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AN ASSESSMENT OF SOCIAL VULNERABILITY OF MEDINA GOUNASS DAKAR (SENEGAL), TO FLOOD

A Thesis

By

Ousmane Diouf SANE

Submitted To the West African Science Service Centre on Climate Change and Adapted Land Use of Université de Lomé
In partial fulfillment of the requirements for the degree of
Master of Science

November 2014

Major Subject: Climate Change and Human Security

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ABSTRACT

An Assessment of Social Vulnerability of Medina Gounass Dakar (Sénégal) to Flood. (November 2014)

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This study was conducted in Medina Gounass Dakar, Senegal to bring out evidence that flooding is a threat to human security. The aim of this present study is to assess the social vulnerability to flood in Medina Gounass. Meteorological data were obtained from Dakar Yoff station. Survey was carried out using structured questionnaires drawn on one hundred randomly selected households. The methodology is about climate data and socioeconomic data gathering and processing. With some tools (softwares). For vulnerability assessment, the move framework is used to characterize vulnerability through three key factors, namely (1) exposure, (2) susceptibility, and (3) lack of resilience. As a result, Medina Gounass inhabitants have a particular relationship with the place they have been living for decades. Although facing diseases and many challenges in their everyday life, people actually resist the government's relocation projects because of their symbolic relationship with the area. The vulnerability index showed a highly vulnerable north-eastern part of Medina Gounass to floods. Recommendations are formulated towards the government which should take their responsibilities to displace some and relocate them elsewhere.

Key words: assessment, flood, social vulnerability, Medina Gounass, rainfall.

Résumé

Cette étude a été menée a Medina Gounass Dakar, Sénégal et a pour objectif d'apporter des éléments de preuve que les inondations sont une menace pour la sécurité humaine. L'objectif principal de cette étude est d'évaluer la vulnérabilité sociale aux inondations. Les données météorologiques ont été obtenues de la station Dakar Yoff. L'enquête a été réalisée aux moyens d'un questionnaire structuré sur cent ménages choisis au hasard.

La méthodologie est basée sur la collecte et traitement des données climatiques, des données socio-économiques et leur traitement avec quelques outils (logiciels). Pour l'évaluation de la vulnérabilité, le cadre conceptuel MOVE est utilisé pour caractériser la vulnérabilité grâce à trois facteurs à savoir l'exposition, la sensibilité, et le manque de résilience.

Par conséquent, ces résidents ont une relation particulière au lieu où ils ont toujours vécu. Bien que faisant face à l'insécurité et aux multiples problèmes, les habitants résistent aux projets de relogement du gouvernement en raison de la relation symbolique avec leur milieu. L'indice de vulnérabilité a montré que la partie nord-est de Medina Gounass était la plus vulnérable aux inondations. Des recommandations sont formulées envers les autorités gouvernementales qui devraient prendre leur responsabilité en déplaçant certains ailleurs.

Mots clef : évaluation, inondations, vulnérabilité sociale, Medina Gounass, précipitations

DEDICATION

In the name of Allah, this Master Thesis is dedicated to my dear Mother Aminata Camara and to my late father Famara Sané. I love them more than they could imagine.

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List of Abbreviations and Acronyms

ANACIM	Agence Nationale de l'Aviation Civile et de la Météorologie
DRM	Disaster Risk Management
DPC	Direction de la Protection Civile
DRR	Disaster Risk Reduction
GFDRR	Global Facility for Disaster Risk and Recovery
H.L.M	Habitation à loyer Modéré
IPCC	Intergovernmental Panel on Climate Change
MOVE	Method for the Improvement for the Vulnerability Assessment in Europe
ITCZ	Intertropical Convergence Zone
NGO	Non-Governmental Organization
NMS	national meteorological services
OCHA,	Office for Coordination of Humanitarian Affairs
ORSEC	Organisation des Secours aux Catastrophes
PROGEP	Projet pour la Gestion des Eaux Pluviales
UNDP	United Nations Development Programme
UNFCCC	United Nation Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UN/ISDR	United Nations International Strategy for Disaster Reduction
WFP	World Food Programme
WMO	World Meteorological Organization

CHAPTER 1: INTRODUCTION

1.1. Background of the study and Problem Statement

For centuries, human progress has depended on access to water in sufficient quality and quantity to make possible life on earth. This water has a great number of sources, the most common and known by almost everyone is rainfall. This latter depends on the climate and it is known that the most brilliant civilisations that planet earth has ever known became prosperous in periods of favourable climate.

Nowadays, this planet which produces the ecosystem services for human well-being has some disturbances in a pace that threatens the future of humankind. Thus, the earth is facing challenges, such as raising population, increasing desertification and, of course, climate change.

Climate change, in IPCC usage, refers to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activities. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and that is, in addition to natural climate variability, observed over comparable time period (IPCC, 2007). Therefore define, this panel has a long history and periodically publish key findings in the state of the climate. Their predictions emphasized that we are going to experience more extreme events, like droughts and floods and these extremes are said to be more frequent and more violent.

The occurrence of disasters linked to damages of physical events and social losses have a direct relationship with human existence. However, it comes into sight that their frequency and damaging impacts are drastically increased during these last decades. According to Lavell *et al.,* (2003), the explanation for the continuing increase in losses and their impacts on national, regional or local economies can be found not so much in an increase in the number of extreme natural events that occur, but rather in an increase in the number of persons, population density, infrastructure and production located in hazardous areas and in conditions of such vulnerability that they are more susceptible to excessive damage and loss and face considerable difficulties in coping. Furthermore, Cardona *et al.,* (*2012*) argue that the severity

of the impacts of extreme and non-extreme weather and climate events depends strongly on the level of vulnerability and exposure to these events.

Thus, flooding is an unusual presence of water on land to a depth which affects normal activities, flooding can arise from overflowing rivers (river flooding), heavy rainfall over a short duration (flash floods), or an unusual inflow of sea water onto land (ocean flooding). Ocean flooding can be caused by storms such as hurricanes (storm surge), high tides (tidal flooding), seismic events (tsunami) or large landslides (sometimes also called tsunami).

As is it defined, urban flooding becomes a planetary problem. In many countries and cities, most of the losses and damages are caused by hydrological disasters. According to Guha-Sapir *et al.,* (2011) classification, the distribution of disaster frequency in Africa in 2011 resembled the one seen over the last decade. Hydrological disasters represented 68.8% of occurrences, followed by climatological (17.2%) and meteorological disasters (14.1%). No geophysical disasters were recorded in 2011. The link between climate change and human security is now clearly established. This changing climate prompts climate scholars to argue that Africa is the most vulnerable continent in the world. As Mendelsohn *et al*., (2011) make the point in their article "The Distributional Impact of Climate Change on Rich and Poor Countries", the poor nations of the world bear the brunt of climate change damages primarily because they are located in the low latitudes and are already too hot. According to Depietri *et al.,* (2012) Cities, especially those where urbanisation is un-planned or poorly planned, are increasingly vulnerable to hydro-meteorological hazards such as heat waves and floods. Urban areas tend to degrade the environment, fragmenting and isolating ecosystems, compromising their capacity to provide services. The regulating role of ecosystems in buffering hydro-meteorological hazards and reducing urban vulnerability has not received adequate policy attention until now.

Sénégal is bordered the Atlantic Ocean on the westernmost point of the African continent. Two distinct seasons characterise its climate: a dry season from roughly October to May and a rainy season from June to October. In 2006, Sénégal ranked 156th of 177 countries in the UN Development Programme UNDP, (2011) human development index. Poverty in Sénégal is most prevalent in rural areas, where roughly 60% of the population resides. The other 40% are found in urban areas, where the majority live in rapidly growing urban suburbs.

According to Mbow *et al*., (2008), Dakar, the capital of Sénégal, is characterised by an out of control urbanisation process. Among the many impacts noted, flooding has appeared recently as a major threat to poor population leaving in the suburbs of Dakar.

Dakar is about 550 square kilometres, covering less than 1% of the national territory, but housing about 50% of Sénégal's urban population. Flooding is one of the most severe hazards threatening Sénégal, and in recent decades it has become a frequent and enduring reality (Wang *et al.,* 2009). In addition to that, floods severely affected and continue to affect Sénégal. From 1980 to 2008, floods have affected an estimated 400,000 to 600,000 people a year and caused estimated damages of over US$42 million. Both urban and rural areas are vulnerable to floods. However, the most at risk are the areas in and around Dakar, Saint Louis, Matam, Kaolack, Thiès, Diourbel, Kolda, Kaffrine, and Tambacounda (GFDRR, 2011).

The Senegalese government has done something in terms of institutions and governance to reduce impacts caused by disasters. Disaster risk management was put in place, it is a complex, cross-sectorial tool that involves a political and legal commitment to an early warning system people-centred and effective mechanisms for disaster response. In addition, a DRR (disaster risk reduction) platform was established, a framework that includes all stakeholders to provide and mobilize the knowledge, expertise and resources for disaster risk management and their integration into policies, plans, and programs.

This lesson have led the Senegalese government to take measures, including the adoption of a series of preventive actions (High Commission of Civil Protection, ORSEC National Risks Census), the definition of a strategic vision and the establishment of mechanisms and more effective DRM tools.

Furthermore, a legal and institutional framework has been established which encompasses advisory bodies which are mainly composed by: the High Commission of Civil Protection, the National Platform for the Prevention and Reduction of Major Disaster Risk, 14 Regional Commissions Emergency Preparedness, 45 Auxiliary Commissions Emergency Preparedness. An Executive bodies composed by: the "Direction de la Protection Civile" (DPC), National Brigade of Firemen, and other Departments. The "Direction de la Protection Civile" (DPC) is responsible for the overall design of ORSEC and works closely with the United Nations system agencies engaged in humanitarian (OCHA, WFP, UNICEF, the Senegalese Red Cross). Despite the existence of all these institutions, some areas even in the capital city are constantly under threats mainly in the suburbs. However, flooding in Dakar is a frequent damaging reality due to high urbanization rates, increasing incidence of heavy rainfall in a short period: the wet spells are consequent with inadequate capacity of drains and lack of maintenance of the drainage infrastructures. These causes have sometimes dramatic

impacts during the rainy season: loss of life and property, disruption to transport and electrical power, incidences of epidemics during the flood events. As a result, some tentative solutions have been undertaken by the political authorities who put in place some adaptive measures.

What make its particularity is that flooding becomes more acute year after year and flood water obstructs human activities and many structures situated within a flood plain. In this regards as is it highlighted by (Djigo, 2005), Medina Gounass is essentially the subject of illegal occupation in floodplains to a large extent and thus does not include any urban organisation. The audit by the Municipal Development Agency under the program support has highlighted the very low level of Medina Gounass equipment. The only major road consists of "Tally Boubess" Street extended in poor condition, which passes right through the area. The rest consists of sandy tracks generally inaccessible to motorized vehicles. In 90 % of cases, the sewage is carried out in the street. In addition to that, floods may be caused by accumulation of heavy precipitation within a particular area or the runoff from outside areas.

Medina Gounass is already at risk from periodic floods due to the effects of climate change, such as heavy rainfall events. Additionally, population is equipped, for most, of latrines with septic tanks. These elements show how the area is at risk, that originating from a combination of social processes and their interaction with the environment leading to their vulnerability against flooding. Consequently, the assumption of social construction of risk becomes clearer. For that, the "socio-natural co-production of hazard and the social qualities of vulnerability, the ways in which different stakeholders perceive hazard, vulnerability and risk also need to be considered to understand the social construction of risk"(Birkmann *et al*., 2013).

During this last decade, people are experiencing extreme weather conditions that are, for most of the time, challenging situations for the urban inhabitants and pool back Senegalese economic development. So, the first question one should ask is why in Dakar and not elsewhere? This area has some specificities which are not the same as in other areas: its geographical location and the space occupation process. The limits of the literature review lie in the fact that it did not take into account time lost in trying clean up or repair damages caused by floods for civil servants. In addition to that, the psychological burden caused by this situation impacts negatively people's performance and weaken their economic assets. Hence, the particularity of this present study is the household level which was not taken into account by the literature we reviewed and comes to give an added value to the current knowledge. This area, Medina Gounass, has some specificities which are not the same in other areas.

Thus, I find it relevant to experiment knowledge we received from the Master Thesis courses, because all aspects of socio-ecological system of people vulnerability can be found in this area. In addition, this site has a particular mode of people's settlement. And finally, people refuse to move from this area for many reasons. These are the main reasons which motivate me to undertake a Master thesis research in this area.

1.2. Research objectives

The overall research objective is to analyse the social vulnerability of Medina Gounass inhabitants to floods.

The specific objectives are:

- To analyse the trend of precipitation indices and, at the same time, compare the evolution of temperatures and precipitations at the local level;
- To explore, the socio-economic characteristics of Medina Gounass inhabitants;
- To analyse the exposure, sensitivity and the lack of resilience of Medina Gounass inhabitants to flood.

1.3. Research questions

The central question of this research is to identify the underlying factors and conditions that constraint at-risk vulnerable communities in flood-prone areas to build and sustain their resilience to recurrent flooding events. This question will be answered by further examining the following secondary questions.

- What are the factors that expose people to flood? (Factors of exposure to flood)
- How did flood-prone communities experience vulnerability / risk to flooding? (Manifestations of flooding and people's experiences in flood periods)
- What was the government's/local authority response to flooding during the last major events? (Actions and the policy).
- What issues / events / personalities galvanized community mobilization to address the flooding problems?
- What issue(s) / factor(s) triggered the inception of community initiatives against floods?

1.4. Hypothesis

Main Hypothesis is that people's vulnerability to flood stems from the fact that they settled in a flood prone-area, outside the urban-development sites, in addition to an increase of rainfall in the last years.

Secondary Hypotheses are:

- Flood-affected people settled within that area because they are mostly low-income people that could not afford housing in the urban-planned sites where liable amenities already existed.
- Although facing diseases and unease, people actually resist the government's relocation projects because of their symbolic relationship with the area where they have been living for decades.
- Public actions against flooding were not preventive but remedying after damage was already done and following social contestations and floods made the focus of media attention.

1.5 Thesis Structure

The first chapter deals with the problem statement of the study. This part addresses the context in which the issue of climate change raises the engagement of scientists all over the world. In addition, the state of the art related to flooding is gradually treated by thinking in a first time globally, narrow down to Senegal then, zero in to the local scale Medina Gounass.

In the second chapter is the literature review. This part discusses relevant studies related to flooding and why they are so important to shade light in the study we are undertaking. There is nothing new under the sun; some forerunners have already done something related to this particular topic.

The third chapter deals with the materials and methods. This chapter discusses the steps followed in order to reach our goal. Moreover, the methods used have been well defined and we started by climate and socioeconomic data gathering. It underscores the theoretical framework chosen to tackle social vulnerability and the study area with its different relevant components for the work are treated and different maps have been showed as illustration.

The fourth chapter is about the principal outcomes of the research. Climate data have been analysed and discussed first. The second part in this chapter deals with the

socioeconomic analysis. The last part of this chapter is about mapping the social vulnerability to floods in Medina Gounass.

This present study closes with a general conclusion and some recommendations in order to reduce vulnerability and enhance resilience for Medina Gounass inhabitants and the limitations of the study.

CHAPTER 2: LITERATURE REVIEW

The literature review I'm tackling in this section is about some studies done in the field of flooding and disaster management. It is followed by the definition of some concepts I used to deals with flooding in Medina Gounass.

2.1. Flooding

Flooding occurs most commonly from heavy rainfall when natural watercourses do not have the capacity to contain excess water. However, floods are not always caused by heavy rainfall. In these last decades, flooding has mobilised many scholars from various disciplines According to Forkuo (2011) flood is one of the most devastating natural hazards which lead to the loss of lives, properties and resources. Moreover, as highlighted by (Clement, 2013) it is also significant to mention that human activities have affected the nature of soils in Makurdi town through farming, construction and reclamation. In addition, floods may be caused by accumulation of heavy precipitations within a particular area or the runoff from outside areas.

The severity of flooding can range from flash flood to gradual increasing flood for longer duration which depends on the magnitude or characteristics of precipitation/rainfall and topography of the flood-affected areas (Keokhumcheng *et al.,* 2012:125). Human activities aspect is more visible in big cities, where the population growth increase drastically the risk to floods. In addition to that, this study aims to compare the zoning-based flood hazard from hydrodynamic model simulation and from the actual flood in November 2011 in the study area which is surrounding the new Bangkok International Airport. The presence of the airport and rapid urbanisation of the study area induce adverse effect to the flood situation (Keokhumcheng *et al.,* 2012: 129). As the population grow, and the availability of a secure land and well planned reduce, and economic conditions did not allow them to live in these areas, people have the incentive to go to the low land, where it is easy to have a piece of land. In the same vein, Lavell (2003) stated that land use and territorial planning are key factors in risk reduction. The environment offers resources for human development at the same time as it represents exposure to intrinsic and fluctuating hazardous conditions. Population dynamics, diverse demands for location, and the gradual decrease in the availability of safer lands means it is almost inevitable that humans and human endeavour will be located in potentially dangerous places. In addition, threats from hazardous events are directly linked to human security. In this regards, O'Brien *et al.,* (2008:5) argue that "recognition of the threats to

human security associated with climate change has generated growing interest in the relationship between disaster risk reduction and climate change adaptation".

