from July to September with precipitations varying from 300 mm to 600 mm. Temperatures are also very high with the peak reaching 48 °C during the dry season (Koutoudio, 2005). Due to the dry character of the area, the sources of water are mainly rainfall and surface water with the presence of ponds which dry up in the dry season. The underground water is composed of *Maestrichtien* aquifer discovered in 1938. It helped in the construction of drills to fix the pastoralists around water sources and was the beginning of the sedentarization of pastoralists. The distance between villages and drills are estimated to be 15 km (Koutoudio, 2005).

3.2 Materials Used

To conduct this research, many materials were used. They rank from household survey to Focus Group Discussions and interviews. Information on household survey was collected using the ODK Collect software V1.11.0. When collected, the information was sent every to a server for analysis. Interviews and Focus Group Discussions were realized using recorder and notes. GIS and remote sensing through ARCGIS 10.0 software was used to quantify the land dynamic of the district. The Standardized Precipitation Index was computed using EXCEL software to have the anomalies and drought years.

3.3 Methodology

3.2.1. Sampling Method

The sampling site is identified according to the work done by Agronomes et Veterinaires Sans Frontières (AVSF) who have been working in the Commune since 2013. The information provided reveals a division of the commune in five (5) Pastoral Units as a tool to manage water and pasture resources. These are Dayane Kodiolél, Mbem Mbem, Velingara, Mboundou Mbaba and Thionokh. The area presents a similarity and almost all the people are practicing livestock farming. However, because it is divided into pastoral units, each Unit functions differently. Some are working well while others are not getting it right. Examining its function can help in the choice of sampling method.

According to the National Agency for Statistics and Demography (2013), the population of the Commune of Velingara Ferlo is estimated at 21,052. The characteristics of pastoralism in the different Pastoral Units (PU) were identified using the stratified random sampling technique used by Steven K. Thompson in 2012. The choice of such technique is to capture the points of view of the different actors. In fact, even if the community is almost a pastoral community, the difference comes in the fact that every pastoral Unit has its own way of managing its resources. Some are well managed while others are still facing difficulties. With a confidence level of 95% and a population size of 21,052, this gives a sampling size of **200** for our study area.

Because the size of the strata were unknown, we assumed a random sampling in each strata by dividing the sample into five strata (the five PU), which gave 40 questionnaires for each stratum that defined here as being the Pastoral Unit (PU). In each Pastoral Unit, two villages were randomly chosen. Households were chosen randomly in each village.

3.2.2 Data collection

In this study, both primary and secondary data were used.

➤ Primary data

Questionnaire: Structured questionnaire with an open-ended and pre-coded was designed to collect information in the households of the study area. ODK collect software V1.11.0 was used to collect data (www.odk-collect.fr.uptodown.com). The enumerators were trained to administer the questionnaire in the far-away villages. The questionnaire was tested before the official investigation. It aimed to have a view on the effects of drought and land use change on the livelihoods of pastoralists and adaptation strategies put in place.

Interviews: They concerned authorities involved in the development of the pastoralism (AVSF, AAH). They shed light on the adaptation strategies that they are implementing and challenges faced.

Focus Group Discussions (FGDs): Two focus group discussions were held in the five pastoral units. The participants freely expressed their opinion and perceptions about the subject of this study. The discussion focused on the impacts, changes and adaptation strategies in the pastoral unit scale as well as the management of the resources during drought periods.

➤ Secondary data

Primary data gave the perceived effects of drought and land use/ land cover changes on the pastoralists. This information was used with the secondary data for test and comparison. The following secondary data were used for this study:

The GIS and remote sensing: Quantification of the land use/ land cover change in the pastoral area necessitated the use of GIS. 30-year (1987–2017) time series Landsat images were downloaded from the website of United States Geological Survey (USGS) (www.earthexplorer.usgs.gov) were used for measuring the dynamic of pastoral space of the study area. Four out of thirty images in the study area were analyzed. The selected years 1987, 1997, 2007 and 2017 were based on historical events such as droughts, policy changes, and

availability of satellite images. Since Landsat produces two types of images every month, the study was interested in the year when period of dry season was very advanced. The months of April to May were considered. This choice allowed us not only to measure the changes in terms of increase in farm land areas, settlements, forests and ranches over the years, but also the pasture coverage. The Universal Transverse Mercator (UTM) geographic projection, Clarke 1880 spheroid, and Senegal Zone 28 North datum were used in geo-referencing the images.

The processing step of the images was done using image classification techniques, precisely the semi-supervised classification. It assumed a field visit in the area for recognition of the different land use types. ARCGIS was used to produce maps. Land use and land cover maps gave the expansion of farming activities, settlements and the shrinkage of grazing lands which were compared to the baseline 1987 to appreciate the total of grabbed area by agriculture and habitat, and the total loss of grazing lands by livestock farming.

Climatic data: Precipitation data for the period of 16 years (2002–2017) were collected from the meteorological station of Velingara Ferlo. The data was used for the computation of the Standardized Precipitation Index (SPI). In line with the McKee et al. (1993), precipitation deficit was quantified using multiple time scales. This was computed by considering the precipitation anomaly with respect to the mean value for a given time scale and divided by its standard deviation. The distribution of precipitation was not assumed to be a normal distribution, at least for time-scales less than one year.

The Standardized Precipitation Index (SPI) was used to analyze drought severity. The SPI was calculated for 12 months (M12) for the period of January 2002 to December 2017. Negative values of SPI were considered to represent dry periods and positive values reflect wet periods.

The following formula was used for the computation:

$$SPI = \frac{x_{ij} - x_{im}}{\sigma}$$

Where

σ is the standard deviation,

x_{ij} is seasonal precipitation,

x_{im} is long term seasonal mean precipitation.

Drought was considered to have occurred when the SPI value is negative and the drought ended when positive value starts. Drought severity is also classified into different categories based on the range of the SPI values shown in the table 3.1

Table 3.1 SPI values

SPI values	Class
>2	extremely wet
1.5 to 1.99	very wet
1.0 to 1.49	moderately wet
-0.99 to 0.99	near normal
-1 to -1.49	moderately dry
-1.5 to -1.99	severely dry
< -2	extremely dry

Source: WMO, 2005

Demographic data: The demographic data was used to validate the land use and land cover changes with respect to population growth of the area. It was also used for the assessment of increase in settlement and agriculture farming areas. The demographic data was further used to determine the land space required for livelihoods of the growing population of the study area.

Bush fires and conflicts data: Information on bush fires and conflicts were collected from the local authorities and NGOs working in the study area. The acquisition of information on conflicts and bush fires over the years was used for the assessment of adaptation strategies adopted by pastoralists in the study area.

3.4 Data Analysis

Quantitative data were analyzed using EXCEL 2013 from <https://microsoft-excel.fr.softonic.com> to produce the graphs. Qualitative information was also analyzed using recorder and notes. Climatic data for the 16 years periods were analyzed with EXCEL 2013, while the land use/land cover maps were produced using ARCGIS10.0 (<http://desktop.arcgis.com>)

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Results

4.1.1. Drought characteristics

4.1.1.1. Precipitation characteristics

The district of Velingara Ferlo recorded low amount of precipitation during the period 2002-2017, being part of the semi-arid area of the Sahel. Globally the recorded mean rainfalls do not exceed 400 mm (Koutoudio, 2005). The figure 4.1 shows the characteristics of annual rainfalls in the district from 2002 to 2017.

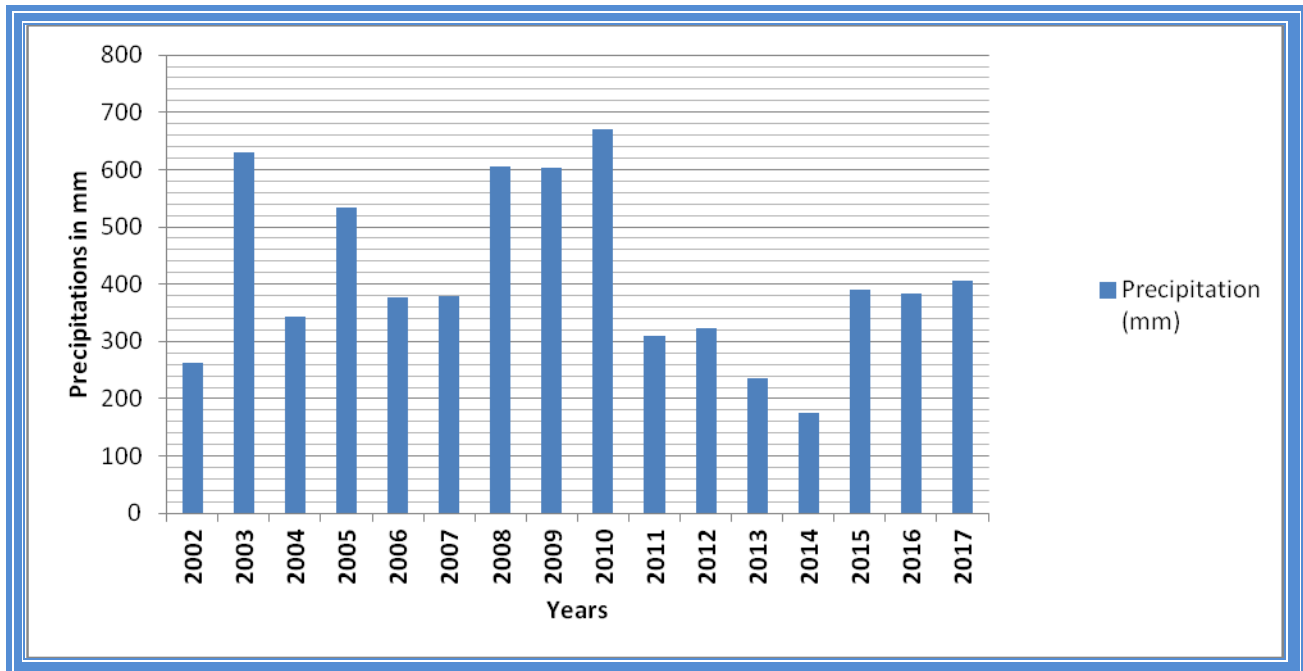


Figure 4.1: Precipitations in Velingara Ferlo district from 2002 to 2017

This figure presents a decrease of annual rainfalls over years with, however, some important rainfalls recorded in 2008, 2009 and 2010. Generally, the district of Velingara is located in the hysohiete between 300-400 mm which is characterized most of the time by frequent droughts.

4.1.1.2. Standardized Precipitation Index (SPI)

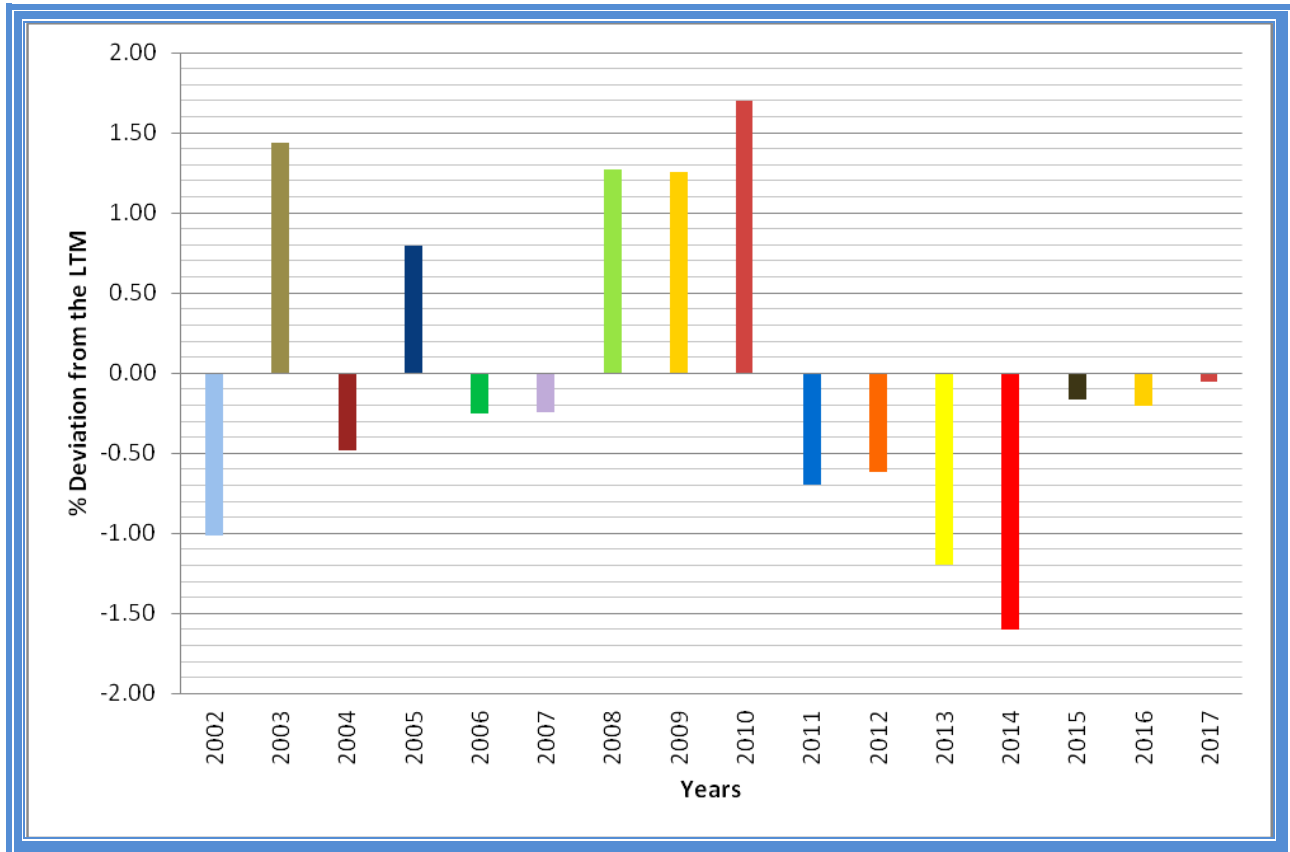


Figure 4.2: Standardized Precipitation Index (SPI) of Velingara Ferlo from 2002 to 2017

The Figure 4.2 shows the rainfall anomalies in the study area for a period of 16 years beginning from 2002 to 2017. The absence of rainfall data recorded in the meteorological station from 1987 to 2001 in the study area is the reason for the choice of 16 years rainfall data that was available. This short period of rainfall data availability is a great limitation for this work. The rainfall mean for this long term period is 414.28 mm. Drought is considered to have occurred when the long term annual mean rainfall is greater than annual rainfall. There was an indication of drought of about 66.6% during the study period in the district of Velingara. Precisely, there was 11 years of drought out of 16 years study period. These years are 2002, 2004, 2006, 2007, 2011, 2012, 2013, 2014, 2015, 2016 and 2017. The result of the study shows a continuous record of drought for a period of 7 years beginning from 2011 to 2017.