All the above studies are very relevant but I think that they lack one important thing, the extent to which people are affected and the degree of their vulnerability to floods and what happens at the households' level. Furthermore, most articles are written to deal with other continent, like Asia, but Africa does not share same reality with Asia even if we are talking about the same hazard. The only article that focuses on a similar case study is by Adelekan's assessment of flood vulnerability of in the city of Abeokuta in Nigeria during the flood event in 2007. This study used a questionnaire survey to reach its goals. In his study, flood vulnerability was assessed by examining exposure, susceptibility, and coping indicators in the study area. One of his key findings is that most of Abeokuta inhabitants did not anticipate a flood event of such magnitude to occur, despite its location on a flood plain and, therefore, were unprepared for such hazard (Adelekan, 2011). The study is very pertinent and proceeds at the household level to assess social vulnerability, but this study does not specify a conceptual framework to assess vulnerability. In addition, in another done in Cameroon by Tchotsoua *et al.,* (2007), the study area resembles in many aspects to Medina Gounass. The difference is that in Medina Gounass there is no river there and people don't use rainfall for agriculture.

Furthermore, in her Master thesis, Priem (2009) has done a very good study in Medina Gounass with details. Many things are highlighted in the document from the geography to socioeconomic aspects. But, she failed in the fact that the document is too broad. The reader may have the impression that she is dealing with the whole country instead of Medina Gounass. As a result, she missed determining social vulnerability of the location inhabitants against flooding. There is no map or indicator which showed clearly who are the most vulnerable in the area.

2.2. Working Definitions

We cannot define working concepts without stating with context. In this regard, we are dealing with hydro-meteorological events. Hydrological events are those caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up (Guha-Sapir *et al.,* 2011:7). Hence hydrological risks are mostly seen in terms of overflowing water due to heavy rainfall and it is the case in our present study. Floods are sudden events that occur as a result of heavy rainfall on a limited area. They are sudden, short duration and have

a relatively high discharge peaks. They are most often called “flash flood” or “Wash Wood”. In sum, flooding is an eruption of water in a normally dry field or a submersion of field by water overflowing from the normal river canal, or water accumulation from drains areas in fields that are not normally submerged.

A disaster is “a serious disruption of the functioning of a community or a society causing widespread human, material, economic, or environmental losses which exceed the ability of the affected community or society to cope using its own resource. This statement leads to deal with the risk components.

Risk can be seen in my study as encompassing elements of the hazard and the vulnerability of the human-environmental system towards extreme rainfall induced floods. Risk is a function of vulnerability multiply by the hazard. Risk can be defined as the probability of frequency and magnitude of a disturbance of a hazard as well as the inherent weaknesses and strengths of humans. This definition of risk leads to the vulnerability.

Vulnerability is a broad concept with has a multitude of definitions according to the discipline or the institution, in this study, I will be using the one adopted by the UN/ISDR vulnerability is determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. (UN/ISDR, 2004). Vulnerability is generally seen as a composite of exposure, susceptibility or sensitivity, and resilience or adaptive capacity (Kaplan *et al.,* 2009: 2).

According to the UNDP, vulnerability can be defined as “a human condition or process resulting from physical, social, economic and environmental factors, which determine the likelihood and scale of damage from the impact of a given hazard” (UNDP, 2004: 11).

Coping Capacity is “a combination of all strengths and resources available within a community or organisation that can reduce the level of risk or the effects of a disaster” (UN/ISDR, 2002). In addition, coping is an aspect of resilience that signifies “here and now” capacity and includes a set of actions available to those at risk. Coping, in this way, is part of the formula that determines vulnerability at any one moment in time. However, coping mainly deals with the conservation and protection of the current system and institutional settings (Birkmann *et al.*, 2013).

Vulnerability and coping capacity manifest themselves once a vulnerable community is exposed to a hazardous event. In this context, hazard is understood as a potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of

life or injury, property damage, social and economic disruption or environmental degradation (UN/ISDR, 2002). Therefore, vulnerability gathers multiple elements among them the susceptibility to a harmful extreme event and lack of capacity to cope and adapt to the adverse impacts.

Compared to the terms hazard and vulnerability, the term risk can be described as the product of the interaction between hazard and vulnerability.

Hazard is defined as a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydro meteorological and biological) or induced by human processes (environmental degradation and technological hazards) UN/ISDR Geneva 2004. According to Birkmann *et al*., (2013), hazard is the potentiality of geodynamics or hydro-meteorological processes to cause effects upon exposed elements. It is the potential occurrence of natural, socio-natural or anthropogenic events that may have physical, social, economic and environmental impact in a given area and over a period of time.

According to UN/ISDR **resilience** is the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure This is determined by the degree to which the social system is capable of organising itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures.

According to Rygel *et al*., (2006: 743) the concept of vulnerability is fundamental to human-environment research. The word "vulnerability" is derived from the Latin word vulnerare, meaning "to wound." At a very basic level, vulnerability can be defined as "the capacity to be wounded" or the "potential for loss". Therefore **Social vulnerability** is a concept which encompasses many aspects at the same time. It is not limited to social weaknesses to withstand to a natural or manmade hazard but includes social discrepancies in terms of food security, health security, and all the components of human security at large in the flooding situation**. Social vulnerability** is also directly linked to the environment in which people are living. For the people living in the study area, the topography and the living conditions constitute sources of vulnerability. It is a dynamic process people have been experiencing for years and trying to strengthen their coping capacities toward perennial

flooding events. Additionally, Flanagan *et al.,* (2011) argue that social vulnerability refers to the socioeconomic and demographic factors that affect the resilience of communities. Social vulnerability can have multiple forms: it can be the state of the system before the event, the likelihood of outcomes in terms of economic losses and life lost, and it can also be the lack of capacities or weaknesses to face and recover quickly when the disaster strikes. This latter deals with the resilience of a system or a community to respond and recover with its internal means to the adverse impacts of the disaster. Studies on, the social production of vulnerability as a central theme of research on the human dimensions of environmental change hold that vulnerability to environmental disasters is largely a product of the way humans occupy and use the natural environment (O'Brien *et al.,* 2013). Dwyer *et.al.* (2004), have identified when it comes to social vulnerability to natural hazard impacts four different levels;

- Individual within household (relating to personal attributes)
- Community (relating to how we interact with those around us)
- Regional/Geographical (relating to how far we are from services)
- Administrative/Institutional (relating to disaster funding and mitigation studies)

Human security is a condition in which people and communities have the capacity to respond to threats to their basic needs and rights, so they can live with dignity. It focuses on the freedom to choose and act. Additionally, it is "to protect the vital core of all human lives in ways that enhance human freedoms and human fulfilment, which encompass human rights, good governance, access to education and health care and the freedom of future generations to inherent a healthy natural environment."

Adaptation is the adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harms or exploits beneficial opportunities. In addition, adaptation also presents itself as a continuous property, with levels of adaptive capacity changing over time as the status of vulnerability components identified change and the demands of a shifting risk environment alter the appropriateness of particular asset bundles for risk reduction. Adaptation denotes a longer-term and constantly unfolding process of learning, experimentation and change that feeds into vulnerability. Adaptation can be felt acting to shape all aspects of vulnerability and is observable through the systems and outcomes of learning-planned and spontaneous, pre- and post-disaster (Birkmann *et al*., 2013:196-197). As is it highlighted above, adaptation is a

continuous process which equally takes advantage of opportunities from a disastrous event to rebuild sustainable infrastructures and enhance people's resilience.

Vulnerability Index

The word index has many meanings. For example, in mathematics it is used to denote the number of times a given number is multiplied with itself. In economics and business it is a single number derived from a series of prices and or quantities (for example, price index, market performance index). In finance an index is a statistical indicator providing a representation of the value of the securities which constitute it. For our purpose, it is numerical scale calculated from a set of variables selected by myself for all the district. That is, this numerical value is used in the ordinal sense i.e. on the basis of this index different regions are ranked and grouped to be relatively less or more vulnerable. It is constructed in such a way that it always lies between 0 and 1 so that it is easy to compare regions (Iyengar *et al.,* 1982). Sometimes the index is expressed as a percentage by multiplying it by 100. Therefore, for the vulnerability index, the construction consists of several steps. First is the selection of study area which consists of several regions. In each region a set of indicators are selected for each of the three component of vulnerability. The indicators can be selected based the availability of data, personal judgement or previous research. Since vulnerability is dynamic over time, it is important that all the indicators relate to the particular year chosen. If vulnerability has to be assessed over years then the data for each year for all the indicators in each region must be collected.

CHAPTER 3: MATERIALS AND METHODS

3.1. Study Area

Medina Gounass district is located between 14.769 latitude North and -17.387 longitude West in the Guédiawaye Department. Formerly, it belonged to the Pikine Department. Guédiawaye as a department was created in 1990 (Decree 20434 of 08 October 1990), following the decentralization law. Nowadays, it has five boroughs, including the Medina Gounass.

The city of Guédiawaye is bordered on the north by the Atlantic Ocean, to the south and east by the city of Pikine, to the west by the city of Dakar. Medina Gounass is located south-east of the city of Guédiawaye. It is by far the most densely populated district.

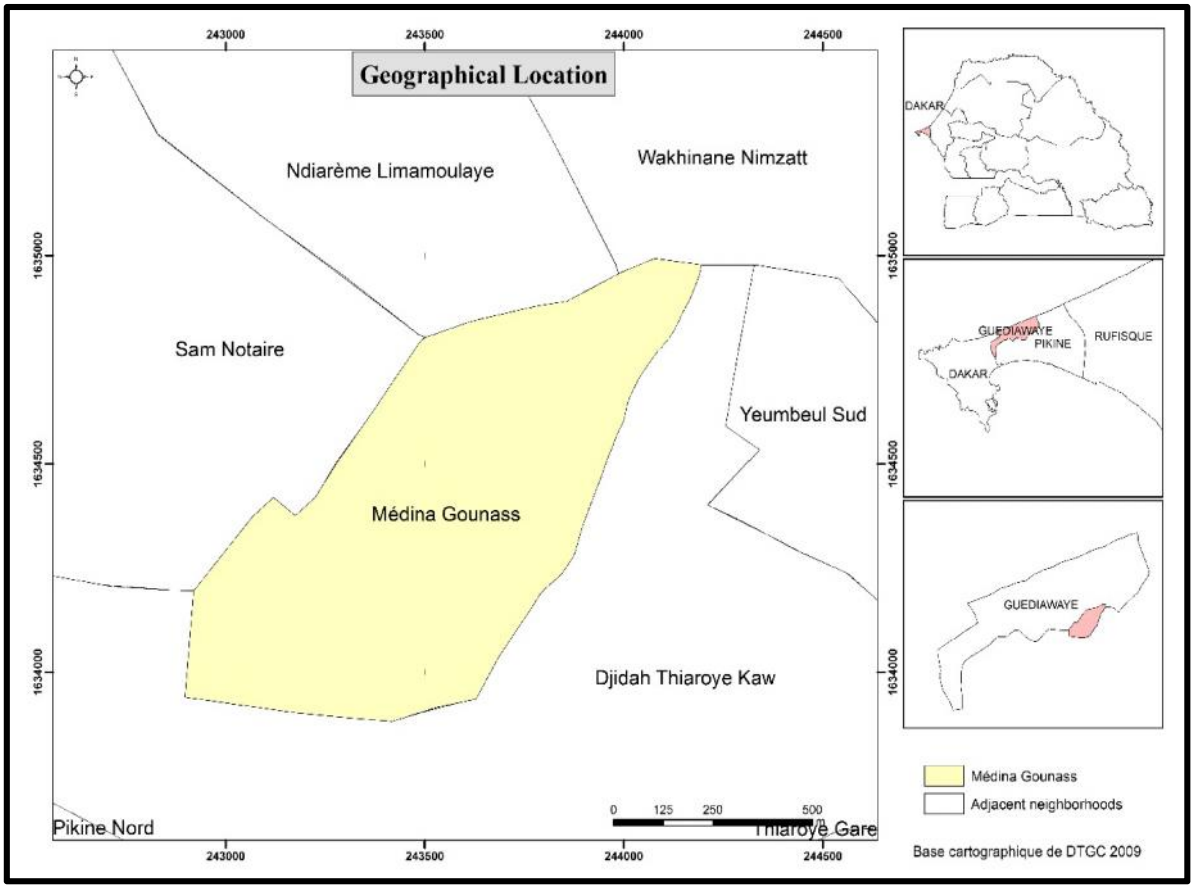


Figure 3.1 Geographical location (source: author of the study)

Medina Gounass is limited in the North by the district of Sam Notaire and the Ndiarème Limamoulaye district; in the east by the district of Wakhinane Nimzath and to the south and west by the district of Djiddah Thiaroye Kao. Gounass has a small area (1.1 km2) compared to Ndiarème Limamoulaye, Sam Notaire, Wakhinane Nimzatt, and Golf but has

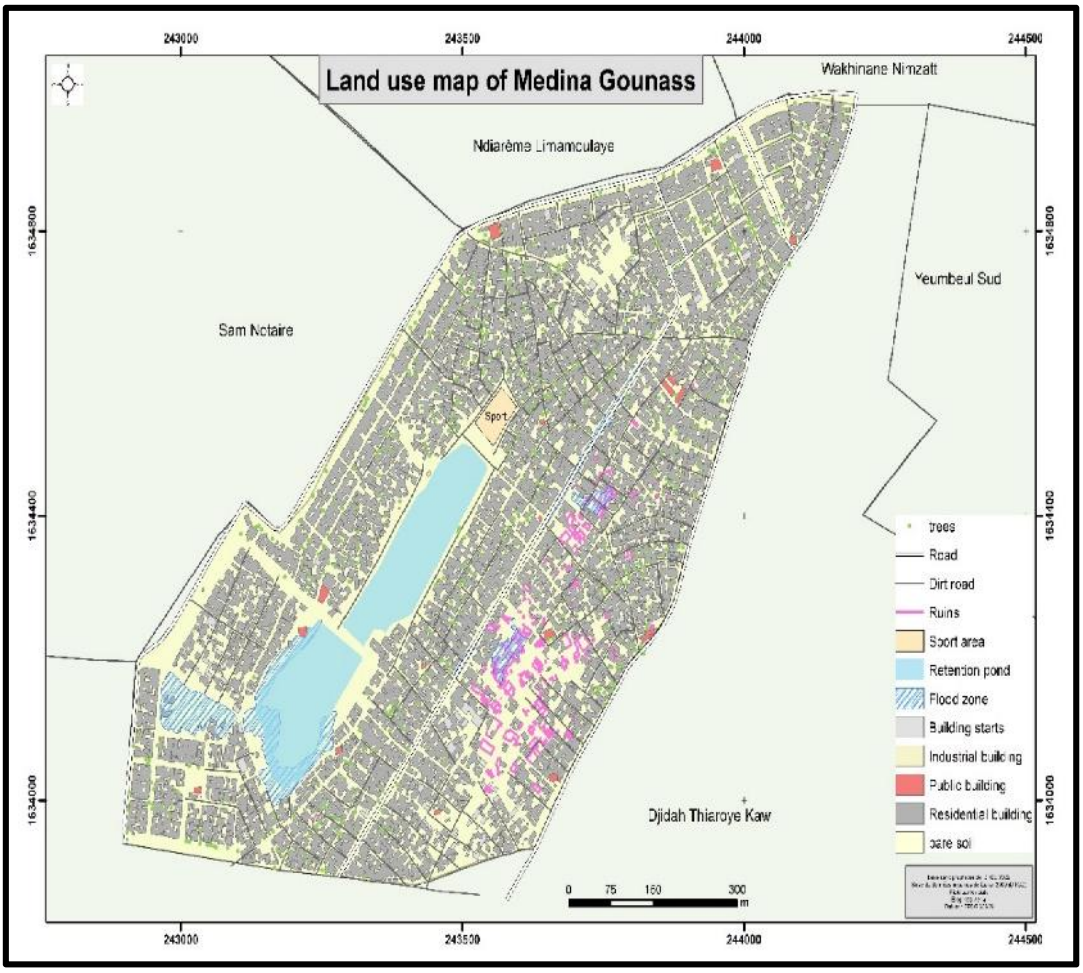
the highest density of 31,086 inhabitants per square kilometre across the department Guédiawaye (Djigo, 2005).

3.1.1. Population

The number of people living in the study area is not definitely established. Djibo (2005) mentioned 44.000 inhabitants but in our interview with the former Deputy Mayor of Medina Gounass we have another version. According to him, the district has 43.000 inhabitants but some people have been displaced for months before this study and others will do so in a near future. Now the population is estimated at around 40.000 inhabitants. After the flood events in 2005, the former government has built a city to relocate people and this project was called "Plan Jaxay". The present government has done the same in another location "Tivaouane Peul" called Plan "Tawfekh".

3.1.2. Land Use

Medina Gounass is totally occupied. There is no protected area; the space available there is a small field, where young people used to play football. In addition, another space is used to build two basins for rain water collection. This space used to be the houses of some inhabitants who were the most affected by the 2005 events and who are relocated in another area far from Medina Gounass. What is important to highlight here is that some inhabitants have left their houses that are being used as dump site by neighbours.