Table 4.1: Drought severity in the district of Velingara Ferlo

Years	Annual rainfall	Drought Severity Index (SPI)	Drought category
2017	406	-0.05	Mild
2016	384.4	-0.19	Mild
2015	391.2	-0.15	Mild
2007	378.7	-0.23	Mild
2006	377.1	-0.24	Mild
2004	342.6	-0.4	Mild
2012	323.2	-0.6	Mild
2011	310.6	-0.69	Mild
2002	263	-1	Moderate
2013	236.1	-1.18	Moderate
2014	174.9	-1.69	Severe

***Mean annual rainfall of the study area: 414.28 mm**

Table 4.1 shown above indicates various categories of drought that were observed in the district of Velingara within the study period. Three categories of drought were identified. These were mild, moderate and severe. The severity index of mild drought observed in the years 2004, 2006, 2007, 2011, 2012, 2015, 2016 and 2017 ranges from -0.05 to -0.69. Moderate droughts were observed in the years 2002 and 2013 with severity index of -1 and -1.18 respectively while severe drought occurred only in the year 2014 with severity index of -1.69 and no record of extreme drought during the study period.

The characteristics of drought displayed in this study show two prolonged drought. Prolonged drought is a major threat to livestock farmers' activities. In fact, it destroys the socio-economic activities of households and makes their adaptation and coping strategies tough. The first and second prolonged drought within the study period occurred in 2006–2007 and 2011–2017 respectively in the district of Velingara. These two phases of drought were different in intensity and severity. The first one was qualified to be mild because of short period it covers (only two years) while the second drought was combination of different classes of drought such as mild, moderate and severe because of long period it covers. The peculiarity of severe drought is that it has a large spatial extension and does not only concern a particular place or area. In Senegal, the most recent severe drought occurred in 2014 which led to food insecurity experienced in the

whole country. The drought of that year made the Senegal policy decision makers to declare drought as a national disaster that requires relief aid in the country.

4.1.2. Land dynamic characteristics

4.1.2.1. Agriculture and settlement expansion

The district of Velingara, which is known for breeding vocation is now characterized by an expansion of crop farming and habitat like other districts of the region to the detriment of breeding spaces. It is the second district in the Department which accounted for the largest number of animals after the district of Oudallaye. The study of the land dynamics of the city covers a period of 30 years beginning from 1987 to 2017. The following years 1987, 1997, 2007 and 2017 were selected for this study.

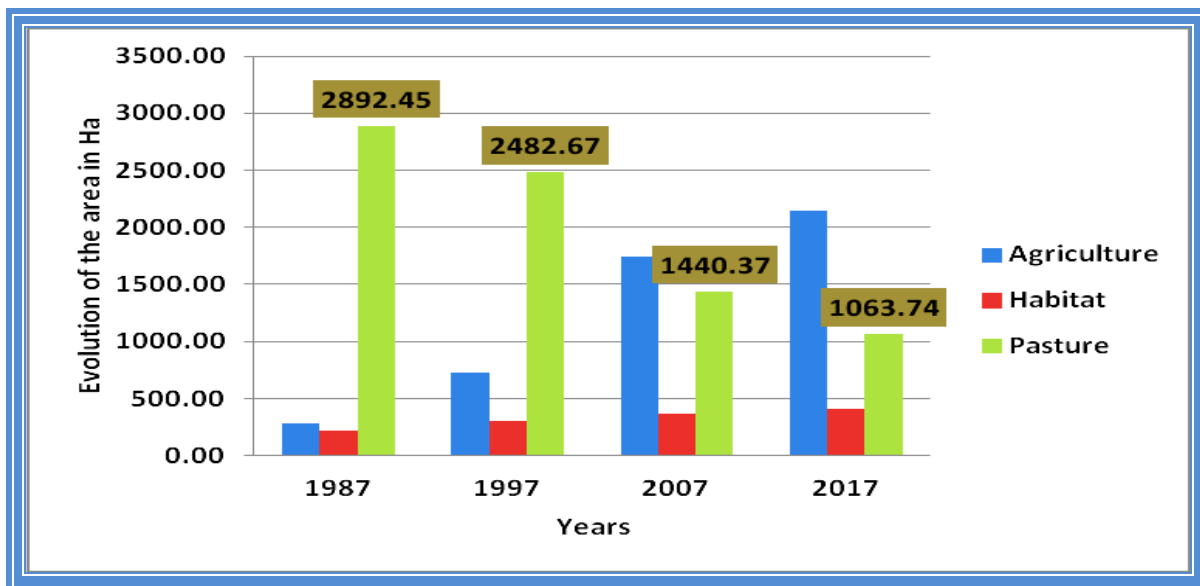


Figure 4.3: Evolution of the area from 1987 to 2017

The Figure 4.3 shows a rapid increase of crop farming activities and a slight increase of habitat. Farming activities occupied 2143 Ha in 2017 against 283 Ha in 1987. The year 2007 recorded an expansion of farming areas (1747.88 Ha). Habitat extends approximately by 100 Ha per decade while grazing lands have reduced to 1063.74 Ha in 2017 against 2892.45 in 1997. The Figure 4.4 below compared the three last decades to the baseline 1987.

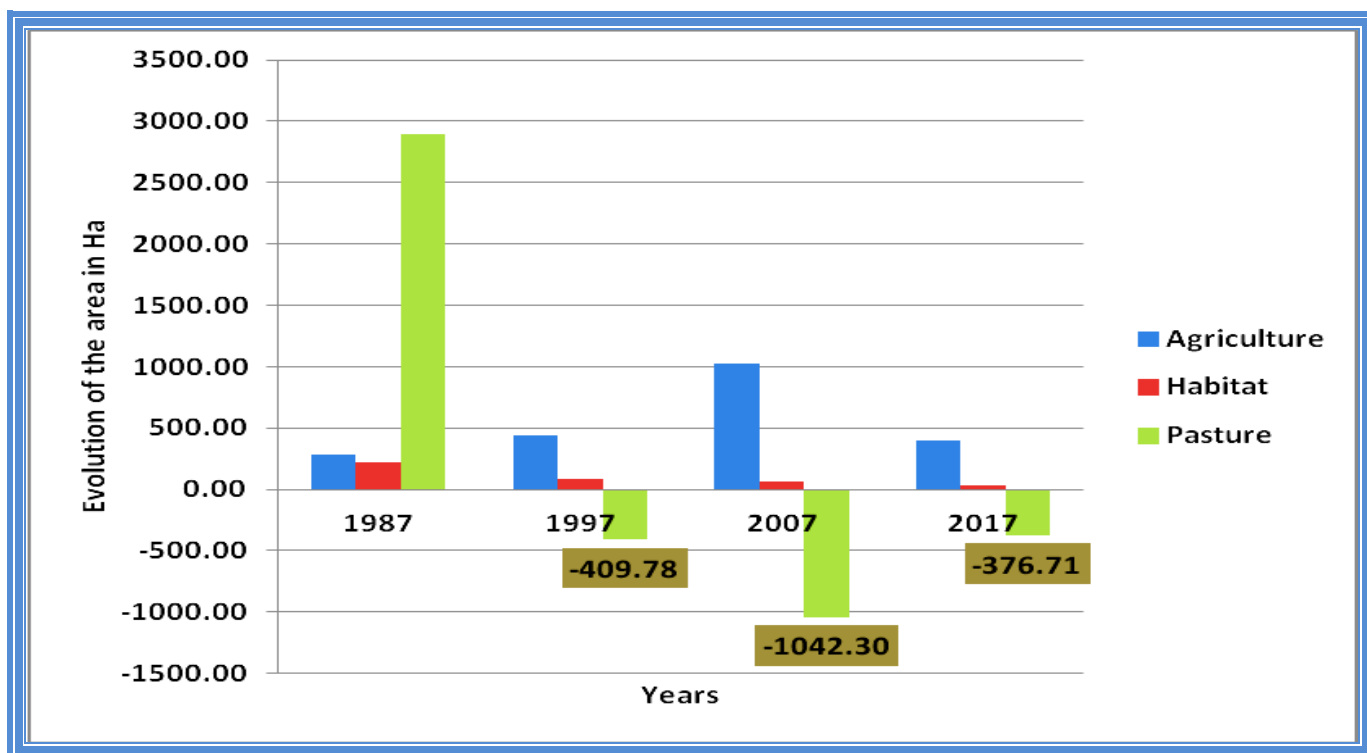


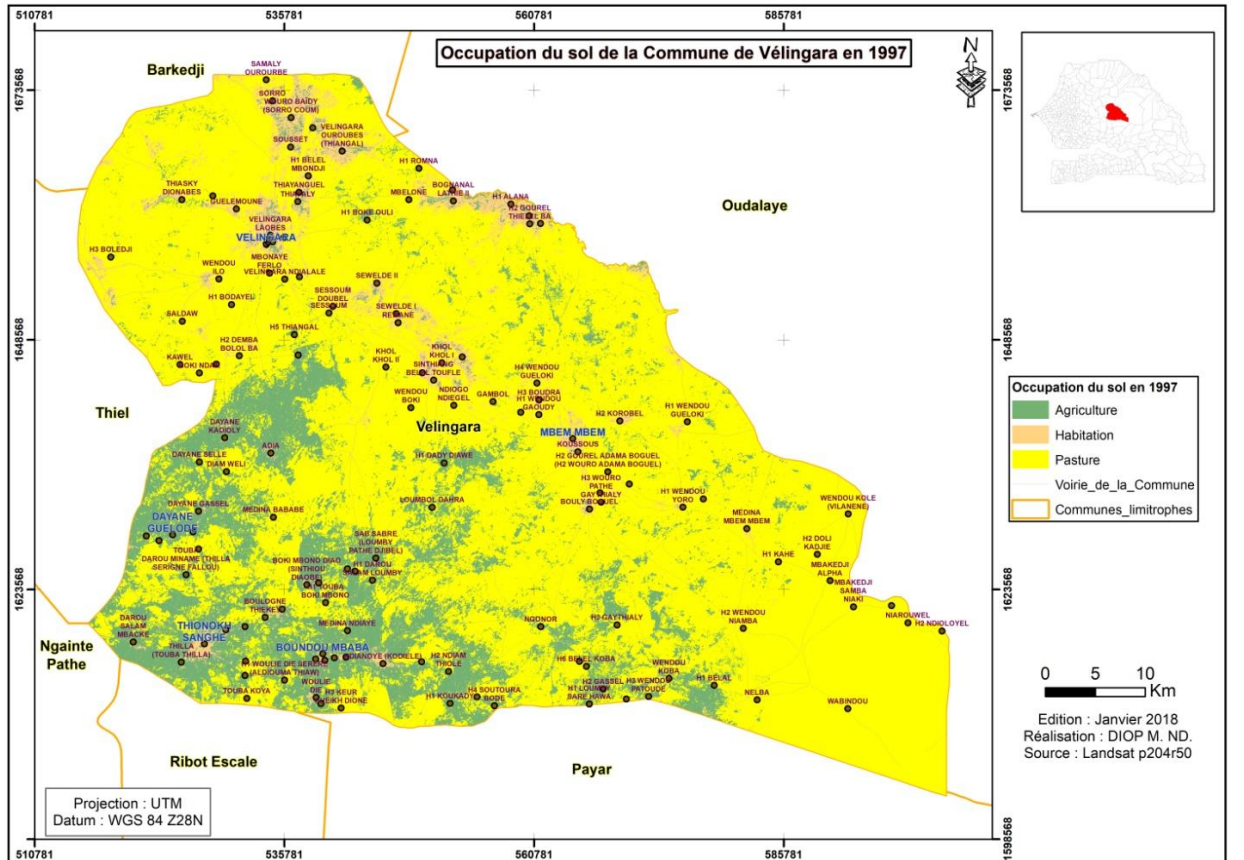
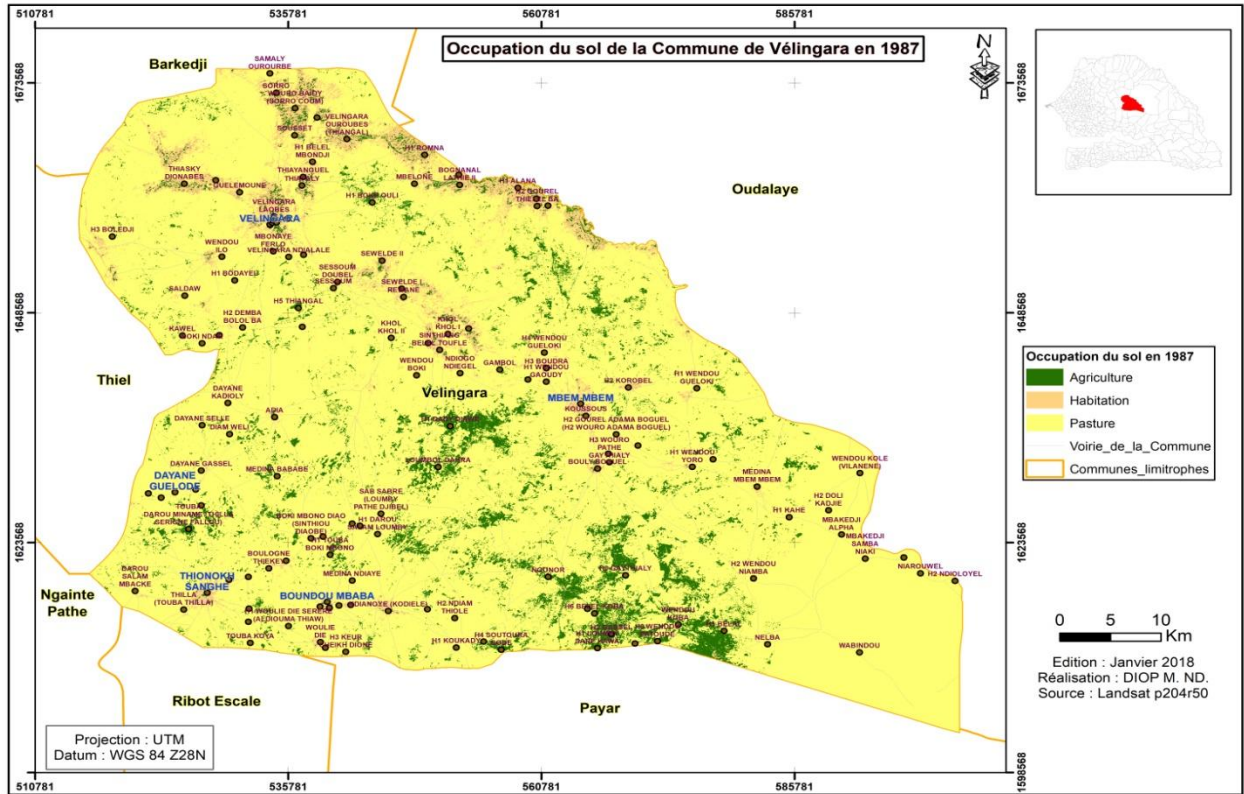
Figure 4.4: Land Use and Land Cover Change compared to baseline 1987