. **Figure 3.3 Land use; (source: author of the study)**

3.1.3. Infrastructures

Medina Gounass lacks in terms of infrastructure. Therefore, there is no hospital, no secondary school, no permanent market only one weekly which is held every Saturday, no church. There is one dispensary, one main road passing through the area, numerous tracks, a district municipality house, one public primary school, one pharmacy, two basins to collect rain water, one station to pump rain water and many mosques.

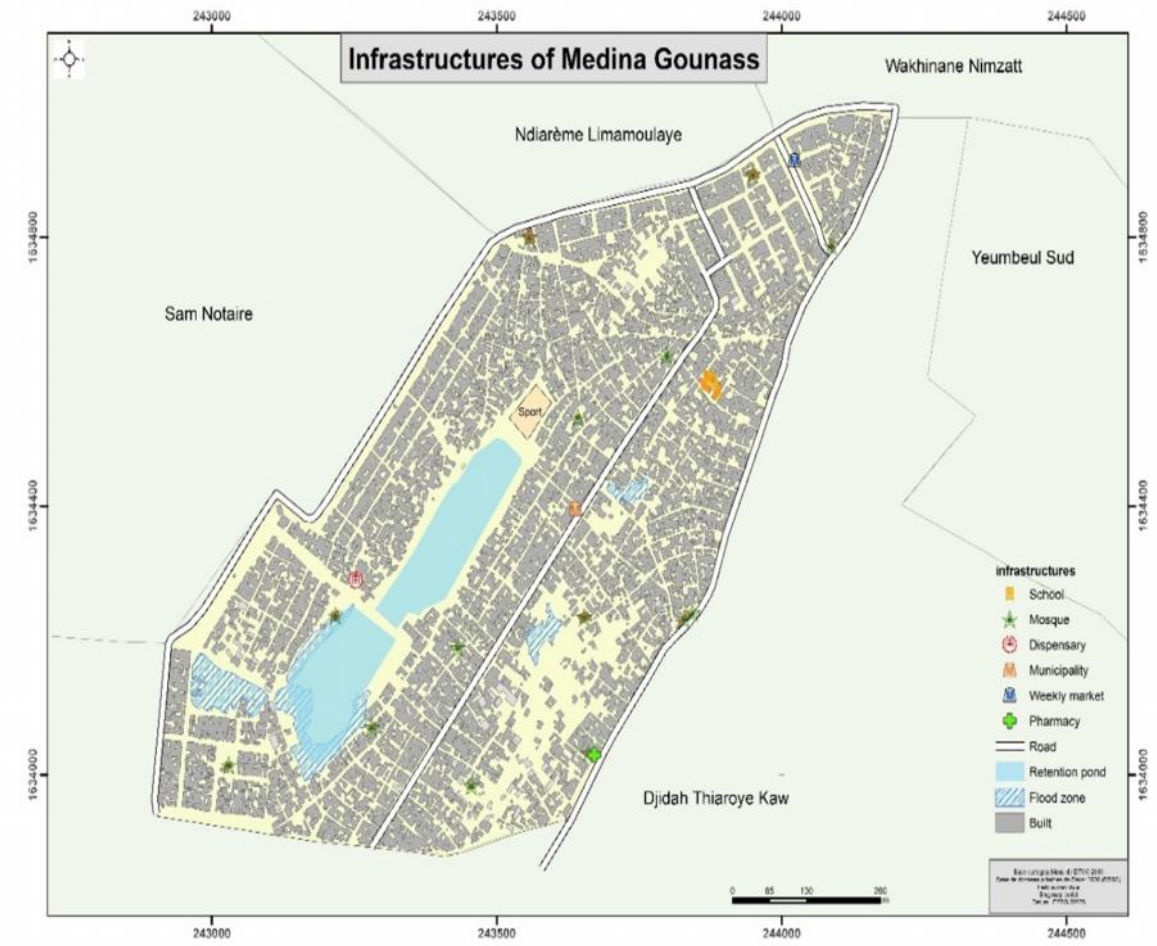


Figure 3.4. Infrastructures; (source: author of the study)

3.1.4. Hydrography, Hydrogeology

Hydrologically, the watersheds are small in size. Degradation of the river system resulted in the formation of a chain of lakes or ponds. Flows are endorheic (having no outlet) as offshore bars prevent their escape to the sea. Strong soil sealing in urban areas has changed the nature of runoff quantity (decrease losses flow, rapid movement of water). Over the past thirty years, this region has experienced very rapid urbanization, linked to the rural exodus that climatic deterioration and degradation of living conditions in rural areas have resulted in the entire Sahelian region (Priem, 2009).

Moreover, the ground water correspond to outcropping geological formation consisting of sand dunes dating from the Quaternary or the continental terminal. These sands underlain by sedimentary geological formations. Shows successively those dating from the Middle and Upper Eocene (marl and limestone marl, limestone marl), those of the lower Eocene (marl and limestone marl) those Paleocene (sandy clays topped limestone) and old back to the Maastrichtian (sandstone, sands); these different formations correspond more or

less to water or groundwater aquifers. Indeed, the continental fresh groundwater discharge into the ocean, while salt water seeps into the ocean seabed and flow to the continent. With the influence of the density difference, an equilibrium is established and water contact fresh / salt water form an outwardly inclined bevel interface forming the salt (Ndao, 2012).

3.1.5. Geomorphology of the Niayes

The morphology of this region is complex and Niayes reveals several forms reliefs. Between the dunes, peaking between 15 meters and 20 meters, there are slacks and depressions where the water table is flush. These depressions and corridors are Niayes that gave their name to this natural region of the "Grande Côte". The dunes are sterile and active on the coast (dunes bright white), but stabilized gradually as one moves inward (red dunes) with the appearance a very fragile vegetation (Ndao, 2012). These information given by the author seem to be valid for Medina Gounass because Djidah Thiaroye Kao is in the eastern part of the study area.

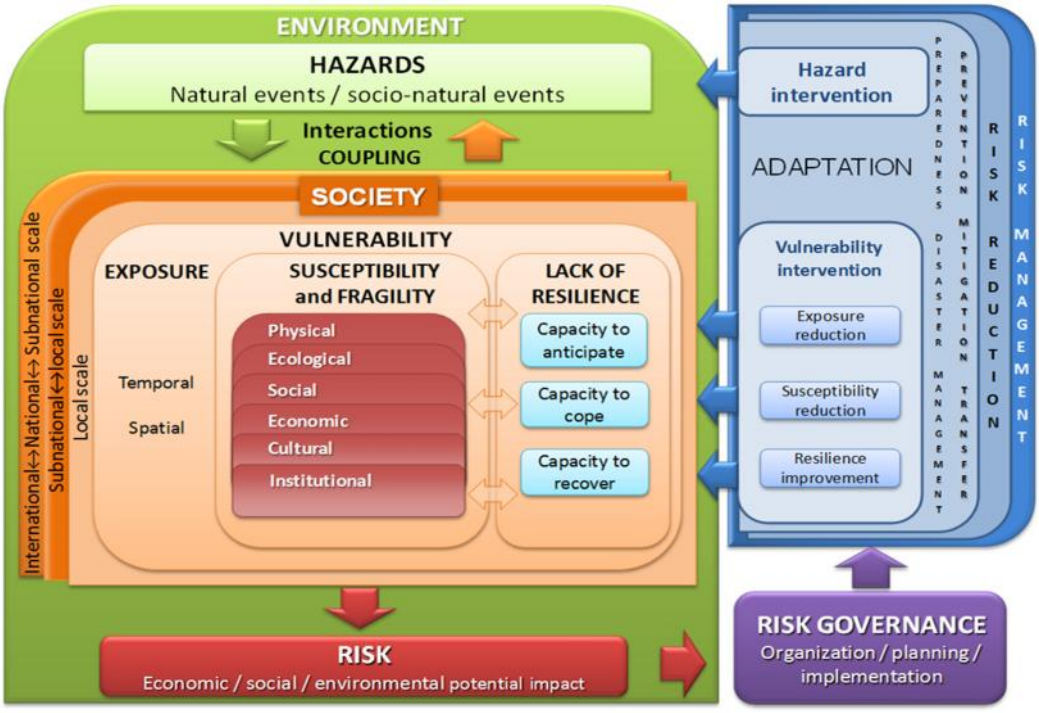
3.2. Theoretical Framework

In my previous works in sociology, I dealt with the functionalist perspective of sociology; each aspect of society is interdependent and contributes to society's stability and functioning as a whole. Functionalists believe that society is held together by social consensus, in which members of the society agree upon, and work together to achieve, what is best for society as a whole. In addition to that, I now deal not only with the social system but equally with socio-ecological system in which the environmental aspect plays a key role. It is obvious that Emile Durkheim's (1894) theory which consists in explaining a social phenomenon by another social fact is valid in some cases, because it ignores the biophysical aspect in a world of climate change. In this regard, and according to my hypothesis and objectives, the Move framework is better fit to the study. In addition, this Master thesis is tackled mainly from a sociological view.

3 .2.1. MOVE Conceptual Vulnerability Assessment Framework

Key factors of such a common framework are related to the exposure of a society or system to a hazard or stressor, the susceptibility of the system or community exposed, and its resilience and adaptive capacity. Additionally, this approach underlines the necessity to consider key factors and multiple thematic dimensions when assessing vulnerability in the context of natural and socio-natural hazards (Birkmann *et al*., 2013). It is the case in the study area because flooding is not only caused by extreme events like a heavy rainfall but it is a

combination of rapid urbanisation and anarchic settlement for decades that trigger natural hazard-associated risk that threaten human security globally. This theoretical framework shows the linkage between different concepts of disaster risk management and climate change adaptation and appears as a useful tool for communicating complexity; it stresses the need for societal change in order to reduce risk and to promote adaptation. Therefore, the MOVE framework makes a clear differentiation between risk and vulnerability and also deals with the integration of the concept of adaptation in vulnerability assessments to natural hazards (Birkmann *et al*., 2013).



Source: Birkmann et al. (2013): Figure 3.5 Framing vulnerability, risk and societal responses: the MOVE framework. Natural Hazards

3.2.2. Characteristics of the Move Framework

Exposure describes the extent to which a unit of assessment falls within the geographical range of a hazard event.

Susceptibility (or fragility) describes the predisposition of elements at risk (social and ecological) to suffer harm.

Lack of resilience or societal response capacity is determined by limitations in terms of access to and mobilization of the resources of a community or a social-ecological system in responding to an identified hazard.

The adaptation box deals with the ability of a community or a system to learn from the past disasters and to change existing practices for potential future changes in hazards as well as vulnerability contexts.

Hazard is used to describe the potential occurrence of natural, socio-natural or anthropogenic events that may have physical, social, economic and environmental impacts in a given area and over a period of time.

3.3. Methods

The difficulty of the problem I have to tackle in this study needs a combination of various tools to generate synthetic information related to causes, consequences and flood management.

3.3.1. Data Collection

A. Climate Data

Climate data involved in this study were monthly values of minimum and maximum temperatures and rainfall amount sorted by decades for the whole time series. Climatic data are obtained from the meteorological agency principally ANACIM (Agence Nationale de l'Aviation Civile et de la Météorologie). These data are from the Dakar Yoff station. The dataset covers the time period from 1947 to 2013 for rainfall and 1947 to 2012 for temperature. Therefore, we did an internship there and participated to the briefings of the weather forecasting.

B. Socio-economic Data

Quantitative method is also used. The advantage of quantitative research is that the findings from the sample under study will more accurately reflect the overall population from which the sample was drawn (Vanderstoep *et al.,* 2009).The questionnaire form is designed to give information on the following variables:

- 1. Socio-economic indicators: sex, age, educational level, monthly income, and occupation.
- 2. Susceptibility indicators—type of building structure, length of stay of respondents in flood-affected area, past flood experience, awareness of flood hazard, perception of flood risks, and preparedness for possible flood occurrence, the number of children under four years old.

- 3. Exposure indicators: the size of the households.
- 4. Recovery indicators—coping: the distance from household to the nearest health centre.

*** Sampling Method**

The sampling method of Israel, (2013) simplified formula is used to calculate sample size. A 95% confidence level and P= 5%, 7% and 10% are assumed for different population size by the equation below.

(1) $$n = \frac{N}{1+N(e^2}$$

Where **n** is the sample size, **N** is the population size and **e** is the level of precision. For my study area, for instance, my first investigations give a total population of Medina Gounas to be 44.000 inhabitants. According to the formula, the sample will focused on 100 households because we apply P= 10% with the formula above.

- This research adopts also an exploratory approach, using predominantly qualitative methods to examine the research questions in order to achieve the stated objectives. The main advantage of qualitative research is that it provides a richer and more in-depth understanding of the population under study. Techniques such as interviews and focus groups allow the research participants to give very detailed and specific answers (Vanderstoep *et al*., 2009). For the focus groups a recorder is used so that I can better capture the inhabitant's perceptions of flooding issues. Focus group discussions determine relevant indicators to describe vulnerability. I equally use some aspects of eco health approach like participation, gender and equity which are key pillars in community-based participation in strategic development for their well-being. It helps me to understand at which level they are involved in finding solutions to flood events.

- Several open interviews are undertaken which are not interviews with questions that cannot just be answered with yes or no, but, they are open for discussion, free and flexible with stakeholders about floods and their consequences on people living in the study are and also the disaster managers.

- Some semi-structured interviews and life stories are used. A semi-structured interview is a method of research used in the social sciences. It is open and allows new ideas to be brought up during the interview as a result of what the interviewee says. The interviewer in a semi-structured interview generally has a series of themes to be explored. Life stories are

biographies or portrays that stakeholders of an event tell their experiences about what they faced or they are facing in these events.

The method of content analysis is used and are all organisational documents relevant to the study site, such as work plans, NGOs documents, grant proposals, State annual reports, Students Master thesis, Ph.D., newspapers. Quantitative and qualitative data are from the field survey. For the documents of content analysis, they are reports from the civil protection agency, academic articles, books, Master thesis and Ph.D. dissertations, soft libraries.

C. Vulnerability Data

In this study we use GIS which is considered as fundamental tool to act promptly in case of floods. Regarding vulnerability indicators, field survey data were used and with a GPS we collect points of the study area boundaries, houses where the questionnaires are administrated and put them in the ArcGIS 10 software (2012). This is the most crucial activity in my research. Therefore, the hazard is temporal and spatial. The components of vulnerability are combined to determine an overall vulnerability to flood and visualized.

3.3.2. Data Analysis

A. Climate Data Analysis

Descriptive statistics for both monthly mean temperature and monthly total rainfall amount were firstly extracted. With Excel, annual minimal, maximal and mean temperatures in Dakar Yoff station were computed to see the trend of temperature evolution. At the same time, annual cycle of minimal, mean and maximal temperatures are computed. The diagram average monthly mean temperature and rainfall is made by using the following formula:

(2) $P = 2T$

Where P=monthly mean rainfall from 1947 through 2013.

T=monthly mean temperature from 1947 through 2012

For the Lamb index determination the following formula is used: Lamb (1982) as cited in Sene *et al*., (2002), who proposed a rainfall analysis method named "rainfall anomaly index. This index is calculated by the following formula:

(3) $X_j = \frac{1}{N_j} \sum_{i=1}^{N_j} \frac{r_{ij} - m_i}{s_i}$

Where r_{ij} is the rainfall measured in a year *j* at a station i, m_i and σ_i are the average and standard deviation of the rainfall recorded at the station *i* and N_j *is the number of stations that have recorded rainfall in the year j*. In our study there is one station (Dakar Yoff station), so the above-mentioned formula becomes:

(4) $$X_i = \frac{r_i - m}{\sigma}$$

Where Xi is the rainfall anomaly index for the year I, ri is the total annual rainfall for the year i, m and σ are the average and standard deviation of the annual rainfall recorded during the period of time chosen for this study.

B. Socioeconomic Data Analysis

EpiData software, excel and SPSS are used for the statistical analysis. EpiData Analysis is used for: Basic descriptive analysis of quantitative data, defining and modifying data, editing / correcting data already entered. For use of EpiData software, questions should be coded in quantitative form so that it could be easily analysed. This software is very useful because it can allow us to convert different variables from the field survey to an excel file for the statistical analysis in SPSS. Thus Pie charts and bar graphs are drawn.

C. Vulnerability Analysis

The MOVE framework characterizes vulnerability through three key factors, namely (1) exposure (E)–reflecting the extent to which a unit of assessment falls within the geographical range of a hazard event, (2) susceptibility (SUS)–which describes the predisposition of elements at risk to suffer harm, and (3) lack of resilience (LoR), which is determined by limitations in terms of access to, and mobilization of the resources of a community or social-ecological system in responding to a particular hazard.

Based on data availability, previous research and personal judgement, the following indicators were selected under each vulnerability component.

E: Household size

SUS: Number of children under 4 years of age

LoR: Distance to nearest hospital (m)

a. Normalisation of Indicators

All datasets were standardized, using linear min-max normalization (equation 1) according to Malczewski (1999) cited by Hagenlocher *et al* (2013).

(5) $$\vartheta_i' = \frac{(\vartheta_i - \vartheta_{min})}{(\vartheta_{max} - \vartheta_{min})} * sign + 0.5 \square (1 - sign)$$

Where, ϑ_i refers to the actual pixel value, ϑ_{min} and ϑ_{max} values derived from the original value range and sign (or polarity) indicates whether the indicator contributes positively or negatively to vulnerability. This results in normalized values (ϑ_i') in the zero to one interval.

b. Weighting Method

According to Iyengar and Sudarshan (1982), it is assumed that there are M regions or districts, K indicators of vulnerability and x_{ij}, i=1,2…M; j=1,2,…K are the normalized scores. The level or stage of development of i^{th} zone, $\overline{y_i}$, is assumed to be a linear sum of x_{ij} as

(6) $$\overline{y_i} = \sum_{j=1}^{F} w_j x_{ij}$$

Where w's (0<w<1 and $\sum_{j=1}^{K} w_j = 1$) are the weights. In Iyengar and Sudarshan's method the weights are assumed to vary inversely as the variance over the regions is the respective indicators of vulnerability. That is, the weight w_j is determined by

(7) $$w_j = \frac{c}{\sqrt{var(x_{ij})_i}}$$

Where c is a normalizing constant such that

(8) $$c = \left[\sum_{j=i}^{j=K} \frac{1}{\sqrt{var x_{ij})_i}}\right]^{-1}$$

The choice of the weights in this manner would ensure that large variation in any one of the indicators would not unduly dominate the contribution of the rest of the indicators and distort inter regional comparisons.

The aggregation of the three components (i.e., E, SUS and LoR) into the final composite indicator of socioeconomic vulnerability was then performed using the equation below, while taking into account specific weights for the three components as detailed below:

(9) $VU = \frac{\sum_{j=1}^{n} w_j x_j}{n}$ Hagenlocher et al.(2013)

In the equation VU refers to the vulnerability index for a given neighbourhood, m equals the number of components, w_j represents the weights for domain j and x_j is the index of component j (i.e., E, SUS, LoR). In this study the three components have the same number of indicators. So, the weight w is equal to 1 for each of them and m is represented by 3. The vulnerability index so computed lies between 0 and 1, with 1 indicating maximum vulnerability and 0 indicating no vulnerability at all.

Finally, the values obtained were grouped into five classes using the quantile method, which is a predefined function of the ArcGIS 10 software (2012). With this method, each class contains an equal number of features, thus all classes differ in their values ranges. To facilitate comparison, the qualitative labels “very high, high, medium, low, very low” are used in the legends.

CHAPTER 4: RESULTS AND DISCUSSIONS

In this section, results are going to be presented as the outcomes of the study. First, let us consider the results of the analysis of meteorological data and then those of the field survey.

4.1. Results of Meteorological Data Analysis

4.1.1. Temperature Analysis

To justify climate change at local level, it seems to me that temperatures are the most adequate. The following figures show the annual cycles of minimum temperature, maximum and mean temperature in Dakar. For instance, since 1970, an increasing trend in minimum and maximum temperatures is observed. They are telling that the climate is changing and this appears clearly through the figure 4.1 below. In the field of climate change we used to mostly observe that figures showed an increasing trend in the global scale.

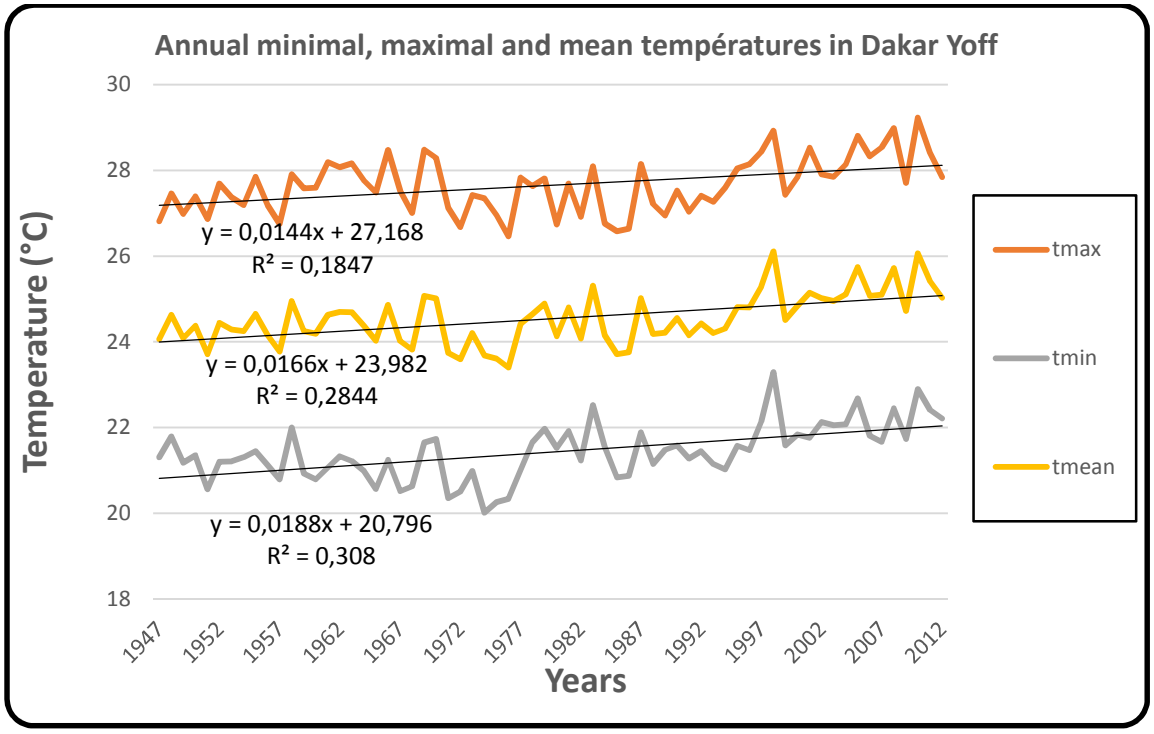


Figure 4.1Annual minimal, maximal and mean temperature in Dakar Yoff: (source: author of the study)

In the graph 4.1, there is no big difference in the trend between maximal and minimal temperature. In general, the thermal amplitude is about 5°C. Therefore, the difference may be found in the monthly temperature.

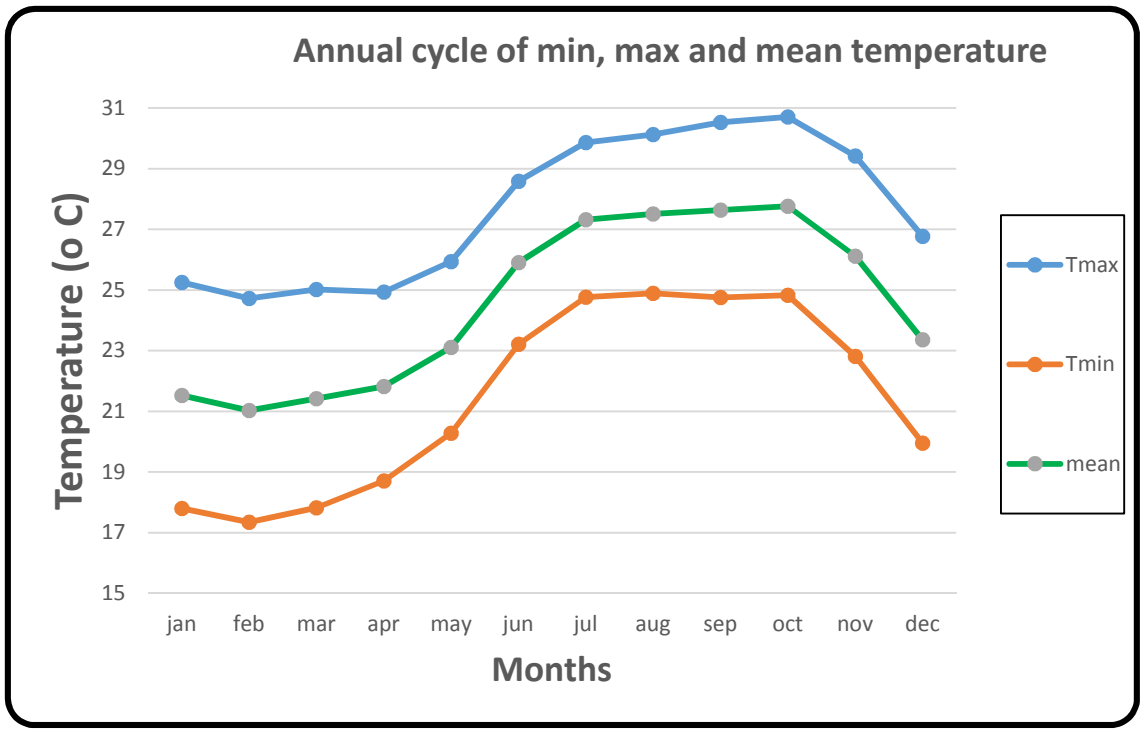


Figure 4.2. Annual cycle of min, mean and max temperature; (source: author of the study)

These annual cycles of maximal, mean and minimal temperatures are computed by using all monthly observations of the times series (1947-2012). For instance, the description of annual cycle shows that the maximal temperatures in Dakar are observed in October but the trend began to increase in May to gain its maximum in October and decrease again till December where temperatures are in their minimum. The same trend is also observed with minimal even in the mean temperatures. However, flood events can be better understood by giving a particular attention to the rainfall at the local level.

3.1.2. Precipitation Analysis

Generally speaking, precipitation in Sénégal is closely related to the one that prevails in the Sahel. It occurs with the advent of the African Monsoon. During the second half of May and June, the ITCZ is stable around 5 degrees north. It is the first rainy season in Guinea Africa region. While in July, the ITCZ has moved rapidly to the north, reaching its second equilibrium position at 10 degrees north and remaining there until mid-August. It is the wet season in the Sahelian Africa region.

However, in the Sahel, rainfall is by far the most crucial variable that influences the climate and people's lives. It is determinant to the changing environment in this region. Thus, it is the most suitable parameter to characterize and analyse climatic changes in the Sahel.

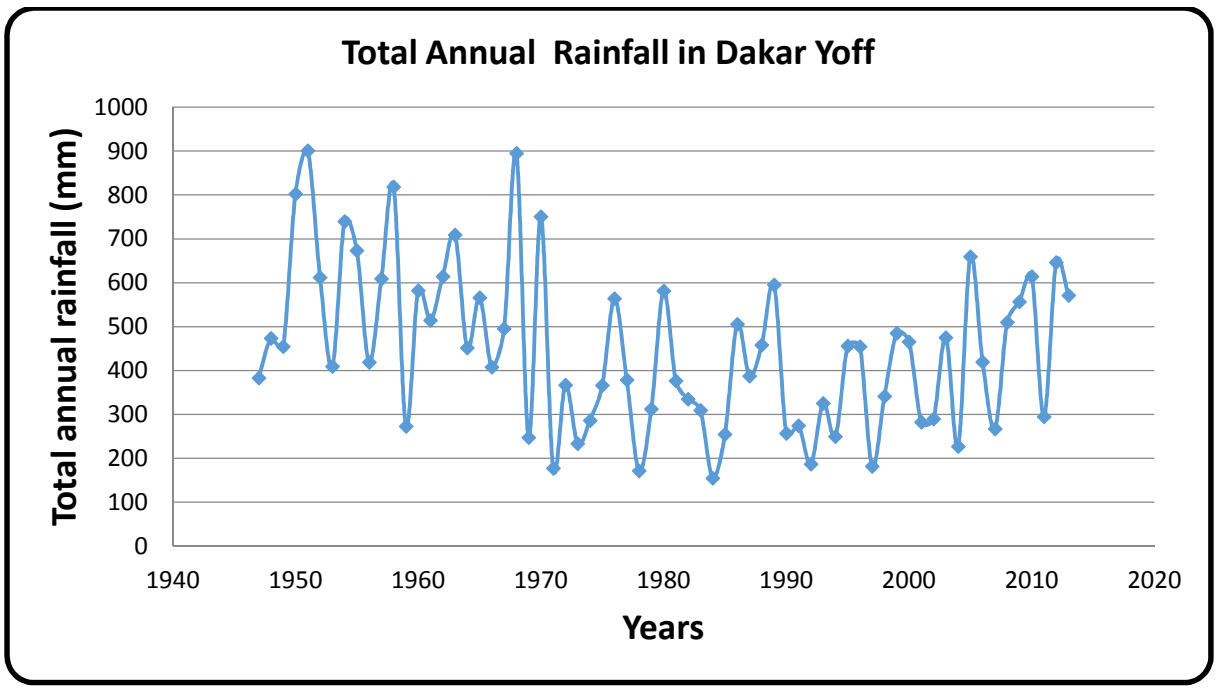


Figure 4.3.Total annual rainfall in Dakar Yoff (source: author of the study)

The above graph is about the total annual rainfall in Dakar recorded in the Yoff meteorological station. It shows the interannual variability of rainfall during the time series of 1947-2013.

In the case of flooding in Dakar, particularly in Medina Gounass, the graph shows the variability year after year where there is excess of rainfall, normal and deficit within the time series. Thus, rainfall can be well distributed during the whole rainy season from May to November and no flood event occurs. But we can record the same amount of rainfall within one or two months and necessarily flooding happens in some sensitive areas. Therefore, the total annual rainfall in Dakar recorded cannot explain the different flood events in Dakar, particularly Medina Gounass. It is important to refer to the total annual rainfall, but it cannot give us the details of what happens in the rainy season. The main explanation can be found in the graph below to better assess the distribution.

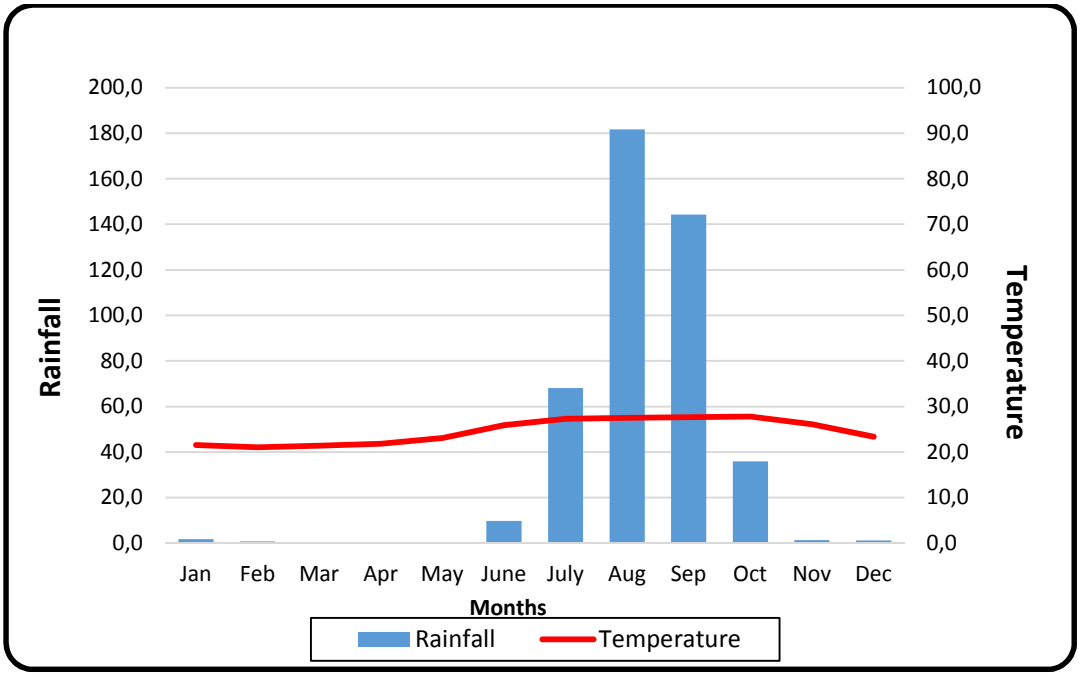


Figure 4.4.Average monthly temperature and rainfall for Dakar Yoff from 1947 to 2012 diagram (source: author of this study)

The graph above which is a combination of the monthly mean of rainfall and monthly mean of temperature from 1947 to 2012 shows clearly how rainfall is distributed in Dakar. This confirms that July, August and September are the wettest months in Sénégal. They are also the periods where flood events occur mostly. In this combined graph, we can observe that the months of rainfall are the hottest in Dakar. Therefore, the monthly mean rainfall of July is around 70 mm for August, 180 mm and for September 145 mm where August is the most pronounced in terms of rainfall.

According to Sene *et al*., (2002), as the maximal daily rainfall, flooding rainfall is analysed to see the frequency if it corresponds to annual daily maximal rainfall. The analysis of these episodes is important, because it allows understanding real causes of flooding and the nature of rainfall. The study start from known examples of Dakar, Kaolack, and Saint-Louis because the local News Paper Wal Fadjri of the 2nd of August 2000 or the direct experience. (Sene *et al* 2002) highlighted that 105 mm of rainfall are recorded in 24 hours which triggered flooding in Cities as Dakar 22nd of July, 2000 and Saint-Louis the on 1st of August 2000.

In the same vein, (Wade *et al*., 2009) argued that in details, 2005 is characterised by the frequency of heavy rainfall within a short period. Therefore, with a total annual rainfall of 590mm, 270mm with a percentage of 46% have fallen within seven days in mid-August and 360mm in fourteen days with 61% in the end of August and the beginning of September.