From Figure 4.4, a net increase in farming areas and a sharp reduction in livestock areas was noticed. Progressive increase in the land area occupied by habitats does not constitute a threat to livestock production in the same way as agriculture do. This finding corroborates the responses of field surveys carried out for this study. According to the herders, Land Use and Land Cover (LULC) of the district are perceived by agricultural expansion (52%) whereas 18% of the surveyors perceive the changes in the reduction of the pastoral area. Deforestation and conversion of farming lands into housing represent 15% of the perceived environmental changes. As it is applicable to everywhere in Senegal, districts with potential resources are converted by internal and external actors (agro-businesses, transhumants and local political leaders). Politically, land issue has become an opportunity for the delocalized authorities who use it for electoral purposes.

About the drivers of agriculture expansion that have triggered the spatial dynamic in grazing areas, the answers are diverse. They range from drought which makes all activity vein (51%) to population growth of the district (34.5%). Migration of foreigners inside the district accounts for

10% of responses while poor governance and private farms represent 3 and 1% respectively. The figure 4.5 below shows the land use and land cover change from 1987 to 2017.

The LULC also resulted in similar results with that doing on Land-use/cover dynamics in Northern Afar rangelands, Ethiopia (Tsegaye et al., 2010). According to this study, a rapid reduction in woodland cover (97%) and grassland cover (88%) took place between 1972 and 2007. Bushland cover increased more than threefold, while the size of cultivated land increased more than eightfold. Bare land increased moderately, whereas bushy grassland and scrubland remained stable. According to accounts from local people, major events that largely explain the changes include: (1) severe droughts in 1973/74 and 1984/85; (2) increase in dry years during the last decade; and (3) immigration and increased sedentarization of pastoralists.(Tsegaye, Moe, Vedeld, and Aynekulu, 2010).



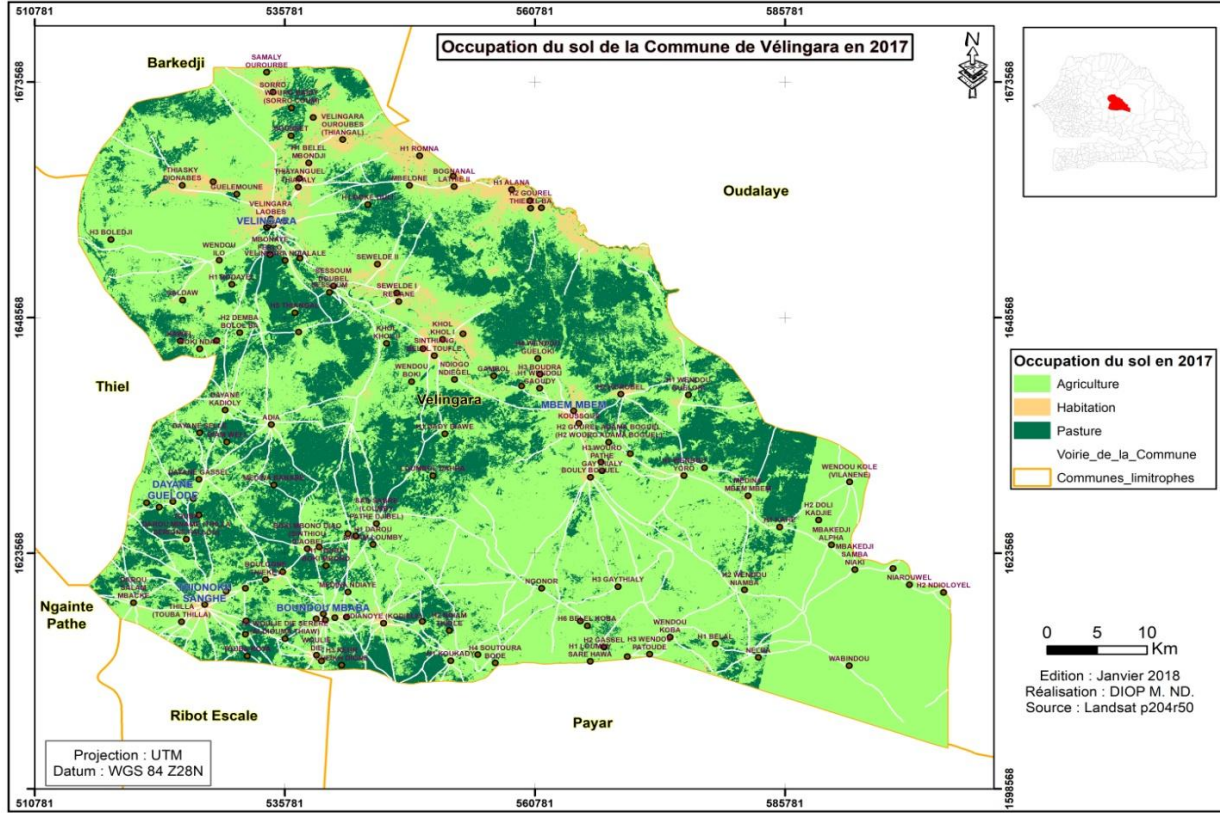
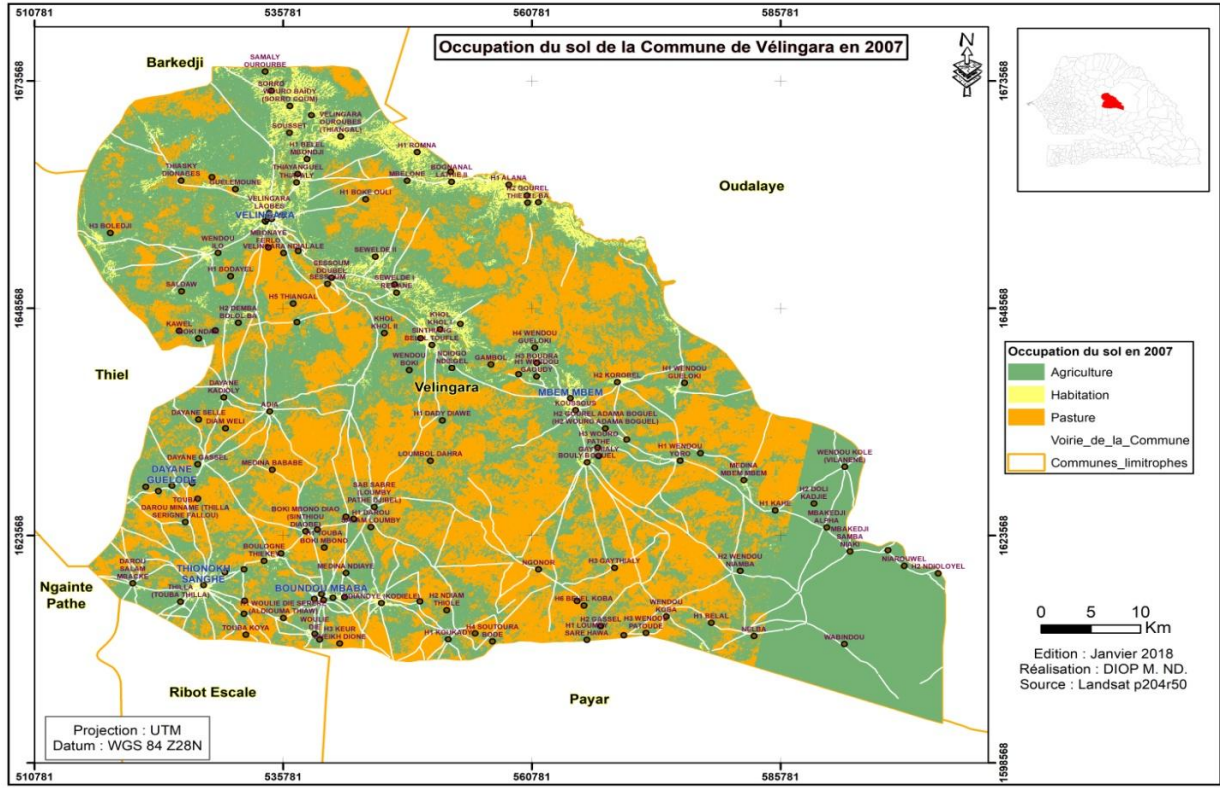


Figure 4.5: land use and land cover change from 1987 to 2017

4.1.2.2. Increase in human and animal population

The population of Velingara Ferlo district has changed considerably over the past decades. This is largely due to the population growth rate and the massive arrival of other actors from agriculture and trading. These people end up staying and setting up villages. The examples are Sereres' villages, an ethnic group of farmers coming from the center of the country for agriculture and Moorish villages which are mainly focus on trading. According to the data, the population grows from 16.181 in 2006 to 21.052 in 2013, this show an increase of 76% within 7 years (ANSD 2014). Figure 4.6 below shows the demographical patterns of the district from the year 2006 to 2017.

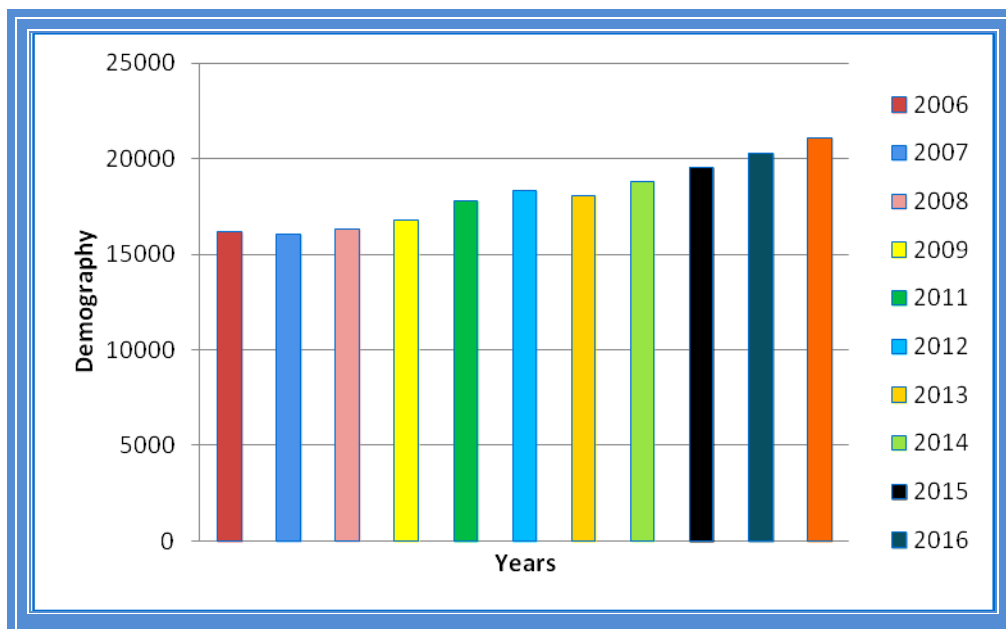


Figure 4.6: Demography of the district of Velingara Ferlo 2006-2017

Over the study period, it was observed that cattle have been increasing over the years in an increasingly small space, posing the problem of pastoral overload and land degradation. The same observation was noticed in several studies on land use and land cover change (Tsegaye et al., 2010). The results of this study show that land-use shifts caused by external and internal drivers have influenced many traditional resources management regimes, especially in semi-arid

areas where often a pastoral way of life has been the tradition. The outcome of this study conform with the result of the study of Tsegaye et al. (2010) that pastoralism has been considered as environmentally destructive resources exploitation resulted in overstocking and the disruption of a perceived ecological equilibrium.

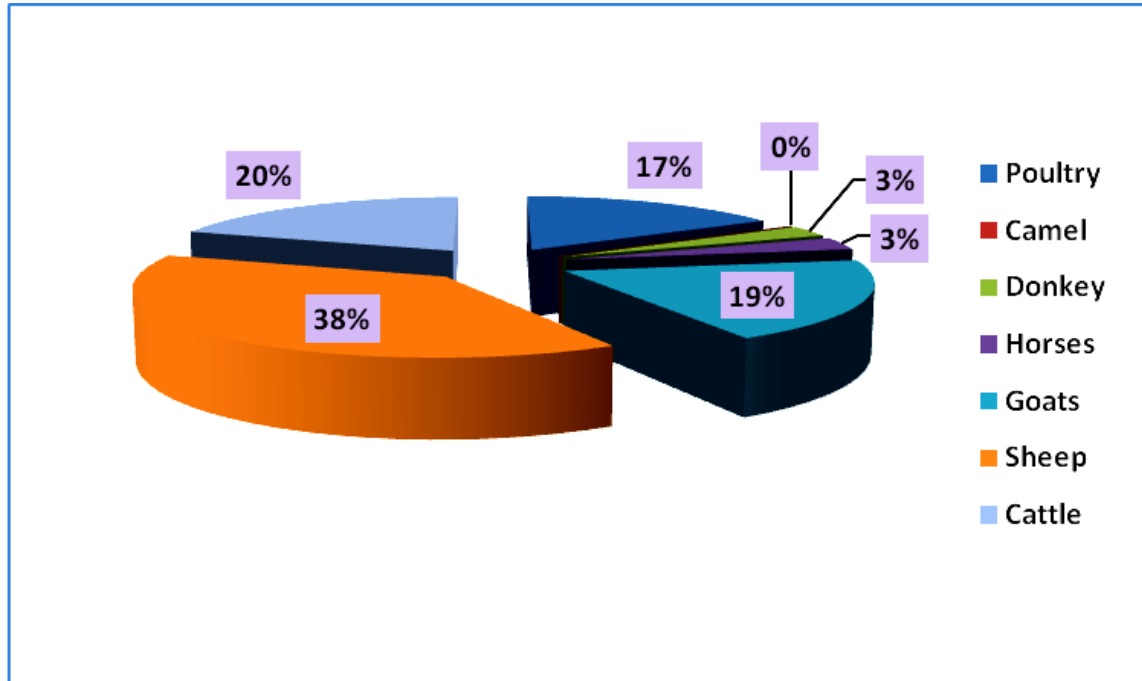


Figure 4.7: Animals’ population in the district

4.1.3. Effects of drought on the pastoral community

4.1.3.1. Physical effects

Drought affects pastoral livestock systems essentially by reducing the amount of forage available and thereby leading to the death of livestock as a result of starvation. It may also directly kill livestock through lack of drinking water (Caleb, 2011). Interviewers declared that the most difficult problem they are facing in drought periods are the lack of pasture, followed by the lack of water in the deep dry season (dryness of ponds and technical problems of the boreholes). As a result of the above problems justified by this study, the Regional Hydraulic Service (RHS) provides 21, 68 and 58 drills in the department of Ranerou, Matam and Kanel respectively while the district of Velingara has 6 drills. Drought may also increase the vulnerability of livestock to a

range of animal diseases, both during the dry phase and a succeeding recovery phase when internal parasites may flourish in newly rainy conditions environment as expressed by the respondents. Figure 4.8 shows the effects of drought as perceived by the pastoralists.

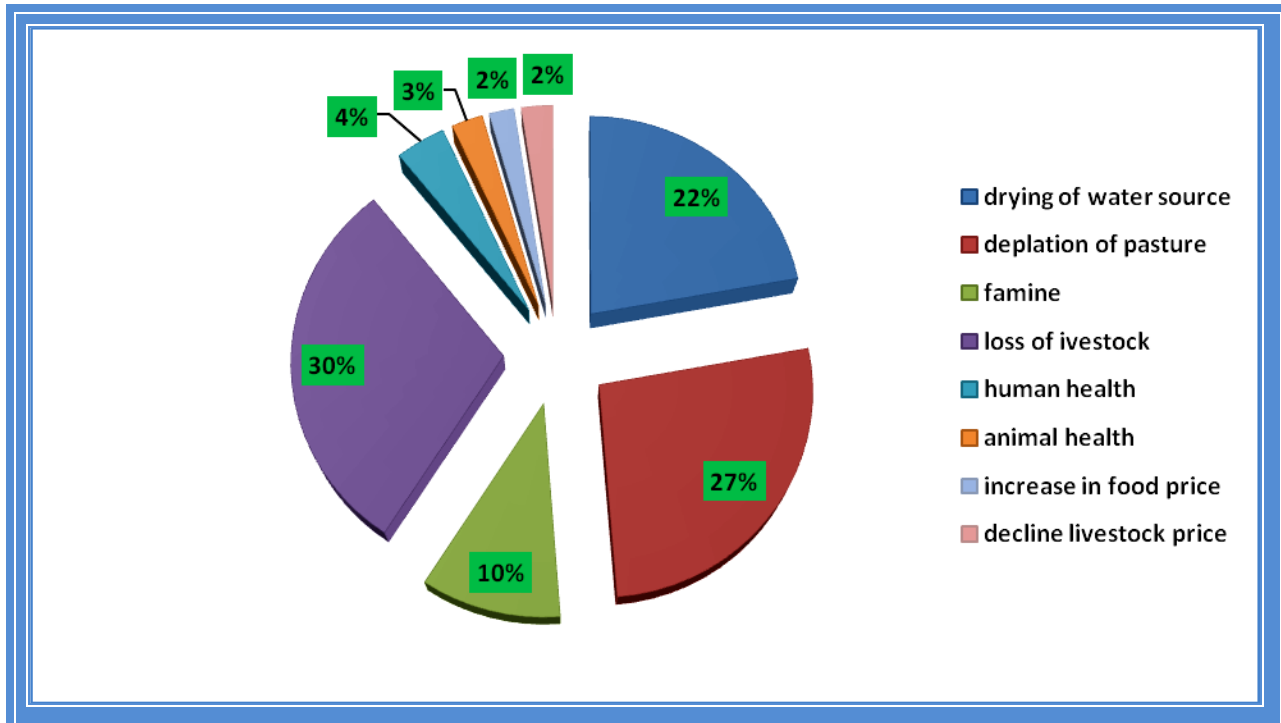


Figure 4.8: Effects of drought and land use/land cover dynamic

It is interesting to note from the responses given by respondents that the lack of pasture (27%) and water (22%) is the most important factors effecting pastoralism. Further analysis on the effects of drought as contained in the responses given by the respondents indicates that loss of livestock represents 30% of the responses while human’s health accounts for 4%, followed by animal’s health 3%. Increase and decrease in food and animal price represent 2% each. The above findings established that Velingara Ferlo community depends heavily on natural resources for their livestock production. The severity of drought and its impact on livestock production translate into reduction in purchasing power of pastoral households.

Based on the responses from the respondents in this study, the effects of drought and land dynamic among the pastoral community have negative consequences in their livelihoods. In the event of scarcity of water and pasture due to the absence of sufficient rainfall, animals become weak and vulnerable to various diseases. During this period, herders are left with two options:

the first option is to sell some of the cattle to buy food for the rest while the second option is to see them all dying of hunger and starvation. During interview, most of the respondents said the second option is mostly common because of their long experience of drought. Respondents during interviews asserted that their households do not store water in drought periods. They depend on the drills which annually met management or technical problem making herders and their animals to move far in search of water. This attitude of the pastoralists can be understood when looking at their water access. They purchase 88.5% of their water which is constant while 11.5% is seasonal. The transhumants from other regions that use ponds and well do not pay because the access to these resources is free. The community of Velingara Ferlo is not used to migrate in drought periods; this is largely due to their culture and tradition. 95.5% of the respondents use drill's water managed by the community while others have their private water source. To have access to the resource, the respondents shows that 88.5% set fee to the drill comity and 10.5% do not offer any payment as shown in Tables 4.2, 4.3 and 4.4

Table 4.2: Water sources and characteristics

Characteristics of water	%
Constant	88.5%
Seasonal	11.5%
Total	100%

Table 4.3: Management of water

water_management	%
Community Management	95.5%
Private	3.5%
Other	0.5%
Total	100%

Table 4.4: Types of contribution in water resources

Types of contribution	%
In case of break down	1.0%
no contribution	10.5%
Set fee	88.5%
Total	100%

These tables show that even if the pastoralists have access to water, it is clear that the accessibility remains difficult for many reasons. The resource, specially the drills, is for those who can afford it. In addition, problems of breakdown of the drill are a risk for those who depend only on it. The lack of water, through the scarcity of rainfall that leads to an early drying up of the ponds and the difficult access to drilling during drought affects both herders and their livestock through a huge loss of animals and household food insecurity.

The absence of sufficient rainfall favours a rapid depletion of the herbaceous carpet, making herders to either buy cattle feed or to move to areas where there is sufficient rainfall. The first option is the most common in the area. Interviews and Focus Group Discussion revealed that the purchase of livestock feed is a common practice in the district. Breeders are not used to keep forage in anticipation of drought. Only households engaged in agriculture keep a stock of peanut leaves for the cattle as shown in Plate 1.



Plate 1 Stock of pasture

Depletion of pasture and drying of water sources are the starting point of negative and cascading effects on the livelihood of pastoralists leading to the loss of animal collapsing by hunger, disease and thirst as reported by Lekapana (2013). During interviews, respondents assumed that because of drought, most of them are not considering themselves as pure livestock farmers. They argue that most of the cattle died in the last droughts and they are now focusing on agriculture. Serious droughts that occurred in the region in the 1970s and 1980s remain anchored in the memory of pastoralists. The droughts of 1970s and 1980s like that of 2011 caused serious suffering, leaving most of pastoral households destitute. Such effects are particularly felt by poor members of the community with small livestock holding as they almost lost their entire possession (capital) when their animals perish. Table 4.5 shows the animals' loss during the last decade.

Table 4.5: Number of animal lost during the last decade

Type of animal	10	10-20	20-30	+30	Total
Bull	55	90	75	175	395
Cattle	46	57	45	65	213
Sheep	55	75	75	1223	1428
Goats	55	75	70	280	480
Donkeys	40	2	0	0	42
Poultry	22	30	50	80	182
Camel	0	0	0	0	0
Total					2740

Table 4.5 shows that drought as a climatic stress affects sheep and cattle mostly while donkeys are the most adapted animals with the lowest loss during drought and no information about camel. These effects of drought on livestock breeding which results in the loss of animals have major socio-economic consequences on the pastoral community

4.1.3.2. Socio-economic effects

Livestock plays a key role in the livelihoods of the district of Velingara Ferlo. The value of livestock goes beyond the production of meat, it is based on the full set of services it supplies (milk, skin, etc), their asset value as a form of savings, and their cultural symbolism. In recent time, there is a significant social change in the community due to the arrival of new economic activities that led to the behavioural changes of the herders with a tendency of reducing the herd, migration, or economic re-conversion.

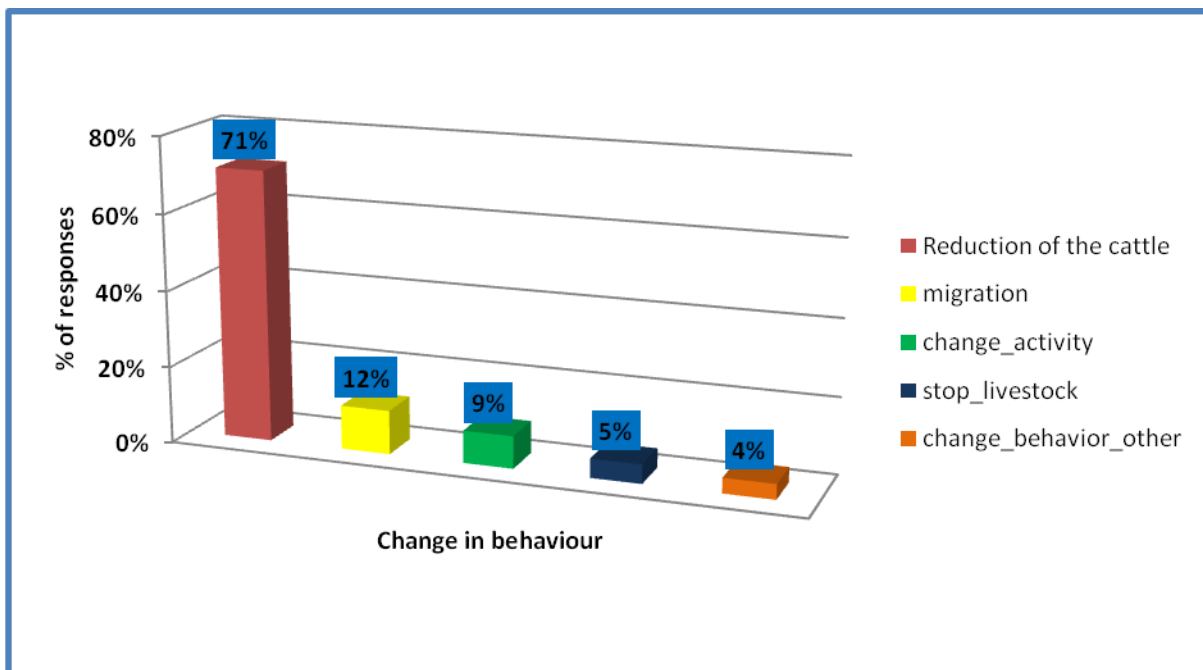


Figure 4.9: Change in behaviour among the pastoralists

Figure 4.9 shows there is a behavioural changes in the activities of the pastoralists in the study area. Based on the findings from respondents, reduction of the cattle (71%), migration (11.50%), change of activity (8.50%), stop of livestock farming (5%) and others (< 5%) which includes the production of arabic gum, petty trading and deforestation. People are reducing the cattle because of water scarcity and lack of pasture due to drought and reduction of the pastoral area which do not allow them to keep more animals. Losses of animals in the past and the market price for cattle are also becoming a real challenge for those who want to continue animal trading. Focus

Group Discussion has shown that even if they keep on increasing the number of the cattle, the challenge would still be the selling price at the market. In general, livestock price usually declines during drought period. The Senegalese urban population knows that pastoralists used to face problem of feeding their animals during dry season. They take advantage of these dry periods to invade the weekly markets of the area to stock up cattle, sheep and goats at low prices.