Looking closely at this information with the data collected which are sorted per decade (10 day), we can say that in 2005 the station of Dakar Yoff recorded 188.9 mm and 145 mm for the second and third decades, respectively, for a monthly total of 336 mm. In the first decade of September, 106.8 mm were recorded. Furthermore, in July 2000 Dakar Yoff station has recorded 154.3 mm in the third decade. All the years' cities above confirm what we have from the field survey concerning the collective memory of flood events in Medina Gounass. It seems to me that the data in works quoted are acceptable.

This information confirms that these three months are the wettest where an important amount of rainfall is recorded in Dakar and the most pronounced month is August.

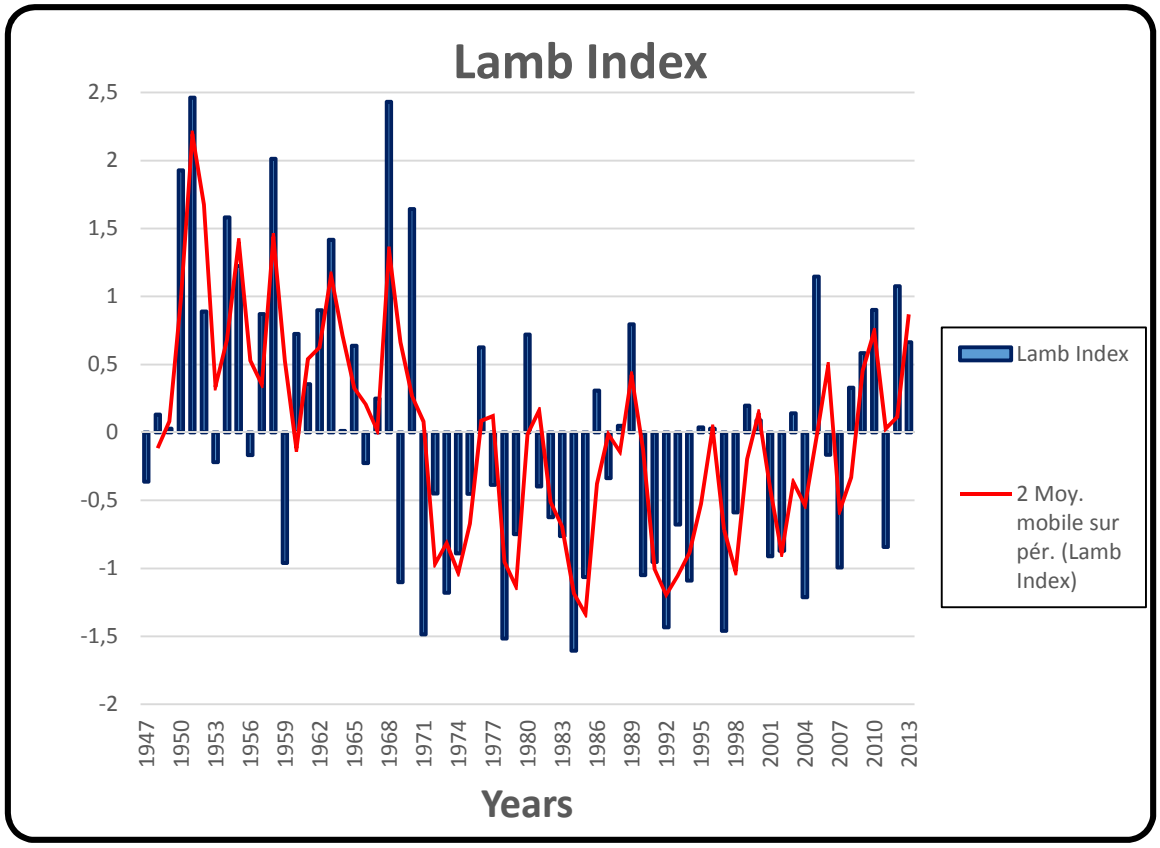


Figure 4.5.Lamb index; (Source: the author of this study)

The Lamb index has a long history in climatology for the determination of dry years and wet years. Then, Balme *et al*., (2006) highlighted that, since the early works of Charney (1975), Sircoulon (1976) and Lamb (1982) among others, the Sahel drought was a recurrent concern for populations, hydrologists and ecologists. Actually, it is West Africa as a whole that was the scene of a drought widespread in the 1970s and 1980s. Thus, the decade 1990s saw a gradual return to more humid conditions of rainfall deficit over the Sahel, continued until 2002, even though attenuated, as shown by the index [(I = (Pi – P mean) / σ, with the Pi

rainfall year i, P mean average rainfall over the period 1950-2002, and σ the standard deviation over the same period)].

For this index, the negative values are considered dry years and positive values are wet years and many scientists use it for their research. Therefore, (Sene *et al*., 2002) use Lamb index to perform rainfall analysis based on daily data precipitation collected at ten synoptic stations of Sénégal from 1921 to 2000. The choice of this series of rainfall lies in a preoccupation of doing a relevant analysis, because taking into account a long period before and after the onset of drought. Analysis of floods- rainfall events relationship is based only on the review of daily precipitation, regardless previous rainfall.

Furthermore, Diop *et al*., (2011) have conducted a survey and used the same station data but from 1970 to 2009 and in their findings they argued that throughout the Sahel, climate variability is manifested through the rainfall totals. Normalized standard deviation for Dakar-Yoff station can vary considerably from one year to another. This variability is due to types of disturbances that bring most of the rainfall in Dakar squall lines and cyclonic disturbances. Additionally, they found that rainfall trend is on the rise from 1970 to 2009 shows generally positive differences during the 2000s. Thus, with the extension of the buildings in high pressure areas, floods are becoming more frequent. Therefore, the 2005 flood affected districts that were not concerned. Houses in Hann-Marist are particularly vulnerable to these increases in rainfall. Even a well-planned area like Hann-Marist was affected; Medina Gounass where people live haphazardly was highly touched by these events.

On the contrary, in the data drawn for this study, the series is not well distributed and it is clearer shown by the mobile mean drawn in red. Even though this index is used to determine flood and drought years, this study puts emphasis on rainfall causing floods. This index is used because the field survey data revealed that there are years which come regularly from local inhabitants during our interactions concerning the history of flood event in the area. However, Priem (2009) within the same Dakar Yoff station in the time series 1947 to 2005 found that the trend breaks are developed using statistical tests to assess changes in climate. The simultaneous application of the test identified unsurprisingly abrupt change in 1969, the beginning of the great drought in the Sahel. After that date, the series is stable and no return to wet conditions. However, the application of these tests to the Dakar Yoff meteorological station showed a return to less arid conditions. Similarly, a simulation shows the coming year's also very likely break at the reference station for a few rainfall even much

lower than that of 1999 and 2000 are recorded. This illustration comes to shade more lights in the behaviours of changes observed in climate.

Nevertheless, Priem (2009) in her Master thesis, argued that in 2005, about 450 mm (1 mm = 1 liter of water per m²) of cumulative rainfall recorded in 24 hours in August 2005 to see Dakar and its suburbs under rain water. For us, it's too much for Dakar to record such a quantity of rainfall in a single day. In the data we have and they come from the same meteorological station of Dakar Yoff, for the whole August we have 336 mm. She used also the Lamb index to determine anomalies during the time series of 1947-2005. However, she argued that, Dakar has experienced more intense rainfall events in recent years and notably in 1989, 1999, 2001 and recently in 2005 and the question is if one can say that it is the return period to the normal. One might be tempted to say that we are at the end of the cycle of drought and beginning of a new wet phase In Sénégal.

For my perception, it's too earlier to argue that it is the return period to wet years in Sénégal. As an example, the 2014 rainy season was forecast to be a normal to deficit one. Thus, till the beginning of September, many areas in the country did not have much rainfall for agricultural activities.

Observing closely the Lamb index graph, it clearly appears that there are wet years during the period 1947-1970 and from 1970 to 1989, this part of West Africa falls into a long period of dryness. This period corresponds to the long droughts which hit the Sahel in general. In 1989, there was a wet year and after that we fall again in drier years till the early 2000s where wet years seem to be more frequent. In this last decade, rainfall is not without negative consequences for urban inhabitants. Hence, Dakar suburban's particularly those from Medina Gounass are constantly in rain water mixed to sewage and drainage water which obstruct people's activities and become a threat to human security at large. This particular aspect is highlighted by (Priem, 2009) that in August and September 2005, nearly 200,000 people in poor suburbs of Dakar had their feet in the water and were later displaced and resettled in precarious sanitary conditions for most of the time. Floods in several locations where there is (no drains, under sizing existing structures with respect to demographic changes in the cities) highlight the fragility of everyday life in the Senegalese capital city, completely paralyzed by rainfall events. As a result, it becomes a threat for human security generally.

The graph below is an illustration on what people's memory remembered about the past. In this regard, they are asked to remember the first flood event they have ever

experienced. The statistics showed that the year 1989 is by far the most represented. This does not infer that it is the only one but the memory of people we addressed is limited to that event.

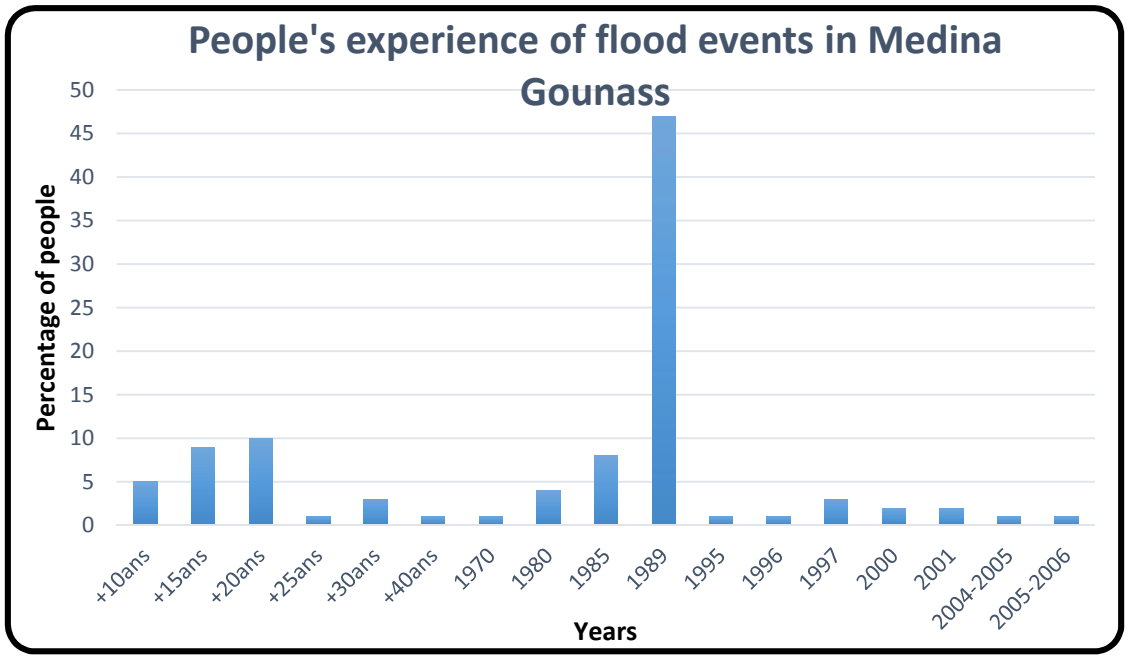


Figure 4.6.Experience of flood events; (Source: author of the study)

The survey revealed that 47% of people point out 1989 and when we observe at the index, it is obvious that it was a wet year. The explanation is that people experienced a long period of dryness during the 1970s drought. There is a retreat of the water table and the demographic growth. At the same time, rural people came to the capital city for job opportunities. The best area to them for settlement is the suburbs where lands are cheaper.

Since the 1970s drought years, people lost prevention measures, and lived haphazardly without any amenity plan, any sewage nor drainage system. As a result, when a normal event of rainfall comes they are flooded and this causes a psychological shock. The normal, by referring to the period given by World Meteorological Organisation, is the period of 1961-1990 in which the normal is 424.046 mm within the time series we have. Thus, 1989 can be considered as normal compared to previous years with a total of 458.5 mm. People's activities are determined by the behaviours of the climate.

After 1989s event, the index showed that we fall again in years of dryness event, wet years can be noticed before the return of the normal in 2005. If the duration before another important rainfall event occurs is too long, people tend to forget about adaptation measures, though their vulnerability to floods increases. That is why when the total rainfall is 659.5 mm

in 2005, it was too much in an area already flood-prone. Since that period, every years the area experience flooding as it is observed in the index.

As a result, it cannot be said with certainty that there is a return period for more rainfall in coming years. What is known with the predictions of the IPCC is that we are in climate change and people will experience more extreme events as droughts and floods and African countries will suffer most because located in low latitudes. Though, the research objective which is to analyse precipitation indices and, at the same time, to compare of the evolution of temperature and precipitations at the local level showed changes in temperatures and rainfall. These changes in the local climate cannot solely explain the social vulnerability of Medina Gounass suburbans. Another explanation can be found in the socioeconomic characteristics.

4.1.3. Weather forecast

For the meteorological briefings, the Senegalese Weather forecast is based in the Agence Nationale de l'Aviation Civile et de la Meteorologie (ANACIM) where the prevision directorate has a team in charge of this activity. For human security, every day, during the whole rainy season, the weather is predicted based on the previous situation with satellite images to see what is happening really in the atmosphere. Meteorological prevision consists in having certain meteorological parameters value at different levels in the atmosphere. The atmosphere is divided in different levels in which the standards are 925hpa, 850hpa and 700hpa. For the prevision, people use surface conditions through depressions and anticyclone zones to have an idea of the weather. Therefore, in the atmosphere the ascendance of water vapour create a cyclonic situation (convergence) at 925hpa, swirling winds at 850hpa and 700hpa and divergence at the higher atmosphere precisely at 200hpa to have an ideal structure of a cumulonimbus. It is the divergent movement which create a kind of hat in the cumulonimbus and it the final phase and the probability to have a deep convection is high. For a vortex at 925hpa to be moist, it is necessary that the flux which feed this vortex comes from the South precisely in the Sainte Hellen anticyclone.

In the briefings, for instance, the technicians try to find and highlight through maps as output of numerical models. This meteorological information is a useful tool for human security. Firstly directed to the State government in the different offices, they are used for planning the government activities, for the sowing periods in the agricultural sector, for herders to find abundant grass to feed animals, for fishery. In cities, these data are useful to know when and where to go, which kind of dressing to wear, for tourism, transport,

construction, governmental decision making. Additionally, the information is a useful tool to predict flood situations in big cities like Dakar and it suburbs.

4.2. Characteristics of the Sample

The sample size of the survey is 100 household administrated in the study area. These people have the opportunity to respond to the questionnaire related to a certain number of social, economic, educational, environmental, and existential in the area where they live.

4.2.1. Sex Ratio and Average Age of the Sample

The study conducted in Medina Gounass district shows that the percentage of males who respond to the questionnaire is 81% and 19% are females. It can be explained by the fact that in this area, males have the power and the responsibility to be the ones who lead the household.

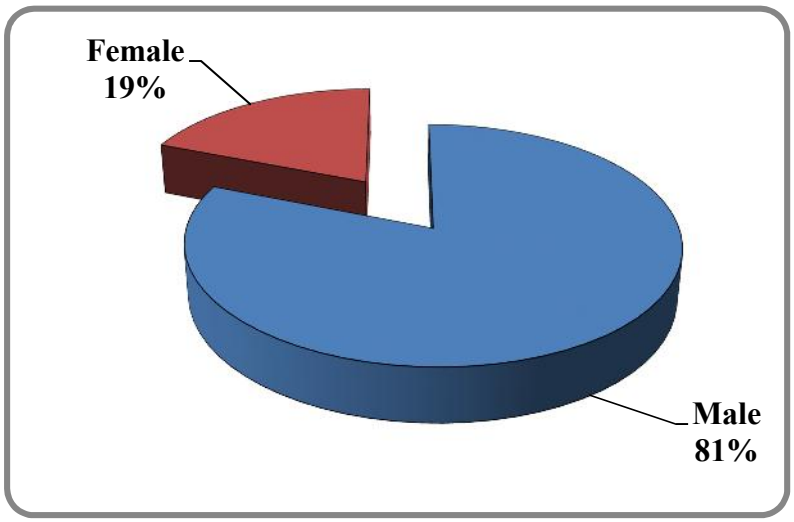


Figure 4.7. Sex ratio; (source: the author of the study)

For instance, during the field survey, we have cases where some wives did not want to answer the questionnaire because their husbands were absent. There are cultural beliefs that the leader of a household is a male as it is the case in Medina Gounass. This element appears clearly during the focus group when females refused to talk first before males. Thus, they did not want to give different opinions from males. This observation is reinforced by the fact that we are in an area deeply rooted in traditions which reflects a community mainly composed by Muslims whose fundamental characteristic is that the male is the chief of the family. This affirmation can be highlighted by the predominance of mosques and there is no church in this area.

In addition, historically, Medina Gounass is created in 1960, and its name symbolizes a recognition of first inhabitants, disciples of the guide El Hadji Mamadou Seydou Ba (great scholar of Haalpulaar community, founder of Medina Gounass Tambacounda) whose intervention was determinant to threats from eviction that have long hung over the neighbourhood. The naming ceremony took place in his presence in this neighbourhood located opposite what is now the current police station of Guédiawaye (Djibo, 2005).