The livelihood trends have been changing significantly with the pastoralists increasingly becoming impoverished as a result of recurrent droughts. Many people agreed that there is a decreasing trend in access to pasture for grazing which necessitate the sale of animals in the markets without commensurable amount. Other respondents believed that the standard of living has been decreasing remarkably due to drought that caused shortage of grain for consumption and cash income. Plate 2 below shows the weekly market where people sell their cattle to buy grain.



Plate 2: Weekly market of cattle in Velingara

The study observed a gradual socio-economic transformation among the pastoral community of Velingara Ferlo to new ones such as migration, reduction of the cattle, etc. During interviews, 76.5% of the respondents confirmed that the main reasons of selling their animals is for income generation in order to feed the family and entertain the rest of the cattle, while 20.5% mentioned drought, and 11% mentioned re-stocking.



Figure 4.10: Reasons for selling animals

Respondents and members of the pastoral unit comity mentioned conflict as one of the social effects of drought and land use dynamics. They stated that since the area of pastoralism is reducing because of massive arrival of several actors, people have noted more conflicts between many actors. In the pastoral unit of Thionokh, for instance, the President of the committee confirmed that a conflict on land was noted between an agro-business man and the pastoralists in the last decade. Conflict also come when transhumants are in the area, this reduces the quantity of available pasture for sedentary people. The lack of water also leads to a social conflict between residents and migrants. In fact, It was noticed that when transhumants come into the community, they used to settle near ponds which is not without consequences. The presence of animals near these water ponds favours the outbreak of animal diseases such as rift valley fever, it also limit the access of other animals to the ponds which most of the time leads to conflict.

By the same time, it limits the access to other cattle to the ponds, leading most of the time to conflicts.

Drought is a natural phenomenon which has no border. Consequences of a drought in a given place may have consequences that go beyond the administrative borders. The district has recorded a mild drought in 2017, but breeders are accustomed to adapt by managing pasture and water. However, in the department of Podor along the river Senegal, worst precipitations have been recorded the in 2017. During the interviews, herders expect to receive numbers of

transhumants during the dry season 2018. According to them, this situation will increase the number of conflicts over resources. The pastoral unit of Thionokh has already started recording the arrival of 209 transhumants. Knowing the water and pasture problems, conflicts are more than possible to occur with the arrival of trashumants. The table 4.6 below summarizes the local and transhumant population in the pastoral unit of Thionokh.

Table 4.6: Number of animals in the village of Thionokh

	Animals belonging to the pastoral Unit	Animals belonging to transhumants	Total
N° of pastoralists	3547	209	3756
Cattle, Bull	1356	2606	3962
Sheep and goats	4621	5047	9668
Horses and donkeys	1000	1252	2252

In this district, the number of herders is more than the number of transhumants while the population of animal that belongs to the transhumants is more than that of the pastoral unit. In view of the large population of animals in this district, the quantity of available resources will be depleted very early in the dry season and coupled with inadequate infrastructure to support such population.

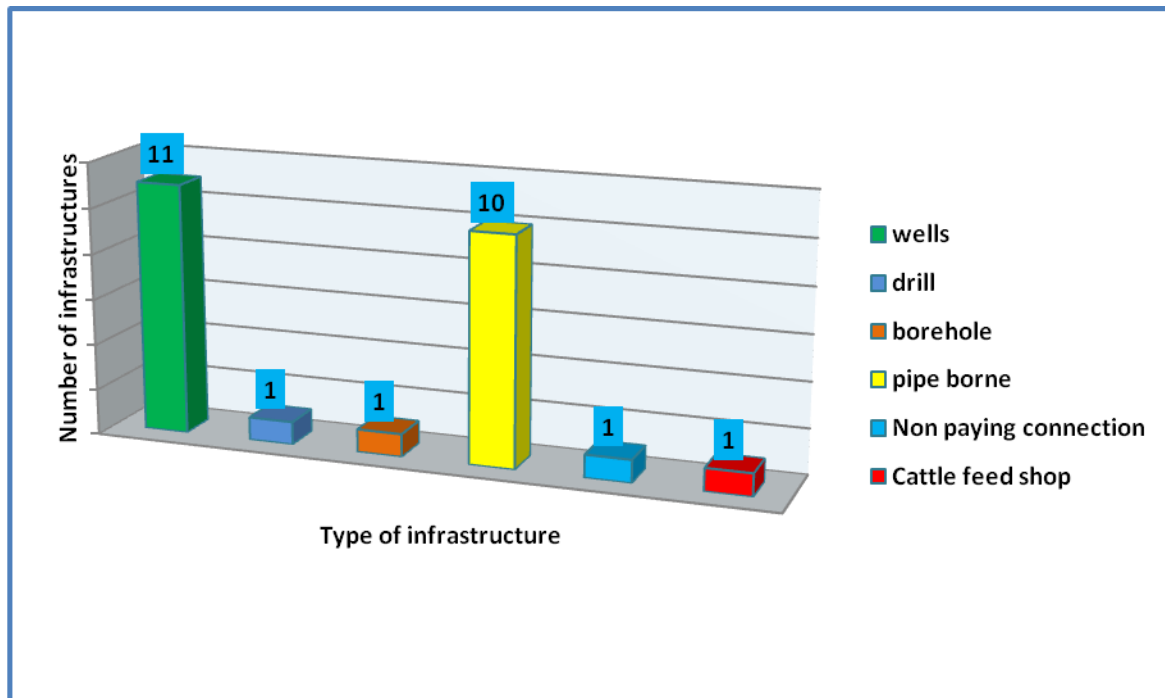


Figure 4.11: Pastoral Infrastructures in Thionokh

Figure 4.11 shows that water infrastructures inside the Pastoral Unit are mostly made of wells and pipes with represent respectively 11 and 10. Wells dry up during the dry season while pipe borne encounter problems because they depend on drills which frequently have technical and management problems when the demand in water is high. It is also noticed that scarce resources that lead to conflict between actors can also trigger other effects in the community.

4.1.3.3. Human security effects

Social effects of drought and land use change as conflict can be noticed in human security, taking into account the individual and economic security. During the interviews, respondents at 4% talked about “other” as response to the question related to the difficulties they are facing in the livestock farming. Digging deeper in the questions with the focus group discussions, it appeared that they all referred to the theft of cattle. In the community as in the overall Senegal, the phenomenon is general. According to the Minister of Livestock and Animal Productions (MLAP), the theft of cattle costs the Senegalese economy FCFA 2 billion/year. In addition, it is done most of the time with violence and human loss. This estimation does not only take the economic value of the animals, but also the effects on the economy and the working hours that the herders had spent on the activity. The scale of the phenomenon has pushed the government to

set up the Unit to fight against theft of livestock. In addition, it has also hardened the sentence of stealing cattle which can range from 5 to 10 years in jail with a fine of FCFA500.000 CFA.

In the district level, livestock theft is favoured by the absence of secure infrastructures either in the households or the weekly markets. In the weekly markets, when animals are not stolen in place, they escape and are lost in the bush. According to the president of the cattle weekly market of Velingara, this situation is very frequent. In such cases, all the members of the group are obliged to financially contribute to the lost animal. Weekly market in the district of Velingara Ferlo is a place where herders can meet, exchange, sell and buy products with other actors. It polarizes many villages and even other districts inside the region.

4.1.3.4. Environmental effects

In the mid dry season, the main available resource for households to alter the negative effects of drought as income generation comes from wood. Talking about the option that they have when the drought become severe, it was noted that 8.5% of the respondents chose as an answer “change activity” and 4% have other alternatives. The information gathered during the focus group discussions and confidences of some respondents, inform that they all refer to the sale of wood and charcoal. Interviews with the Water and Forest Agency of the district revealed that deforestation is a real problem in the area. Even if it is forbidden, people still deforest for income generation. This practice as described by agents of the office causes generally another problem in the area: bush fires.

For years, from September / October to June, the Velingara Ferlo district has been regularly in the grip of bushfires. Bush fires remain a trouble for the population of Velingara Ferlo who experience it every year. According to the coordination of the pastoralists, the phenomenon occurs in the mid dry season and is the fact of charcoal producers and pyromaniacs. Poor rainfall leading to dryness is the cause of bush fires. Even if the agency ensures that they have been reduced, they point out the need to monitor bush fires and sensitization.

4.1.4. Adaptation strategies of the pastoralists to drought and land use change

Adaptation strategies of the pastoralists in the context of drought and land dynamic should be considered in different angles, taking into account the restriction of the activity in a defined area

(pastoral area, agriculture area and habitat) and the traditional adaptation strategies known in all the pastoral zones.

4.1.4.1. Mobility

Pastoralists in the study area considered mobility as their key strategy to cope and adapt to drought. 45.5% of respondents still migrate. It is to enable cattle to benefit from various pasture resources. According to Caleb (2006), it is a natural response to range heterogeneity; pastoralists move their herds sequentially across a series of environments such that each reaches its peak carrying capacity at the time of visit. Key informants ensure that they still follow this tradition but in a different way other than what their parents were doing decades before. In a dynamic area where agriculture expansion is taking place, they changed their way of moving. In fact, in the south of the district, the presence of farmers is taking more and more space, reducing the pastoral area of the district. The solution opted by pastoralists is sedentarization and creation of villages. However, in the dry season when there is no more pasture, the strategy is that one or two members of the household migrate to more fertile areas with the livestock while the other members stay in the village. This strategy is better because livestock rearing is not giving the expected economic results as before and keeping the rest of the family can be a chance for them to practice other economic activities and give chance to children to go to school. Key informants are aware that the livestock farming activity will be difficult in the future and they prefer to anticipate it by investing in the schooling of the children.

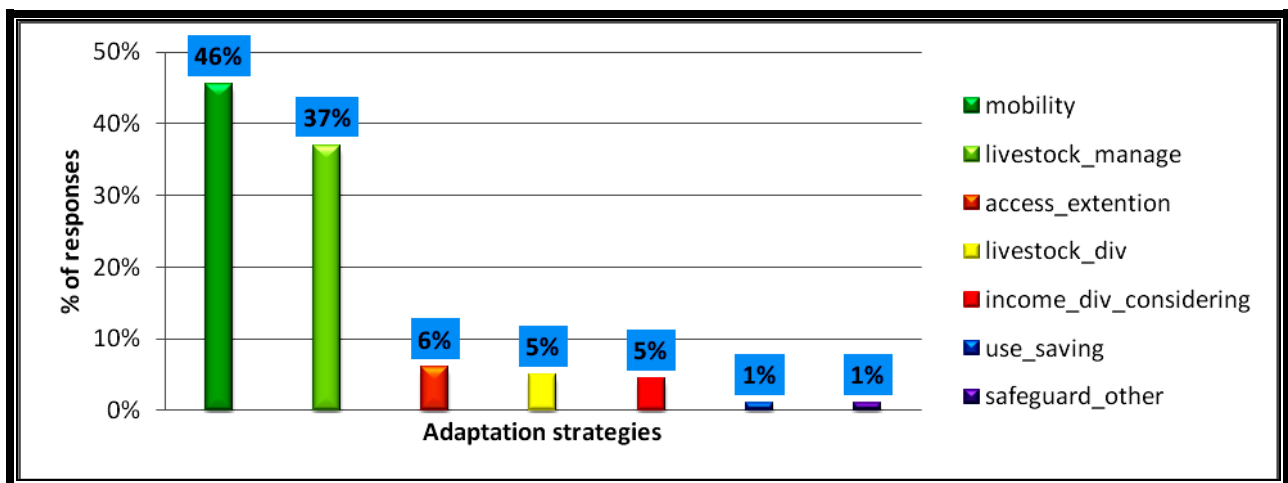


Figure 4.12: Adaptation strategies of pastoralists

4.1.4.2. Livestock management

Population of the area is sedentary even if the cattle move in dry period. However, other strategies have been invented for those who do not migrate in search of pasture. Among the measures used to address the negative impacts of drought is the selling of some of the cattle and use the money acquired from sales to feed the rest of the cattle and also their family. This strategy is justified by their long experience of cattle lost during drought. Opiyo et al. (2015) stated that pastoralists do not only use this option to cover regular adaptation costs, but also to cope with short term shocks. Animals for sale are chosen among the weakest. Breeders usually do not sale cattle, even in drought period. For them, cattle are expensive and it is very difficult to rebuild a herd of beef after a climatic drama. During drought, the price of an ox drops but when it is well fed it can cost FCFA 500.000. For this reason, many interviewees prefer to sell small animals such as goats and sheep during drought. These animals reproduce quickly during abundant of rainfall and the reconstitution of the herds becomes easy.

The above strategy contradicts the traditional view that herders do not sell their livestock. The presence of Non Governmental Organizations (NGOs) working in the domain of awareness helped for changing the mentality. The outcome of interview conducted and FGDs have shown that households refused to sell the cattle for several reasons: the low prices offered before and during drought and their increase after the crisis.

4.1.4.3. Access to Extension Services

Population of the district has a long experience of livestock farming during drought period. The knowledge of the people of the study area is not limited to the traditional knowledge; they gather multiple experiences of dealing with drought through the presence of NGOs and governmental agencies that are working with them in many domains such as forage management, livestock diseases, bushfires, ponds management, etc. About 6% of the people interviewed for this study agreed that livestock training program is beneficiary.