This aspect highlights the link between religion and governance which sometimes can be a real obstacle to the socio-economic development of the nation. Most of the time, religious guides put pressure on the government to have some facilities even though, in the long run, this becomes a problem for the inhabitants in particular and the State in general. It is the case in what happens in Medina Gounass. The former government let people live haphazardly in a low land area. Consequently, people are vulnerable to flood and have their houses flooded because of pressure and lack of amenity plan in a low lying area.

Additionally, the only sex ratio cannot solely explain social vulnerability of people living within this area. Another explanation can be found in the composition by age.

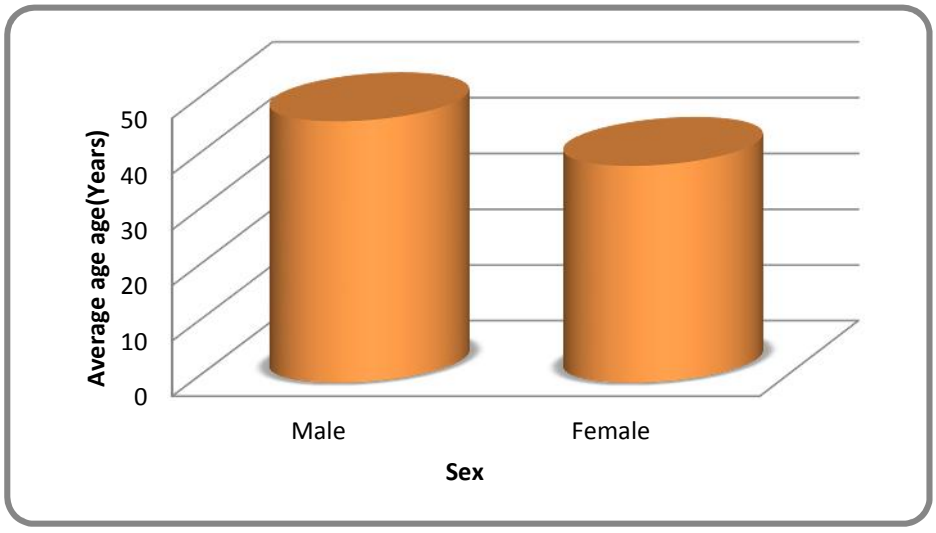


Figure 4.8.Average age; (source: the author of this study)

In the graph above, we see that the average age of the sample is 47 years for males and 39 years for females. These statistics show that in this area the population is relatively young. Consequently, they are supposed to be more resilient than elders against flood events which are recurrent. In an interview with an old man in the study area, the question of the place of young people against flooding was asked and it seems that they are not really involved.

It becomes a problem in a community where those who are the most valid do not have an interest in what is going on in their society. In my opinion, education has an important place, but employment is not an isolated factor for young people's lack of involvement in flood management. Thus, this category revealed by this present study can be considered, sociologically speaking, as full adulthood when the preoccupations of people are much turned on patterns of career progression and termination.

4.2.2. Employment Rate

Concerning the employment rate, the survey revealed that 52% of males and 8% of females are employed. On the contrary, we have a rate of unemployment of 29% for males and 10% for females.

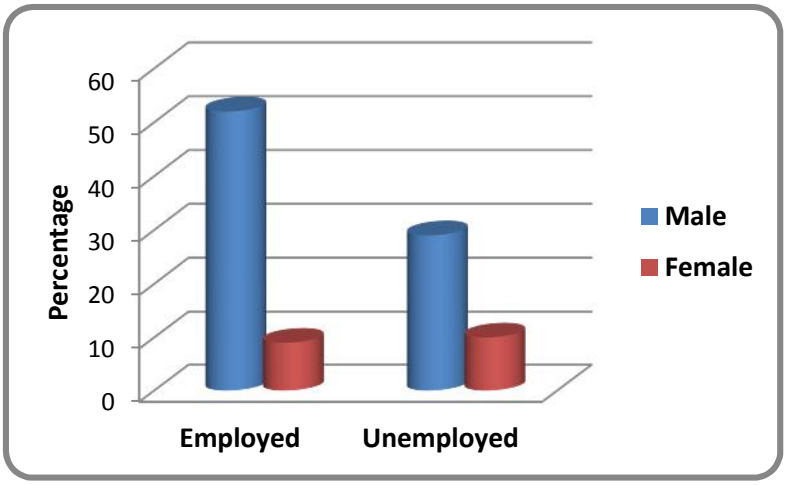


Figure 4.9.Employment rate; (source: the author of the study)

These statistics showed an employment rate of Medina Gounass inhabitants above the average. That means people are employed but for which job and how much they are remunerated? For instance, the large majority is not employed by the State as civil servants but by some companies and private individuals. Some of them run their own business like traders. Socio-economic sectors are sensitive and vulnerable to climate change and variability. When there is an extreme event like floods in the study area, all human activities are disrupted.

These statistics don't show much how the inhabitants are economically vulnerable. The explanation of this aspect can be found in the literacy rate.

4.2.3. Literacy Rate

The education level show sometimes the degree to which a community in able to withstand and recover quickly when a disaster strikes. This graph below illustrates the literacy rate of Medina Gounass inhabitants which is mainly dominated by 46% for the primary school, 24% for the secondary, 16% for university, 4% for professional studies and 10% for the non-educated.

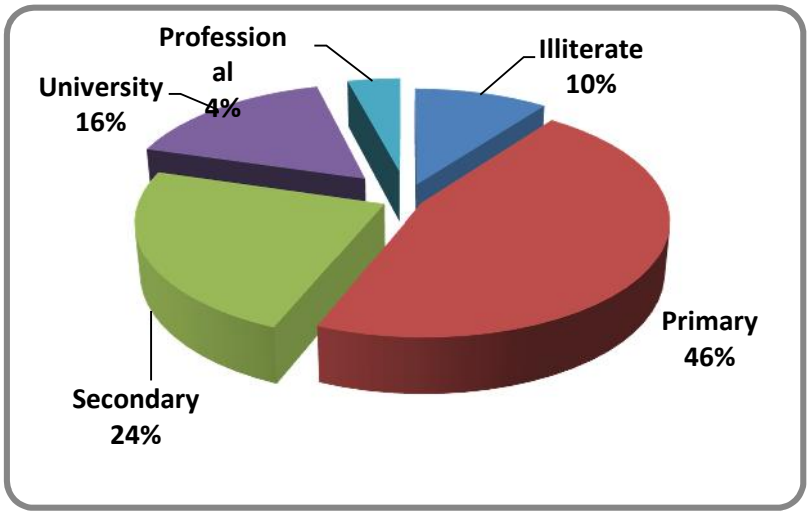


Figure 4.10. Literacy rate; (source: the author of the study)

In the same vein, Priem (2009) argued that in Medina Gounass, it is the informal sector that employs the youngest workers, the less educated and more females. This is also the area where we have the lower income, where social benefits are the lowest and the social welfare is almost null.

The literacy rate sometimes determine the level of income. Thus, people living in Medina Gounass, considering the literacy level, are not highly paid. Most of them dropped from school earlier. Consequently, their level of income cannot allow them to afford housing in the well planned urban areas where viable and liable amenities already exist.

The graph below is an illustration of the types of remuneration inhabitants are paid.

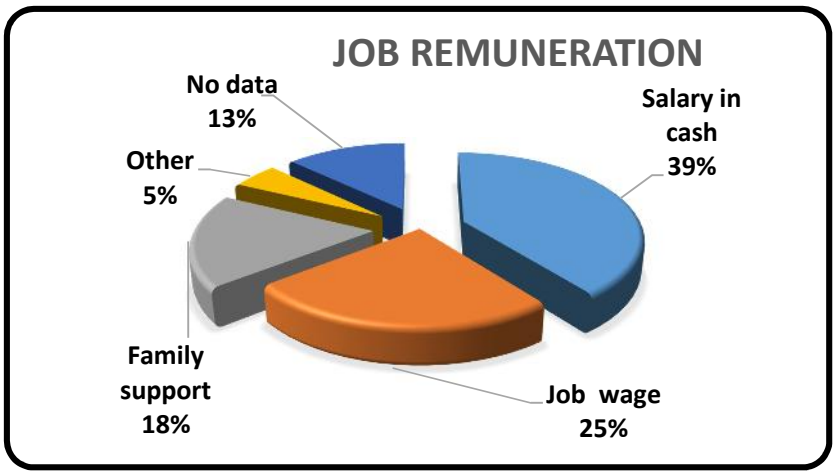


Figure 4.11. Job remuneration; (source: the author of the study)

This graph shows that those who have a salary paid in cash represent 39%, for family support 18%, job wage 25%, other 5% and no answer 13%. These statistics with the linkage to the literacy rate confirm that the Medina Gounass inhabitants in general have limited economic means to buy houses elsewhere where the amenities already exist. Thus, this particular aspect is an answer to the hypothesis that: flood-affected people settled within that area because they are mostly low-income people that could not afford housing in urban-planned sites where liable amenities already existed. Additionally, Medina Gounass lacks amenity plan for a district which is said to rule its own destiny. The pictures below are an illustration.

Picture 1 settlements in Med. Gounass Field survey August 2014

Picture 2 Med. Gounass Field survey August 2014

The socio-economic activities on the site are mostly dominated by small businesses reduced to informal trade along on public roads, the weekly markets and other occupations such as hairdressers, carpenters, sewing.

Furthermore, the first inhabitants of Medina Gounass came from rural areas (Haalpulaar ethnic group coming from eastern Sénégal were the majority with a small minority of Serere) and mostly illiterate. For many years, the lack of a school in the area excluded children from school (Sarr, 2010). This fact explains why we noticed only one public primary school and many other Koran schools placed mostly in many mosques within the study area. These aspects of inhabitants are determinants for their social vulnerability but not sufficient, then another element concerning land ownership may give more details.

4.2.4. House Ownership

In the graph below, it appears clearly that in Medina Gounass the percentage of people having their own houses is by far greater than tenants, with 82% against 18%.

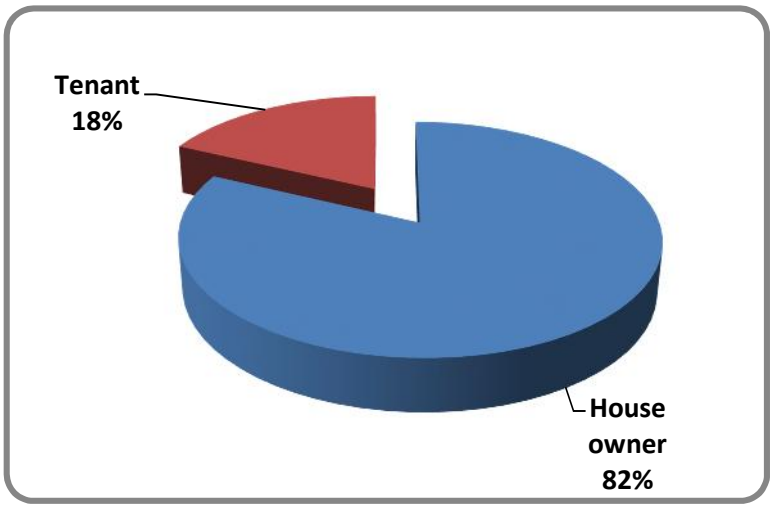


Figure 4.12. House ownership; (source: the author of the study)

For a brief historical view, the site is a former crop fields space (Niayes) belonging to the Lebou ethnic group. They have sold the first plots of land for residential use at prices ranging between 3,000 and 5,000 CFA francs. The installation was done without any respect for the standards of urbanisation (Djibo, 2005).

Furthermore, the economic situation of Sénégal was characterised before and just after independence, by an unequal distribution of wealth and imbalance in the development level between western regions close to the capital city, Dakar and those in the East and the South. This situation is exacerbated by the droughts of 1972-1983, through which had the largest

impact in inter-regional migration. The main migration flows are directed towards the Dakar region (49% of flows in 1976) (Sarr, 2009).

These situations are the driving forces for the high populations of many suburbs among them Medina Gounass. The socio-economic situation, the governance issues and climatic conditions at that period encouraged people to settle haphazardly in these areas and no one at that time could think about what would happen if there is a return period of rainfall. In Addition to that, the population growth in an unplanned site aggravated people's suffering during flood events.

The land ownership was so cheap that people with moderate income prefer to have their houses there even though it is a risky area. These factors put Medina Gounass populations in a permanent situation of human insecurity. It is important to say that even if one acquires a house without paying much money, what he has to lose is by far greater when a disaster as flooding strikes as it is the case in this last decade in Medina Gounass.

Thus, the main driving force in this situation lies in social inequities which are exacerbated by the leniency of governance, lack of preventive measures, bad behaviours and risk awareness. "The inability to sustain stresses is produced by on-the-ground social inequality, unequal access to resources, poverty, poor infrastructure, lack of representation, and inadequate systems of social security, early warning, and planning. These are the factors that translate climate vagaries into suffering and loss" (Ribot, 2013). This statement summarise what happens in the study area. As a matter of fact, they have a strong symbolic relationship towards land they have struggled to obtain. It has become difficult for them to leave for an unknown land with many uncertainties. This reason is an answer to the hypothesis: flood-affected people settled within that area because they are mostly low-income people that could not afford housing on the urban-planned sites where liable amenities already existed.

The situation of land ownership is important but not the only determinant to assess social vulnerability in Medina Gounass. Then, the internal mobility to access critical infrastructures is important too.

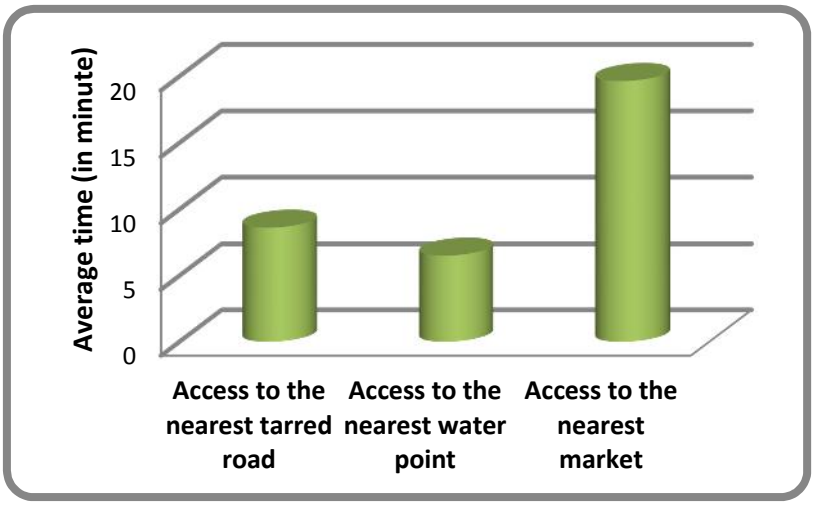


Figure 4.13. Average time; (source: author of the study)

The graph shows the average time one have to spend to reach a certain number of infrastructures. For that, the results of the survey highlight for those who do not have a tap at home, five minutes is the average time to get water which is very important for human life. This information shows how important it is for them to have access to water by a shorter time principally having one's own tap. Moreover, access to the nearest market is too important and the average time to get to nearest market is twenty minutes.

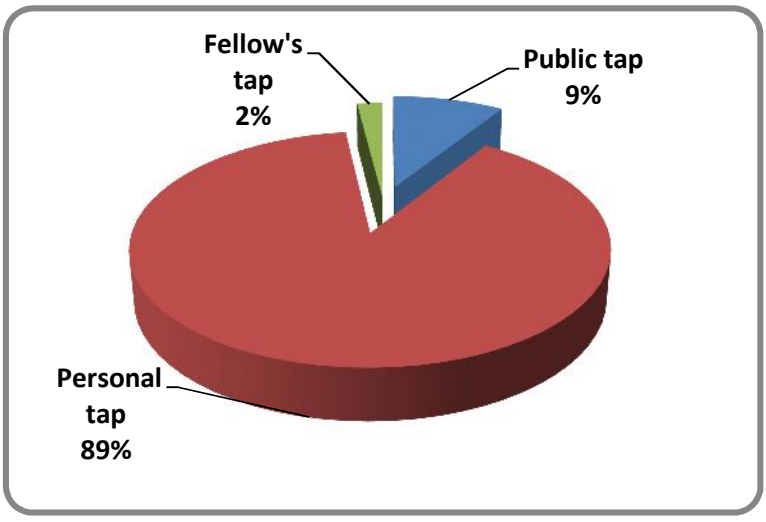


Figure 4.14. Tap used; (source: author of the study)

These statistics reveal that there are 89% of those who use their own tap, 2% use fellows' and 9% are obliged to use public taps. Medina Gounass does not have a major problem of water. There is a relatively good distribution of potable water. It also has public taps located around the area. However, people tend to use wells and pumps, especially in case of shortage to refuel themselves with all the diarrheal diseases that can cause.

Additionally, to have access to tarred roads it takes about eight minutes. Eight minutes are crucial in a human being life if there are no roads in that area to rescue people quickly. The area lacks roads; there are only track for inhabitants to move. That is why in the case of flood events, rescue teams find difficulties in accessing certain zones within the study area. Furthermore, the average time people lose going to the market is much greater. The explanation is that the area lacks a permanent market. There is only one weekly market and people have to move to the neighbouring areas to do their shopping. This is another type of vulnerability Medina Gounass inhabitants have to face in their everyday life. The access to the basic need for a good life is absent in this area. These aspects highlighted above can be sustained by the lack of sewage in Medina Gounass.