4.1.4.4. Livestock diversification

The study shows that herd diversification that was dominantly employed in the past still plays an important role in cushioning pastoralists in the study area against drought. Herd diversification is

a mechanism adopted by pastoralists to reduce the risk of great loss during dry periods. It is also practiced in order to meet their needs as well as to fit species types to the environmental conditions that provide the necessities of life. The capabilities of various species of livestock to adapt during hard conditions are not the same. Some can easily cope during those periods while others will collapse because of the harsh environmental temperatures and their inability to sustain the absence of pasture and water. This strategy is also justified by the fact that using diverse species can give a full use of an area of grazing than a single species alone. A broad array of species is used to optimize the different parts of the forage (goats, sheep, cattle, donkeys and horses). Each type of animal is raised with a specific objective to meet the needs of the pastoral household. Goats have the capacity to use aerial fodder while cattle use only ground fodder. Although herders have the traditional way to diversify the species, they prefer so to others. For instance, many of the herders raise more sheep, donkey and goats than cattle because they are easier to feed than cattle. According to the pastoralists, sheep and cattle are more sensitive to droughts than other livestock species like goats and donkeys.

4.1.4.5. Livelihood diversification

In an environment where the breeding activity is no longer promising, population has long sought to diversify its revenue base through other activities to fill the financial gap caused by the negative effects of drought and land dynamics. In the study district, 4.5% of the respondents have alternatives activities. It is facilitated by the presence of weekly markets which play a key role in the life of the district. The entire economy of the municipality is focused on these selling points which are the main engine of the economic dynamics of the city. During the interviews, it was noted that most of the pastoralists are practicing cattle trading. Livestock trading exceeds the rural scale (weekly market); herders also involve in livestock trading both at departmental, regional, national levels and in some secondary cities of the country. Some religious people that livestock such as sheep are important to their religious festivals (e.g. Tabaski) also involve in livestock trading. This group of people buy sheep at a very cheaper rate in the weekly markets and sell at higher price in Dakar and other cities during their festivals. However, breeders have emphasized on the competitive nature of this activity. To many, the sale of animals as an alternative to the diversification of livestock farming is facing a lot of challenges, for example,

the influx of huge numbers of animals from neighbouring countries such as Mauritania and Mali. This challenge has considerably reduces the expected incomes of local pastoralists.

Figure 4.13 shows the extent of diversification and other sources of income for the residents of the district. The Figure 4.13 below shows that 52% of households in the district have their source of income through the sale of cattle; while 31% and 7% of the households have their source of income through self-employment and small business.

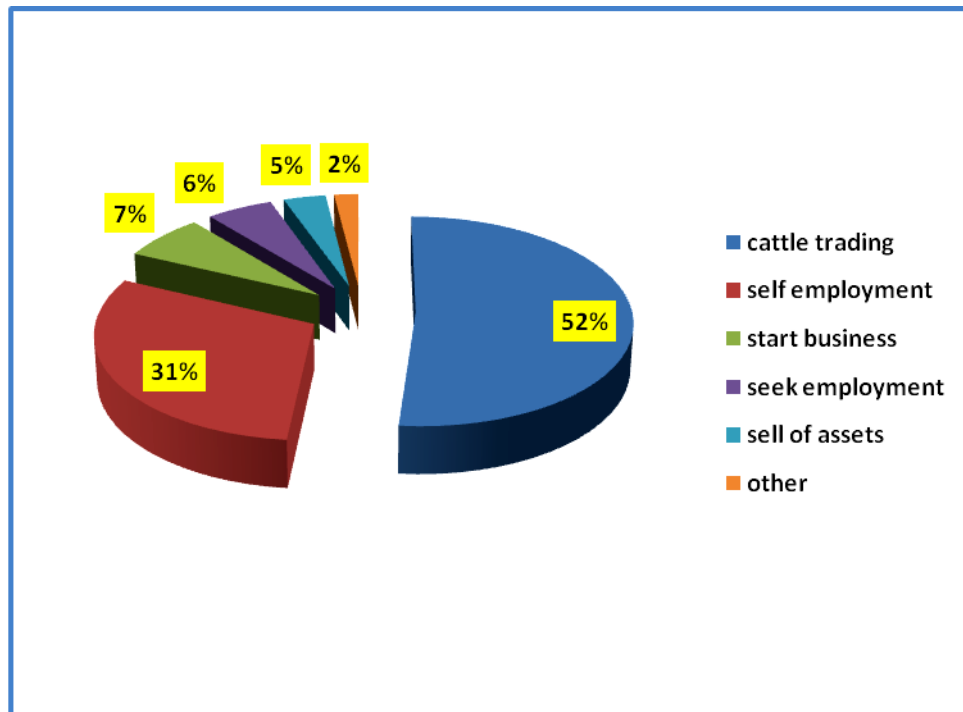


Figure 4.13: Additional sources of income

From this study, there is no doubt that livestock farming activity in the area of Velingara Ferlo can no longer sustain the population of the area due to the huge losses of cattle recorded during the past droughts. During interviews, it was found that most of the participants had their own work (exploitation of Arabic gum, sale of cattle or sale of cattle feed etc.).

4.1.4.6. Pastoral infrastructures

To solve the recurrent problem of access to water for transhumants and local population in the area, external and internal actors came to the rescue of a system undermined by many problems leading to its loss. These actors are the non-governmental organizations supported by the state actors present in the district and the farmers who form the bedrock of all programs and projects. Problems related to the management and exploitation of natural resources of the area with conflicts between residents and transhumant herders, bush fires, deforestation with the illegal exploitation of firewood led the actors to a need for the area to be aware and well organized in order to develop more sustainable strategies. Modern adaptation strategies of herders are structural and technical.

Livestock adaptation infrastructure strategies in the area have been made possible through the support of NGOs such as Agronomists and Veterinarians without Borders (AVSF). The access to water by herdsmen is a key element in the adaptation process. Hydraulic infrastructure has been strengthened by the construction of boreholes in each pastoral unit. In the beginning, it was only the Thionokh pastoral unit that has borehole. In year 2010, AVSF extended its actions to other pastoral areas and 5 pastoral units have been equipped with drilling as at the time of this study. Infrastructure of various types has been put in place for the management of slaughterhouses, cattle feed shops and vaccination parks for animals. To ensure the sustainability of the infrastructure that were in place, various management committees have been set up for each of them. The water is managed by the Association of Drilling Users (ASUFOR). They meet at least once in a quarter at a meeting where the public can attend and each committee is required to present the activities carried out and scheduled in addition to the financial statement. Every month, after making its balance sheet, ASUFOR voluntarily pays 15% of benefits to the management committee of Pastoral Unit to enable it to carry out activities such as reforestation, fire fighting, defences, etc. In each PU, breeders were trained for the animals to be vaccinated. They are increasingly autonomous in the management of animals' health but can also benefit from the support of state agents such as veterinarians. The study has shown during interviews that herders have a mastery of pastoral infrastructures. For most of them, water is no longer a big problem, as it before when they had to travel more ten kilometers to water livestock.

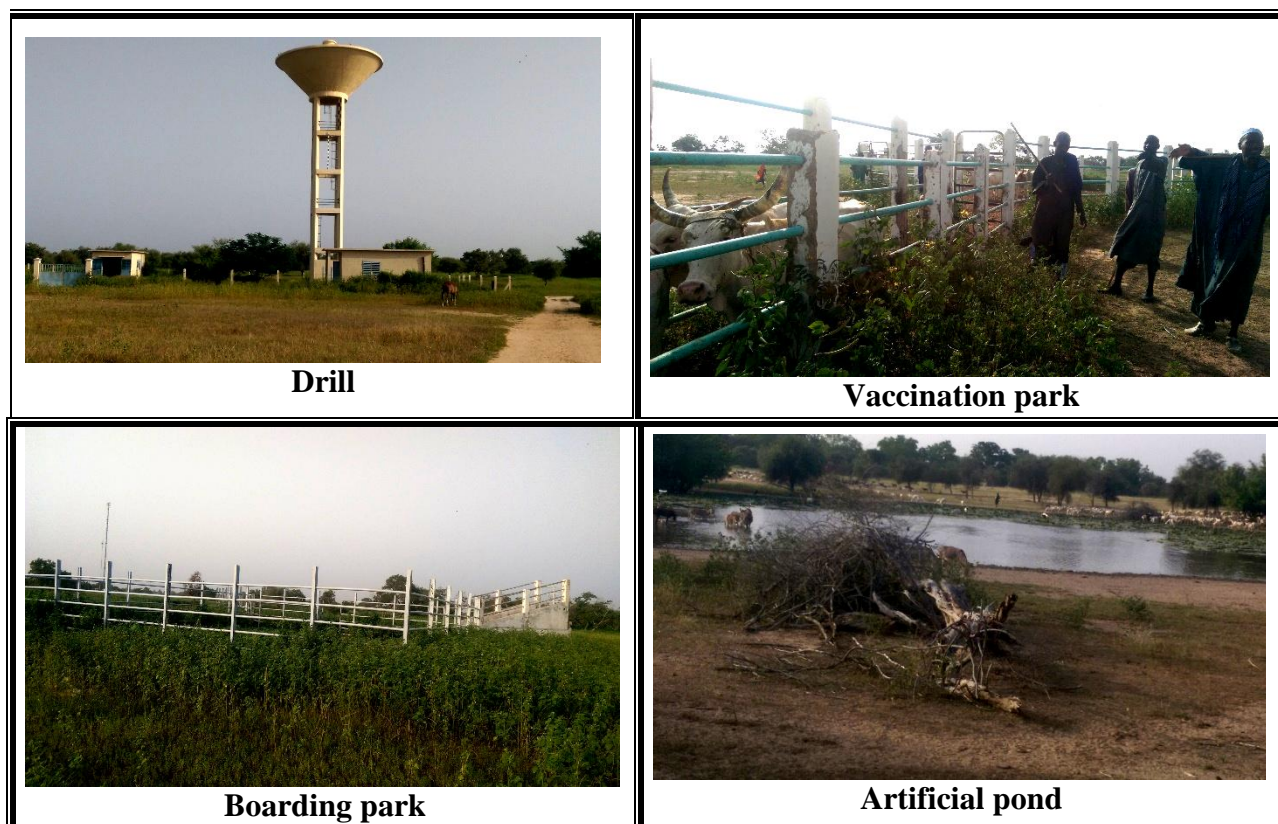


Plate 3: Vaccination park, boarding park, borehole and pond in Thionokh Sanghé

4.1.4.7. Reorganization and management of the pastoral area

After the creation of pastoral infrastructures, the external actors (NGOs and national authorities) proposed an approach for pastoral and territorial planning based on the creation and strengthening of Pastoral Unit (PU). The objective was to ensure a sustainable regulation and easy access to resources (pasture and water mainly). A PU functions as a framework where all the actors: village representatives, transhumants, management committees of all the infrastructures and collective equipment (drilling, stores, vaccination parks, etc.) and managers of the different existing management bodies (transhumant reception committee, bushfire committees, conflict management committees etc.). It consensually develops management plans that periodically define the use of space (areas for crops, pastures, ban areas to promote the regeneration of vegetation, etc.). The right to reorganize the area in different specific zones has been given to the Pastoral Unit by the mayor and the prefect through whom the transfer of jurisdiction was entrusted. The PU holds its legitimacy from the consultation involving all the actors.

Several positive impacts of the reorganization of the pastoral area by the creation of the pastoral unit were revealed during the Focus Group Discussion (FDGs) with the coordinators of PUs.

According to the participants, the management of the territory in co-operation with the administrative authorities, state agents and the different PUs has solved several problems facing pastoralism. The meetings between coordinators of PUs and representative of various villages have been noted in strengthening the social relationship between people of different villages. Environmental impacts were noted by the reduction of bush fires, easy access to water points and pasture according to many farmers. The development of a management plan has boosted the economy of PUs when transactions intensifying during weekly markets.

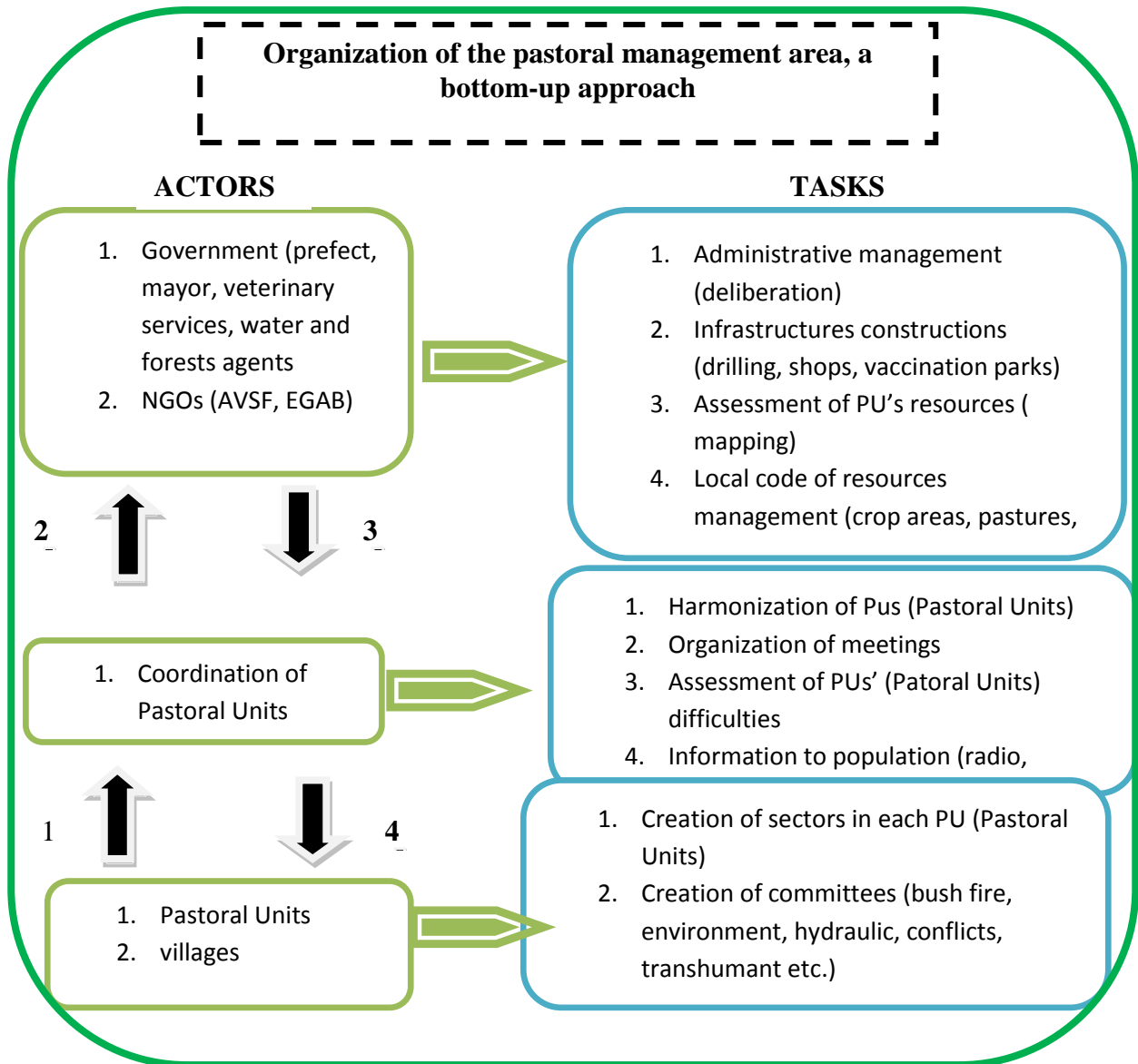


Figure 4.14: Organization of the pastoral management area, a bottom up approach

During interview, herders established a decrease in bush fires due to the adaptation strategy put in place by AVSF. This reduction of bushfires was also noted in the reports of the Ecological Monitoring Center of Dakar (CSE). In year 2011 to 2017, the area burnt in the Matam region decreased considerably from 20.593 Ha in 2011 to 9.906 Ha in 2017 with a peak value of 22.697 Ha burnt in 2014 (Figure 4.15).