4.2.5. Utilisation of Sewage and Septic Tank

The survey reveals that the washrooms in the study area are not connected to the sewage. Only 8% are connected and 92% use the septic tanks. It is a real problem in this area because they are subject to recurrent flood events and the water table is not deep. When flooding occurs, the septic tanks' water and rain water flow together and affect populations. The only ones who are connected to the sewage system are located near the main road Taly Boubess prolonged to the town hall. Thus, sanitation and wastewater management is one of the major environmental problems facing Guédiawaye department and Medina Gounass particularly (Djibo, 2005).

Additionally, Priem (2009) highlighted in her Master thesis that, the implantation of the district of Medina Gounass in an area of bowl in heart the Niayes of Pikine explains the observed permanent flooding since 2005 (but already present since 1989). As a result, the clay soil, the character flush of the water table, lack of sanitation infrastructure and limited means of the district amplify the problems of populations exposed to health and environmental risks. This fact is also an argument of eight persons during the focus group with some of Medina Gounass inhabitants existing conditions of vulnerability that pose a threat for people's livelihoods and the environment on which they depend. Though, these conditions exacerbate social vulnerability in all the components of human security in the area.

For the local government, it is costly to afford necessary equipment thus, this situation negatively impact on the public health and the life quality of populations resulting from inadequate sanitation by the same time becomes a threat for human health security. Additionally, in the district, most houses have devices or materials to evacuate feces.

Challenges remain in the areas where the water table is not deep. In these areas, inhabitants repeatedly dig holes in their concessions or outside near their doors where they pour liquid waste coming from septic tanks. In the rainy season with the flood events, it becomes difficult to breathe the stench. This situation is exacerbated by the lack of sewage and drainage network. This situation of sanitation is not the only one important to determine social vulnerability but responses the State Assistance to alleviate people's suffering is crucial.

4.2.6. State Assistance

This graph below from the survey results highlight the fact that 58% of people argue that they have the assistance of public authorities and 42% claim that they are not assisted by the State. For most of the time it is a political issue for solving the problem.

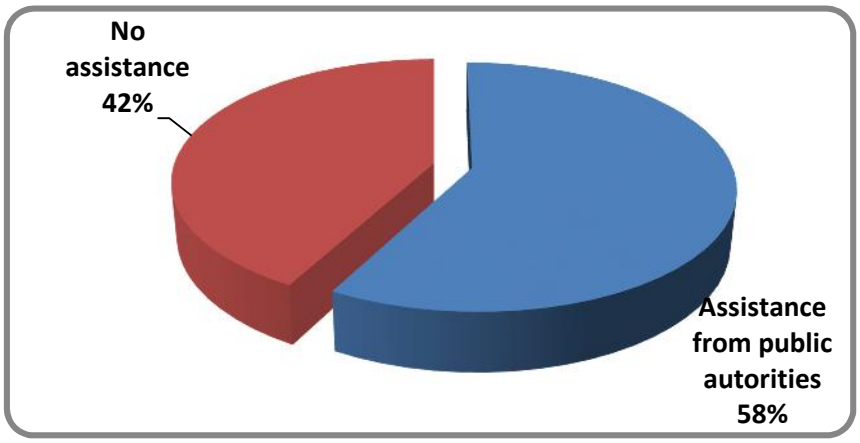


Figure 4.15. State assistance; (source: author of the study)

As it is highlighted by one inhabitant in an interview, as he says that the victims of Gounass are formal. They would rather need more support on the rapid drainage system than these gifts. These donations divide more than they unite, he added that they were not starving; unfortunately, the President Macky Sall's collaborators are doing the same things as the former President Abdoulaye Wade. They prefer power-driven pumps or health assistance because sewage water is mixed with rainwater to which their children are exposed all the time, rather than those bags of rice.

Additionally, the Deputy Mayor of the former regime argues that ministers of the former regime did more and better. During the last rainy season, despite the work done by the former regime, there were no resettlements nor shelters.

On the field, I come across some achievements done by the government such as basins showed below.

Picture 3 Basin1 in Med. Gounass for flood reduction. Field survey, July 2014

Picture 4.Basin2 in Med. Gounass. Field survey, July 2014

The fact is that the field data show the involvement of the government in flood management. As a result, the interview with the former Deputy Mayor Cheikh Dieye highlighted that the current government created an additional site in a location called Tivaouane Peul named Plan Tawfekh, where some of Medina Gounass dwellers will be relocated. There are also other projects in collaboration with the local government for Medina Gounass to become a modern city with all the infrastructures needed. For those projects to become a reality, many people have to move from the area. We can consider these different viewpoints as an answer to the hypothesis: public actions against flooding were not preventive but remedying after damage was already caused and following social contestations and floods made the focus of media attention. Public actions should be preventive and not waiting till the drama occurs to act. This is the major problem we have in our country, political leaders do not have a preventive culture against disasters.

Furthermore, the focus group offered more information about governance. One of the participants Mr Aliou Dione argued that the late Mayor of Guédiawaye Macky Sall in the 1990s after the first flood event took some measures for the restructuration of Medina Gounass. This plan had three phases in which the first was people's displacement and the digging canalisations to channel runoff water to the ocean. However, this plan lacked of supportive measures because, in Medina Gounass, houses are made in cement and those who have to give up their houses should benefit from houses with the same number of rooms as it was the case in their former homes. At that time four hundred (400) households were selected to join the site but the municipality did not have enough money for that. The cost was estimated to seven billion in CFA currency (7,000,000,000 f).

President Wade government forgot about restructuration and rather talked about “Plan Jaxaay” which delocalized some people to allow their tractors and engines which had to dig the basins to move inside the area. So, the advantage of this project is that it collected runoff water into the basins and reduce floods. But the major disadvantage is that families are scattered because the houses on the relocation site are too small to contain big families as it was the case in Medina Gounass. This relocation does not take in account the social aspect of things.

Picture 5 Focus Group in Med. Gounass in data collection, August 2014

Picture 6 Focus Group in Med. Gounass in data collection, August 2014

They have to pay for these new houses on the basis of twenty years before becoming the owner. The site is a property of the state, H.L.M. (Habitation a Loyer Modéré) and the Banque de l’Habitat du Sénégal. What we need now is the former restructuration with all positive actions to alleviate Medina Gounass inhabitants’ sufferings. These are some outcomes from the focus group. This last element leads me to the next aspect which is the willingness for some inhabitants to move from that place.

4.2.7. Willingness to Leave the Area

The study shows that there are 48% of them that want to leave the place and 52% want to stay. The question depends on the motivation of each of them. For instance, those who want to leave the area are motivated by the fact that they are not in security, living almost a decade in such situations. For that they claim to be willing a better future for their children.

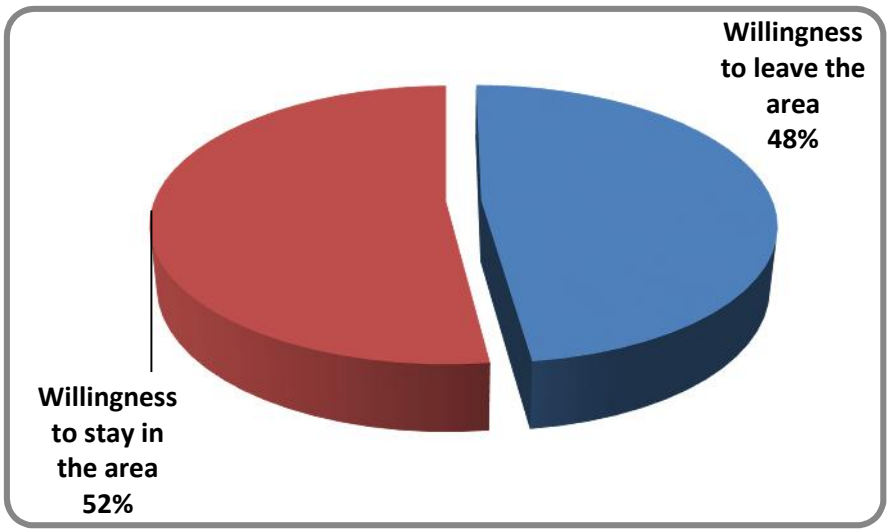


Figure 4.16. Willingness to leave the area ;(source: author of the study)

Obviously, the major part of them do not want to leave the place. The main reason is that they have a particular relationship with the place they have been living in for decades. It is an answer to the hypothesis that although facing diseases and unease, people actually resist the government's relocation projects because of their symbolic relationship with the area where they have been living decades. This view leads to me to think about a social capital they gain in this area during these long years of interactions between all the members of the community.

In this context, Pierre Bourdieu indicates that the volume of social capital possessed by a particular agent depends "on the extent of the network of connections he can effectively mobilize and the volume of the (economic, cultural or symbolic) capital gained by his own within each of those to whom he is related. "Social capital is defined at a first time as what is called a complex social relationship, that is to say an individual and their immediate relations which fit into the macro network of a community. It is constituted by all actors specific to each of them resources held by knowledge that make up their personal network. This network would not be a social gift made at once and for ever but works product establish, and maintain which is necessary to produce and reproduce, useful links and sustainable, calculated to provide material or symbolic profits (Ferrand, 1996).

For those who want to leave the area, the major problem is that they do not have enough financial resources to do so even if there are areas in a big city where amenities already exist but they cannot afford.

All these aspects highlighted above are to be taken into account in assessing social vulnerability. Thus, in these periods of climate change, some people even in the capital city argue that they are not aware of it.

4.2.8. Awareness of Climate Change

For the stakeholder's awareness of climate change, the number of people being aware of climate change is by far greater than those who ignore it and the statistics is 89% against 11%. These percentages are important because at this time almost everybody should be informed about what is happening to our climate.

For the dissemination of the information, all the people who answered to the questionnaire confirmed that they had at least a radio to listen news. The question remains in which language this information is given. Our leaders have much to do if we want to alleviate definitely people's sufferings, particularly the most in need with recurrent flood event in Medina Gounass. Fortunately, some of them are aware of the climate change and the illustration was given by the interview with the Deputy Mayor. He argued that he has participated in a workshop where they discussed about climate change and he had many documents related to that issue. In addition, the focus group revealed that four of the twelve participants are aware of climate change. But, for most participants of focus group rainfall is a domain of God, he is the only one to decide where and when to rain. Hence, even the government does not put much efforts into solving this situation, The Almighty will put them in better situations. This view is for some who give up fighting for a better situation. Their perception towards climate change is shared between those who think that it is God's will and those who are more rational tend to observe what happens in the atmosphere. Thus, during the focus group, some of them argued that they were aware of the scientific viewpoint on climate change but it is important as Muslims to place God in the centre of everything in life. The focus group gave much information but for my perspective, it is a restrictive view to put everything on God. It puts people in a situation that inhibits their creativity. As a human being, this view cannot galvanize them to take actions and by their own initiative to fight against recurrent flood events.

Thus, their responsibility is engaged but the State has the duty to find solutions for these people considered as citizens. So, following the floods of August 2012, the Government of Sénégal was committed to significantly strengthening its post-flood recovery policy. The strong political commitment and key actions that enabled the Government to launch the Ten-Year Flood Management Program (PROGEP, 2014).

It is good to see this kind of actions but at household level these actions cannot be seen because poverty is endemic in that area.

4.3. Vulnerability Analysis

Owing to lack of administrative subdivision and data availability, this analysis has been done related to households within Medina Gounass. Therefore, violet bullets on the maps represent the households.

4. 3.1. Exposure

The exposure is the first element analysed and it is determined by the size of household.

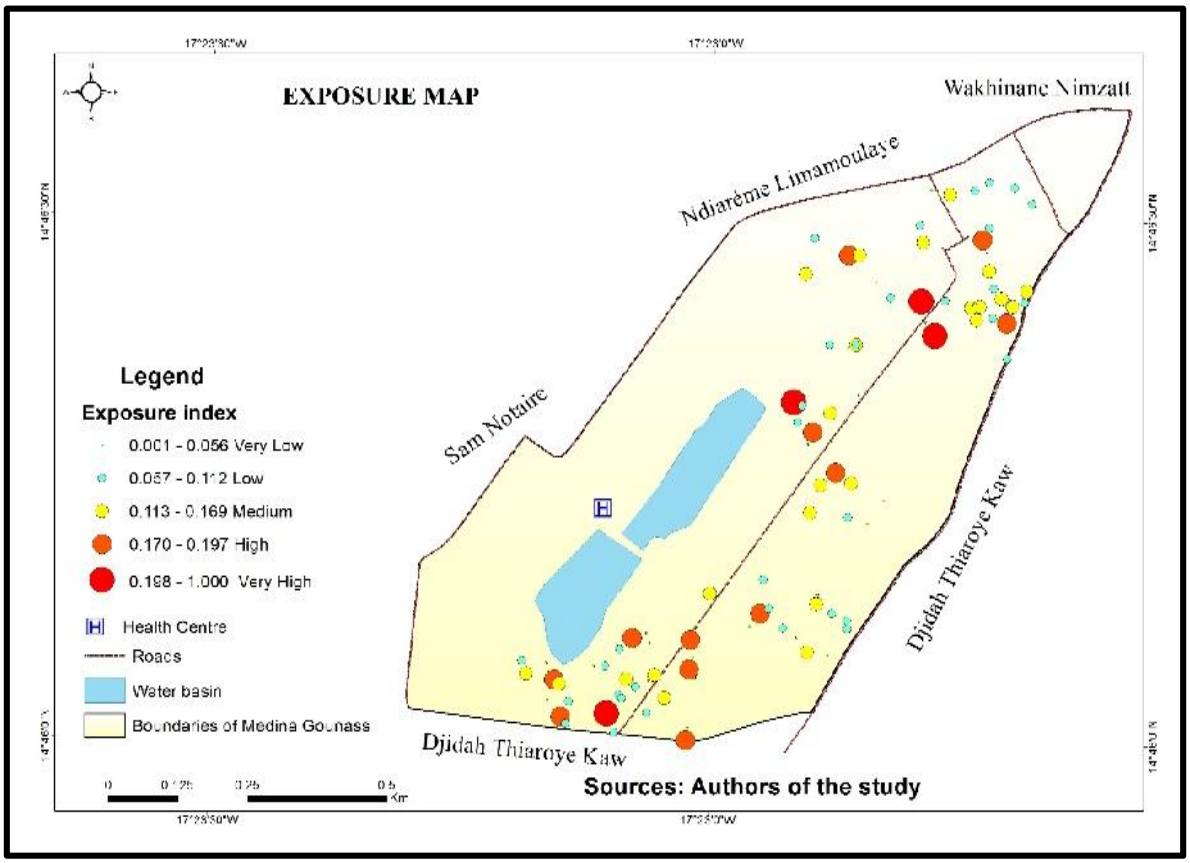


Figure 4.17. Map of exposure

The map above representing exposure shows that the population most exposed to adverse impacts of floods by the family size are spread out all over medina Gounass. It is ranked from very lowly exposed to very highly. The very low represent the smallest bullets whereas the big sized ones mean very high vulnerability to flood. However, the major part of the most exposed are grouped in the South, the centre and the East-Northern part of the area. It is materialised by biggest bullets with a very high degree of household exposition to floods. Therefore, the spatial distribution of exposition to adverse consequences to floods in the

precise case depends on the number of persons within the household. As a result, in this area, large families become a heavy burden when a disaster strikes.

4.3.2. Susceptibility

For the susceptibility index, it is composed of the number of children under 4 years of age in a given household. These households have the predisposition to suffer the most harm due to flood events during the rainy season.