Figure 4.15. Burnt areas from 2012 to 2017

In Figure 4.15, a decrease in the size of burnt area was noticed in the year 2012 at the beginning of the creation of Pastoral Unit in the district. The high value of the size of burnt area observed in the year 2014 can be explained by the severe drought which occurred in 2014 (SPI -1.69). The studies of AVSF, 2012 have established that severity of the drought can lead to bush fires. From 2015 to 2017 there was no record of severe drought in Senegal, and in view of this, records of bush fire has dropped considerably. However, the first causes of bush fires are anthropogenic depending to many studies done by CSE. . The conflict and bush fires trend revealed that the population adapted somehow to the drought and land dynamic.

4.1.4.8. Production of biogas and beekeeping

In order to fight against the environmental, economic and social challenges brought by drought and land dynamic, an approach more centred on the environment was developed by herders with the support of external actors. Biogas production has become a reality in the Velingara Ferlo area. According to breeders, the absence of electricity increases the pressure on forest resources such as wood. The main source of energy in the district is the firewood which is used for cooking. This activity increases deforestation and soil degradation. According to a projection by Paliere; B (2015), the demand for charcoal, estimated at 11 bags / day in 2015, could reach 16 bags a day in 2035 if we only consider the evolution of the population. By adding the increasingly urban character of the district, the projections are 95 bags. Firewood is estimated at 226 carts a day in 2035 against 152 in 2015.

In the field, it was noted that some households had methanization equipment and were producing energy for cooking and lighting as an alternative energy source to wood and charcoal. The district is second in the region in terms of animal production after the district of Oudallaye. This assumes a significant amount of animal manure required for biogas production. However, houses that benefit from those equipments are few. Table 4.7 shows the distribution of biodigesters in the district.

Table 4.7: number of biodigesters in the district

Villages	Number of biodigesters
Vélingara	2
Touba vélingara	1
Thiasky diouanabé	1
Soro	1
Saldao	1
Adja	1
Dayane kodioly	1
Dayane diaby	1
Dayane guélodé	4
Total	13

In order to diversify household incomes, economic activities like beekeeping have been introduced in the district. According to interviewees, part of the population was initiated to beekeeping even if thereafter, the activity was done by the management committees of bush

fires. These economic activities provide a source of additional motivation for them while contributing to the improvement of biodiversity and the limitation of bush fires.

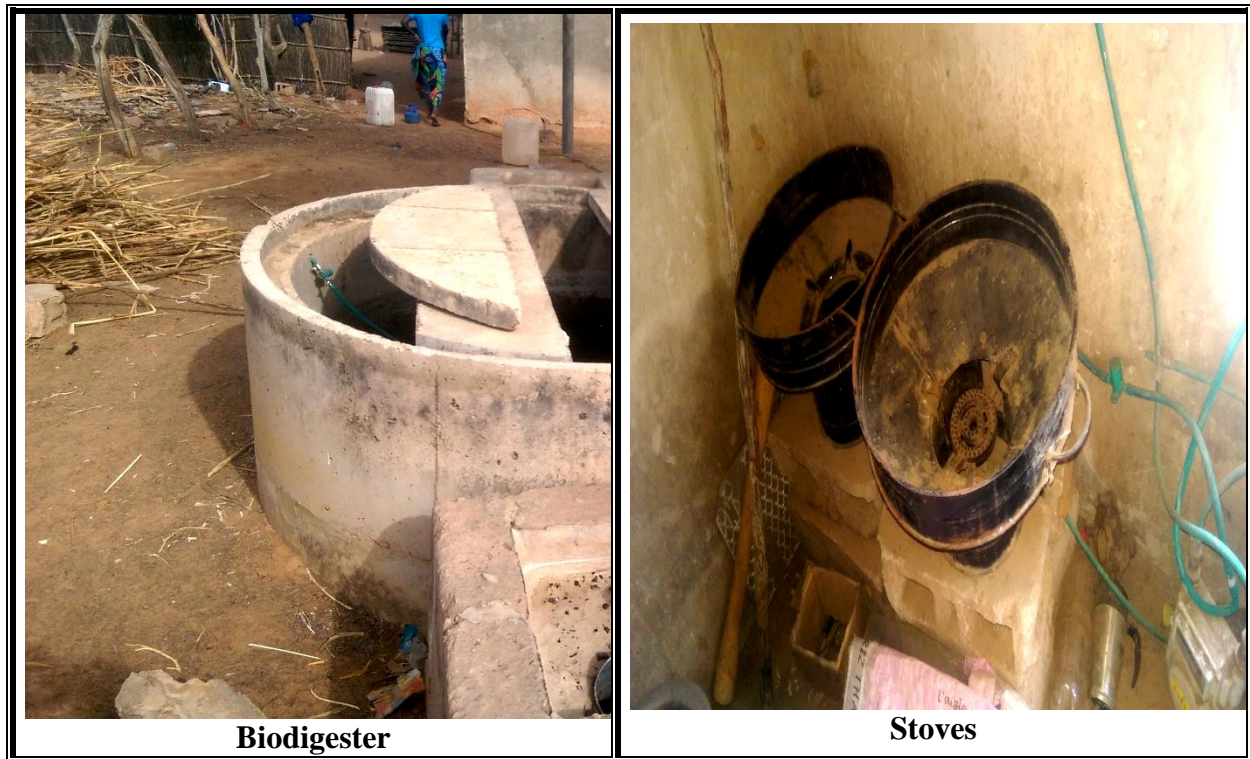


Plate 4: Biodigester and stoves for energy

4.1.4.9. Early Warning System for Drought

To better harmonize the management of natural resources (water, pasture and forests), an early warning system has been put in place to monitor pasture and unforeseen events (rainfall, drought). The warning system is a management tool for more harmonious and sustainable management of pastoral resources. It is piloted by AVSF with support from breeders, state agents, and other development partners. The key element of the early warning system lies in the rapidity of information to beneficiaries (farmers, local authorities).

Before the information reaches the rightful owner, several steps are necessary. The first step is the analysis of parameters such as pastures, rainfall, boreholes and ponds, transhumances, the state of the cattle market, bush fires, animal health, etc. This information makes it possible to

have an insight into the different components of the animal production system. The parameters are provided by the Meteorology Department, the Government Technical Services, the Ecological Monitoring Center, NGOs and breeders.

Finally, for the dissemination of information, several channels are used to reach the end users. These are community radios, phones, and emails. The early warning system is a tool of anticipating climate variability by guiding herders to areas where pasture is abundant and to warn them about possible water stress so that they can prepare for disastrous situations. In this way, breeders become more optimistic about the activity because they can anticipate climatic hazard. With this organisation, the number of conflicts has decreased from 11 in 2014 to 6 in 2017.

4.2. Discussion

The results of Standardized Precipitation Index (SPI), the Land Use and Land Cover Classification (LULC) have shown that the traditional breeding areas of Velingara Ferlo are facing frequent and severe droughts with strong agricultural pressure and habitat. This climatic stress and agricultural expansion have led to an increasing reduction of pastoral land for housing and agricultural intensification. The choice of these techniques makes it possible to understand the implications of water stress and beyond this, the method can be used to classify drought into mild, moderate, severe, and extreme drought. SPI and LULC have been used for a very long time by researchers to evaluate the effects of drought on pastoralism.

The results corroborate those obtained in a study done on drought severity and their effects on rural livelihoods in Laikipia district, Kenya in 2010.(Huho et al., 2010). Indeed, Over 70% of the droughts in the study area occurred in runs. The study has established that, as drought increased in severity, more rural livelihood were disrupted causing high dependency of relief aid. As a result, farmers ventured into charcoal burning, illegal logging and harvesting as alternative livelihoods sources exacerbating desertification (Huho, Ngaira, and Ogindo, 2010). The peculiarity of this study is that it does not consider much land use classes and focuses only on grazing lands, habitat and farming activities. Its purpose is to show how breeders adapt to these changes. For this, a comparison between decreasing grazing lands and agricultural expansion and habitat is sufficient.

Despite the effects of drought and spatial dynamics, breeders have been able to put various adaptation strategies in place ranging from traditional to modern adaptations. The traditional adaptations is about mobility, livelihood and herd diversification while modern adaptations focus on production of biogas, creation of pastoral infrastructure, reorganization and management of resources. The study had assumed that there are other adaptation strategies in the area different from those known in the literature. The use of questionnaires, FGDs and interviews provide insight into different types of existing adaptation strategies. Bush fires' indicators and the number of conflicts had helped to appreciate these strategies of adaptation.

Many studies use only qualitative and quantitative data through surveys and interviews to look at the adaptation of herders. In their study on Drought Adaptation and Coping Strategies Among the Turkana Pastoralists of Northern Kenya, (Opiyo et al., 2015) used household interview supplemented by detailed conversations and focus group discussions. Meanwhile, this study did not limit its research methods to qualitative and quantitative analysis, it also included the approach that projects use to monitor and evaluate their impacts by adding indicators of bush fires and number of conflicts (AVSF, 2012). This study have shown that herders in the Velingara Ferlo district used other adaptation strategies techniques that makes them less vulnerable compared to other livestock farmers of semi-arid areas.

In the district of Velingara Ferlo, people migrate to where water and pasture are available. The movement from one location to other in search of water and pasture is only done by few members of the family that are dedicated to these tasks while others remain in the district to take advantage of the economic opportunities and the education of the children. The above presentation is in line with the report of Ifejika (2010) that breeders are used to move when water and grass resources are scarce while agro-pastoralists used various pasture sources such as common grounds or protected areas. The resources in these areas are not always enough to sustain livestock production under prolonged or frequent droughts as mentioned in the studies of Ifejika (2010) and Speranza et al. (2010). Ifejika (2010) further stated that agro-pastoralists possess indigenous knowledge (IK) on indicators of rainfall variability (as a proxy for future pasture conditions) and believe in their efficacy. In the study area, herders used a pastoral early warning system and information that allow them to be aware of water stress, pasture availability, transhumances in the area, and cattle market and prices.

The importance of this study has shown new techniques of adaptation of livestock farmers with a reorganization of the land and its resources. It also identified an early warning system that focuses on livestock and the production of biogas. The study opens new perspectives of research on the adaptation of breeders.

CONCLUSION

The district of Velingara Ferlo has been the region of prolonged drought in the last sixteen years. The livestock farming which is the main source of income of the population of the area has been threatened extensively. The challenge facing livestock farming was due to dynamic land use brought by the population. The study shows that the more intense the drought, the more the effects on the pastoralists. A strong coincidence is noticed between categories of drought and the answers of breeders. A strong coincidence is noticed between categories of drought and the answers of breeders. 30% of respondents agreed that loss of animals was due to effects of drought; 27% through lack of pasture and 22% through the lack of water. 10% of respondents agreed that effects of drought inevitably lead to higher cereal prices and a fall in livestock price leading to a certain famine.

Physical effects of drought are accompanied by secondary practices that also contribute to the vulnerability of herders. Deforestation through the cutting of firewood and charcoal production are taken as an alternative source of income causing frequent bush fires that further destroy the forest ecosystem. However, herders have been able to adapt to these adverse effects of drought and land dynamics of their environment based on traditional practices of adaptation such as mobility, herds' diversification and income, and also by the adoption of new adaptation strategies. These adaptations range from organization of the area and its resources, pastoral infrastructure (drills, boreholes and taps), production of biogas and production of honey, to a functional establishment of an early warning and information system on livestock.

These adaptation strategies mentioned above have significantly reduced the numbers of conflicts and bush fires. However, many challenges have to be addressed and the study recommends that the government invests in livestock security through construction of stables in the weekly markets, in access to credit and creation of drought insurance. For further research, the study recommends the need to assess the resilience of herders to drought and land dynamic using spatial technologies in monitoring land use and drought.

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APPENDICES

Annex 1: Questionnaire

UNIVERSITY OF LOME -TOGO, MASTER RESEARCH PROGRAM ON CLIMATE CHANGE AND HUMAN SECURITY

QUESTIONNAIRE ON ASSESSMENT OF THE ADAPTATION STRATEGIES AMONG THE PASTORAL COMMUNITY OF DISTRICT OF VELINGARA FERLO, SENEGAL TO A NEW CONTEXT OF LAND DYNAMIC AND DROUGHT

I am a Postgraduate student in Climate Change and Human Security in the West African Science Service Center of Climate Change and Adapted Land Use (WASCAL) based in Lomé, Togo. Presently, I am carrying out a research on the above-named topic in partial fulfillment of the requirement for the award of Master degree (Climate Change and Human Security). I will be very grateful if you will just help take some time off your busy schedule to respond to the questions. It is purely for research purpose.

Thank you.
Michel Ndiaga Diop.

Questionnaire for the Household Survey Introduction

Questionnaire Number			
Number of Pastoral Unit (PU)			
Household			
Village			
SECTION 1 SOCIO-DEMOGRAPHICS CHARACTERISTICS			
Q1.1	Sex of respondent	Male	
		female	
Q1.2	Marital status	single	
		Married monogamous	
		Married polygamous	
		divorced	
		widowed	
Q1.3	What is your age?	respondent	
		Household head	
Q1.4.	Are you the head of household (nuclear family)?	Yes	
		no	
Q 1.5	If not the head, what is your relation with the head of the household?	Spouse	
		Son	
		daughter	
		Other (to specify)	
Q 1.6	Level of education of household head	None	
		Primary	

			Secondary	
			Post-secondary	
Q 1.7	Age of the family		Male	Female
		0 – 5 Years		
		6 – 18 Years		
		19 – 55 Years Over		
		Over 55 Years Primary		
Q 1.8	Number of economically active members living in household		Male	female
		Self-employed		
		Wage employment		
		Other (specify)		
Q 1.9	Number of members living outside the area (migrated, working etc)		Male	Female
		Within the department		
		Within the region		
		Outside the region		
		Outside the country		
Q 1. 10	Type of house	permanent		
		temporary		
Q 1. 11	Household asset	Radio		
		telephone		
		television		
		Water tank		
		Other(specify)		
SECTION 2	SOCIO-ECONOMICS CHARACTERISTICS			
Q 2.1	What are the major constraints to your family well-being?	Drought		
		Floods		
		Human diseases		
		Livestock diseases		
		Conflicts		
		What		
		Poverty Other		
	Other (specify)			
Q 2.2.	What is the key source of	Pastoralism Small		
		Small business Wage		

	livelihood for the household? (only one answer allowed)	Wage employment	
Q 2. 3	What types of livestock do you keep? On average (over the past 5 years),		number
		Cattle- bull	
		Cattle –cow	
		Sheep	
		Goat	
		Camel	
		Donkey	
Q2.4	What problems do you usually encounter regarding livestock keeping? Tick where appropriate	Poultry	
		Livestock diseases	
		Shortage of water and pasture	
		Lack of market	
		Livestock rustling	
		Conflicts	
Q.6	What measures have you put in place to address the above mentioned problems? Tick where appropriate	Any other (specify)	
		Migration in search of water and pasture	
		Restocking through traditional systems	
		Use of traditional herbal treatment	
		Accessing livestock veterinary services	
Q.7	What is the main source of water for the livestock? Tick where appropriate	Sale of livestock during drought	
		River/spring/stream Water	
		Pond	
		Wells/borehole/drills	
Q.8	Is the water source constant or seasonal?	Pipe borne water	
		Constant	
Q.8	Is the water source constant or seasonal?	Seasonal	
		Constant	
Q.9	Who manage	Individually owned	

	the water source?	(Private)			
		Community			
		Other (specify)			
Q.10	How do you contribute to the maintenance of the water source? Tick where appropriate	Nothing is contributed			
		Contributing set fee			
		Contributing in case of a break down			
		Contributing manual labour when required			
		Contributing local materials when required			
Q.11	How many animals have you sold in the last year?		Number		
		Cattle – Bulls			
		Cattle – Cows			
		Sheep			
		Goats			
		Camel			
		Donkeys Poultry			
		Poultry			
Q.12	Why did you sell the animals?	Income generation			
		Sale during drought			
		Restocking			
Q.13	How many animals did you receive/give as gifts last year?		Receive	Give	
		Cattle – bulls			
		Cattle – cows			
		Sheep			
		Goats			
		Camels			
		Donkeys			
		Poultry			
Q.14	How many animals did you lose due to disease last year? How about the last five and ten years?		1 year	5 years	10 years
		Cattle – bulls			
		Cattle – cows			
		Sheep			
		Goats			
		Camels			
		Donkeys			
		Poultry			
Q.15	How many animals did you		1 year	5 years	10 years
		Cattle – bulls Cattle			

	lose due to drought last year? How about the last five and ten years?	Cattle – cows			
		Sheep			
		Goats			
		Camels			
		Donkeys			
		Poultry			
SECTION 3 PERCEPTION OF DROUGHT AND CHANGES IN THE AREA					
Q.1.	What is your understanding of drought?				
Q.2	What causes droughts? Tick where appropriate	Amount of rainfall			
		Seasonality of rainfall			
		Duration of rainfall			
		Deforestation			
Q.3	What are the effects of drought? Tick where appropriate	Drying of water sources			
		Depletion of pasture			
		Famine			
		Loss of livestock			
		Poor health of humans			
		Poor health of animals			
		Increase in food prices			
		Decline			
Decline in livestock prices					
		Others			
Q.4	How does drought impact on your livelihood?				
Q.5	How do you perceive changes in the area due to drought?	Agriculture extension			
		Reduction of pastoral area			
		Deforestation			
		Reconversion of and to human habitat			
Q.6	What are the changes that you observed within the population behavior in drought periods?	Stop livestock farming			
		Change activity			
		Migration			
		Reduction of the cattle			
		Other(specify)			
Q.7	For you, what are the driving	Population growth			
		Bad governance			

	forces of land use change in the area?	Drought	
		Migration in the commune	
		Private farms	
		Others(to specify)	
SECTION 4	ADAPTATION MECANISMS		
Q.1	What measures do you put in place to safeguard yourself against a coming drought?	Mobility	
		Livestock diversification	
		livestock management adjustments (changes in feed, water, grazing land use)	
		access to extension services for knowledge of livestock farming during droughts	
		income diversification Considering	
		livestock insurance	
		use of savings	
		Other (specify)	
Q.2	Considering the source of livelihood in 2.1, do you seek additional sources of income when anticipating drought?	Yes	
		No	
Q3	If yes, which are these additional sources of income?	Sale of assets	
		Seeking employment	
		Starting a business	
Q.4	Do you reserve water for use during the drought?	yes	
		No	
Q5	Do you reserve pasture for use during the drought?	Yes	
		No	
Q6	What is the main source of water		

	and pasture of the household during the drought season? (more than one answer)	Permanent water source nearby grazing reserve nearby		
		Other grazing and water points within the region		
		Other grazing and water points outside the region		
		Other (specify)		
Q7	In case of drought, which animals would you rather have?		Yes	No
		Cattle – bulls		
		Cattle – cows		
		Sheep		
		Goats		
		Camels		
		Donkeys		
	During			
	Poultry			
Q8	During drought, what adjustments do you make in terms of food consumption? How do you cope with food shortages?	Depleting food and cash savings		
		Earning more wage income		
		Liquidating productive assets e.g. livestock		
		Liquidating other assets		
		Household food consumption adjustments		
		Relying on charity		
		Use of social network		
		Permanent		
		Permanent or seasonal migration		
		Village-level institutions		
		Household expenditure adjustments (clothes, education and health)		
	Shift to other			

		livelihood options e.g. fishing etc. Use	
		Use of social networks	
		Relying on public relief programmes	
Q.8	What are the practices for natural resources such as water, pasture and forests?	Having drought reserve grazing	
		Protection of specific plant species or areas	
		Having individual or communal user rights for water/grazing points	
		Other (specify)	
Q9	If the drought was severe, would you move your family out of the pastoral livelihood?	Yes	
		No	
Q.10	What livelihood options do you have, apart from pastoralism?	None	
		Wage employment	
		Self-employment	
		Other (specify)	
Q.11	Did you sell any livestock during drought period?	Yes	
		No	
Q.12	If yes, what was the main reason for selling livestock?	Buying food	
		Buying clothing	
		Paying for healthcare	
		To fund cultural ceremonies e.g. marriages	
		Other (specify)	
Q.13	Did you borrow any money in the last one year? If so, from which source?	Family	
		Friends	
		Other (specify)	
Q.14	What was the major reason for borrowing money?	Buying food	
		Buying clothing	
		Paying for	

		healthcare	
		To fund cultural ceremonies e.g. marriages	
		Other (specify)	
Q.15	What type of support do you get from the government in the event of drought?		
		Information	
		Emergency aid	
		Development aid	
		Financial	
		Financial assistance	
		Development	
		Development of water sources	
		Restocking	
		Other (specify)	
	In your opinion, do you think government intervention, if any, has been helpful?		

NB: Thank you for providing us these important information.

Annex 2: Interview Guides for conducting Interview among Community Key Informants

I am a Postgraduate student in Climate Change and Human Security in the West African Science Service Center of Climate Change and Adapted Land Use (WASCAL) based in Lome, Togo. Presently, I am carrying out a research on the above-named topic in partial fulfilment of the requirement for the award of Master degree (Climate Change and Human Security). I will be very grateful if you will just help take some time off your busy schedule to respond to the questions. It is purely for research purpose.

Exercise 1:

1. What is your understanding of drought?
2. In your opinion, what shows that the drought has occurred?
3. How often has drought occurred in the past? Say in the last 50 years.
4. In the last ten years, how often has drought occurred in this area?
5. What are the impacts of drought on: People's livestock, health, food security, Livestock trade, Purchasing power of people etc?
6. What has the government or NGO done to help reduce the impacts of drought?

Exercise 2:

1. What are the changes that you have noticed during the past decades that you can link to drought?
2. How are you managing the Pastoral Unit?
3. What problems do you face in the management of the PU?
4. How are you dealing with government and NGOs' support?
5. What are the challenges for the survival of the pastoralism in the area?

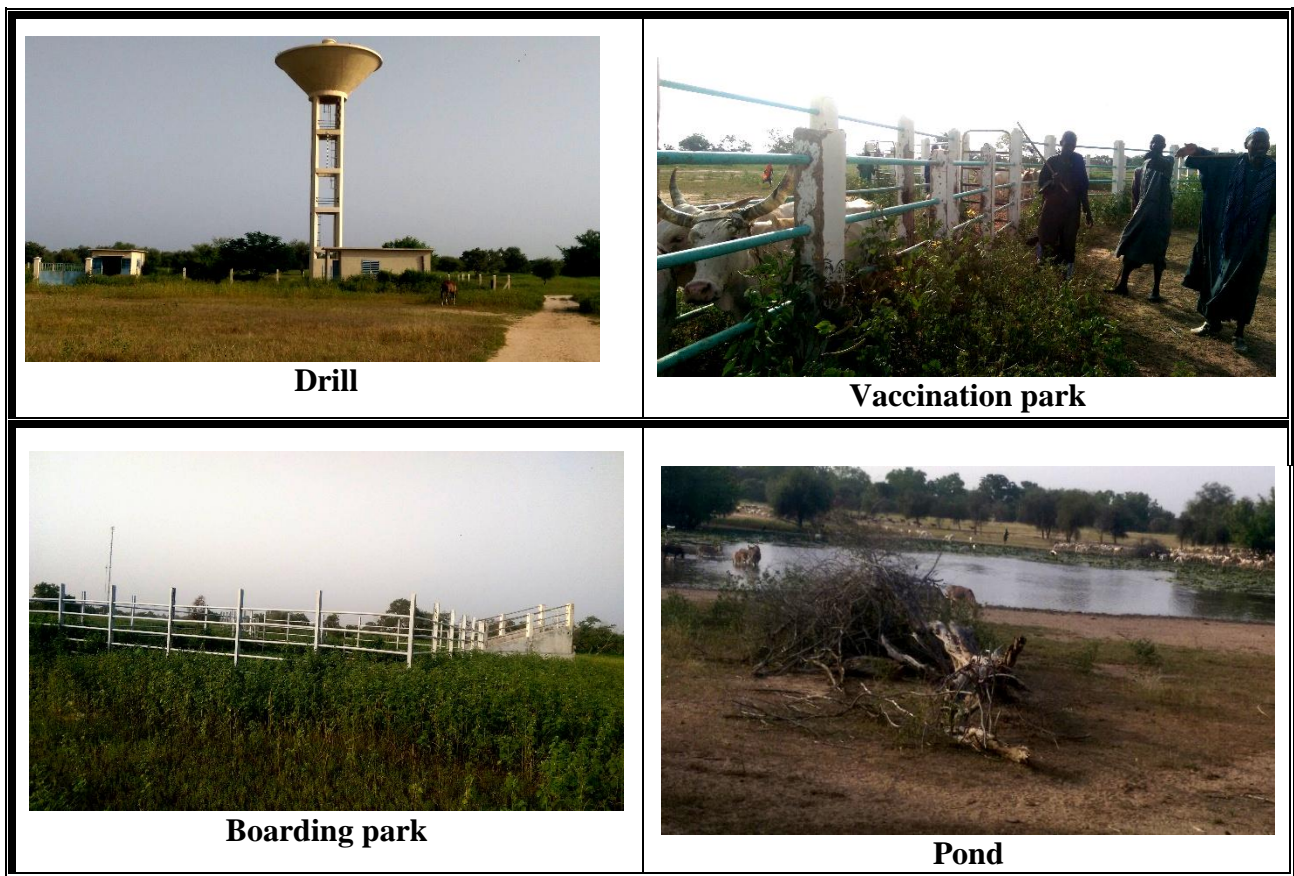
Annex 3: plates



Plate 1: Stock of pasture



Plate 2: Weekly market of cattle in Velingara



Drill

Vaccination park

Boarding park

Pond

Plate 3 : Vaccination park, boarding park, borehole and pond in Thionokh Sanghé



Plate 4: Biodigester and stoves