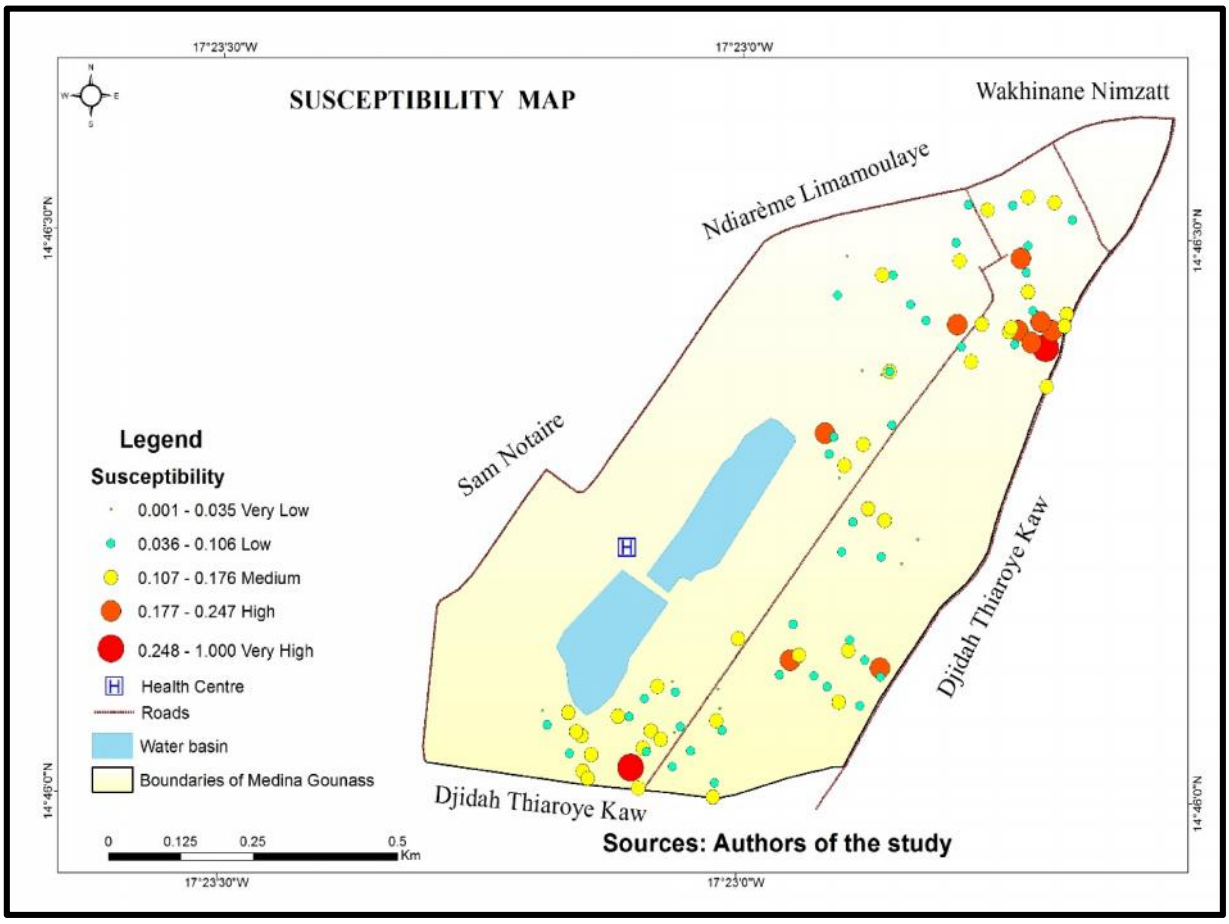


Figure 4.18. Map of susceptibility

The susceptibility as highlighted on the map above is sparsely distributed in the south, the south-east, and the centre and in the east-north. It is also ranked from very lowly to very highly susceptible. This susceptibility of some households is very high because they are houses to an important number of children under four years who are known to be fragile to recurrent flood events in Medina Gounass. Humidity and water borne diseases such as cholera and water related diseases like malaria are very dangerous to this age group. In addition, they are low income people; thus they hardly take care of their children in terms of health. This spatial distribution is due to the fact that Medina Gounass is densely populated

and sometimes families are parked within a small piece of land with a great number of people in a small house.

4.3.3. Lack of Resilience

The lack of resilience is determined by the distance from the nearest health centre within Medina Gounass. Therefore, we can identify clearly that the nearer the household to the health centre, the higher their resilience. In contrast, the farther a household from the health centre the lower is the resilience and, by extension, the higher the vulnerability in terms of health.

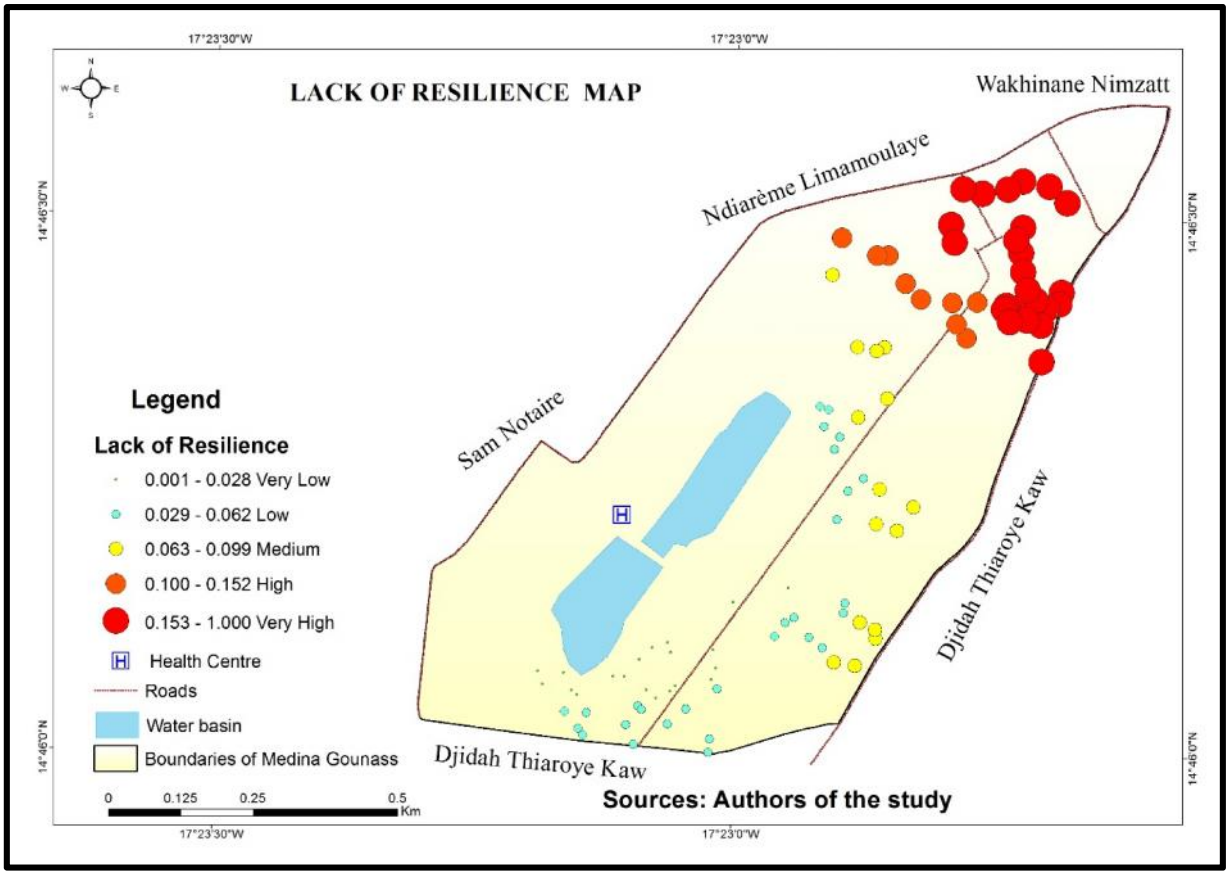


Figure 4.19. Map of lack of resilience

The households located in the north and north-east are highly vulnerable, and those from the east and South's vulnerability is medium. These households living permanently in flood situation during the rainy seasons encounter many challenges regarding their health. This main aspect calls for their capacity to anticipate, cope and recover from the adverse effects of recurrent flood events.

Medina Gounass inhabitants are not resilient. The survey and the focus group done showed that to fight against floods, people use the bags of sand and power-driven pumps.

These measures are not sustainable because they lack of perspective for the future. These power-driven pumps are provided by the government which spends money for fuelling and monitoring flood events instead of putting in place sustainable adaptation measures. Additionally, during an interview with an old person, he highlighted that the fact that in flooding event some inhabitants who have economic means put a great quantity of sand near their houses generate conflicts. These actions block the water ways and water enter in the houses of those who do not have means to do so. Sometimes, conflicts are so violent that the police come to stabilize the situation. As a result, flood generates conflict between people living in the same area, even if there are friends or relatives. In such situations, one of the human behaviour which is individualism appears to the detriment of the community.

However, the description of the results obtained through the spatial analysis for all single and composite indicators are aggregated for the calculation of the final map of vulnerability below.

4.3.4. Vulnerability

The combination of the three composite indicators shows the vulnerability of people living in Medina Gounass to floods. The interactions of these three major aspects of the MOVE framework is a crucial part of vulnerability assessment.

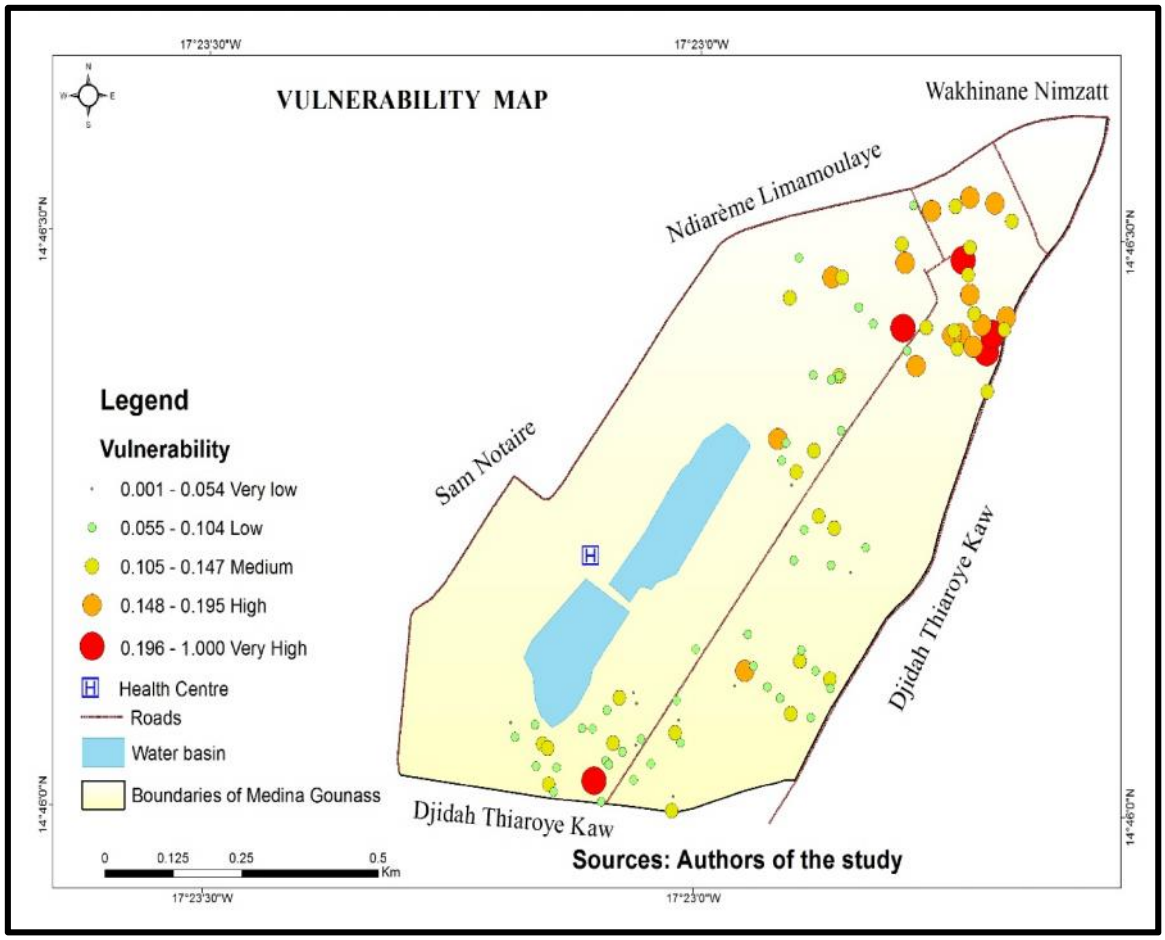


Figure 4.20. Map of vulnerability

From the map above, one can observe a concentration of the biggest bullets in the north-eastern part of Medina Gounass. This result is not surprising because this part is a low land compared to other part of Medina Gounass. Additionally, they are the farthest from the health centre and the interview I conducted with the former Deputy Mayor highlighted the new project of the construction of a basin at that place in order to collect the running waters in the area. This project can reduce considerably the social vulnerability of Medina Gounass to floods.

Furthermore, Priem (2009) argued that Medina Gounass is among precarious neighbourhoods that suffer from the lack of drainage network wastewater and storm water. The streets are narrow and winding and do not facilitate fast and safe movement of people and goods. Thus, flooding is the most obvious risk in these illegal settlements and is a latent scourge behind many vulnerabilities and especially in rainy season. Based on rainfall, topographic criteria, hydrogeological, environmental and hygiene, Medina Gounass is one of the most affected areas. Although the town of Medina Gounass belongs to the city of Guédiawaye, located on a dune site where soils are more permeable and therefore the

infiltration of runoff is more obvious, it is flooded with 75% of its area. In 2005, the number of flooded houses was about 911 houses.

As a result, it can be said that the social vulnerability index to floods does not limit solely to the set of indicators assessed. The reason for this restriction is due to the absence and lack of accurate data to have a more composite index. However, the household size for the exposure, children under four years of age for susceptibility and the distance from the nearest health centre for the lack of resilience, appear to be relevant in assessing the social vulnerability of the community to flood.

CHAPTER 5: CONCLUSION AND POLICY RECOMMENDATIONS

5.1. Conclusion

At the end of the present study, it can be said that Medina Gounass is really vulnerable to floods. This vulnerability is not solely related to climatic conditions but it is a combination of a set of factors. The analysis of climatic data highlights an increasing trend in maximum, mean and minimum temperature at the local scale. This increasing trend is confirmed in the annual cycle within the time series 1947-2012. The latter shows a raise in temperature from May to October where the peak is reach. Consequently, in Dakar, the hottest month is October. Thus, temperature parameter cannot solely determine the changing climate. Therefore, rainfall data have been used jointly and the reason is that the generally, precipitation in Sénégal is related to the one of the Sahel.

In Sahel, rainfall is by far the most crucial variable on the climate and people's lives. It is determinant to the changing environment in this region. Thus, it is the most suitable parameter to characterise and analyse climate change in the Sahel. For that, The Lamb index has been used to analyse the rainfall behaviours during this long times series 1947-2013. Therefore, its appears clearly that there are more wet years during the period 1947-1970 and from 1970 to 1989 this part of West Africa fell into a long period of dryness. This period corresponds to the long droughts which hit the Sahel in general. In 1989, there was a wet year and after that we fall again in drier years till the years 2000 where wet years seem to be more frequent. This last decade rainfall are not without negative consequences towards urban inhabitants. Hence, Dakar suburbans particularly those from Medina Gounass are constantly on rain waters mixed with sewage and drainage water which obstruct people’s activities and become a threat for human security generally.

Furthermore, for the survey data, I found that the percentage of males is greater than the percentage of females within the households (81% for males and 19% for females). It can be explained by the fact that in this area, males have the power and the responsibility to be the one who lead the household. Moreover, the survey highlighted that those who have a salary paid in cash represent 39%, family support 18%, job wage 25%, other 5% and no answer 13%. So they are not highly paid .The statistics with the linkage to the literacy rate, confirms that the Medina Gounass inhabitants in general have limited economic means to buy houses elsewhere where the amenities already exist. Thus, this particular aspect is an answer of the hypothesis that: Flood-affected people settled within that area because they are mostly low-

income people that could not afford housing on the urban-planned sites where liable amenities already existed. Additionally, Medina Gounass lacks amenity plan for a district which is said to be on its own.

Another key element is that they have a strong symbolic relationship towards land they have struggled to obtain. Then, it become difficult for them to leave for an unknown land with many uncertainties. This reason is an answer to the hypothesis that flood-affected people settled within that area because they are mostly low-income people that could not afford housing in the urban-planned sites where liable amenities already existed.

Furthermore, 52% of inhabitants do not want to leave the area in spite of the place being always in flood situation. The main reason is that they have a particular relationship with the place where they have been living for decades. It is an answer to the hypothesis that although facing diseases and unease, people actually resist the government's relocation projects because of their symbolic relationship with the area where they have been living for decades. This view lead us to think about a social capital they gain in this area during these long years of interactions between all the members of the community. For those who want to leave the site, the major problem is that they do not have enough financial resources to do so even if there are areas in a big city where amenities already exist but they cannot afford it.

Another aspect concerning the social vulnerability in Medina Gounass is related to the connection to the drainage system. The survey revealed that the washrooms in the study area are not connected to the sewage. It is a real problem in this area because they are subject to recurrent flood events and the water table is not deep. It constitutes a hygienic problem and the vulnerability towards water-borne diseases and water related-diseases.

Finally, vulnerability analysis revealed that the social vulnerability index to floods does not limit solely to the set of indicators assessed. The reason for this restriction is due to the absence and lack of accurate data to have a more composite index. However, the household size for the exposure, children under four years of age for susceptibility and the distance from the nearest health centre for the lack of resilience, appear to be relevant in assessing the vulnerability of community to flood. As a result, flooding in Medina Gounass through this study showed how inhabitants are in a tricky situation and it is a real threat for human security.

5.2. Recommendations

Regarding all the aspects treated about social vulnerability to flood in Medina Gounass, some recommendations need to be done in order to alleviate people's suffering in this area. First of all, Medina Gounass should have a general planning project in which roads will be well built to facilitate movements in the area. Thus, sewage and drainage networks should be integrated so that runoff water could flow easily. Another basin should be erected in the eastern side of the prolonged Taly Boubess road connected to the existing one to evacuate the surplus of rain waters.

Additionally, there is a lack of infrastructures such as market, hospital high schools. Thus, if they want Medina Gounass to be a modern city as is it highlighted by the former Deputy Mayor, infrastructures should be put in place there. They will allow inhabitants to have another source of income. Small trades in the vicinity could not give the municipality enough money to invest in other sectors as education. For schools, it will foster population's incentives to have more educated people in the district. With the hospital and health centres, inhabitants will be healthier and they are also means to fight against child mortality.

Medina Gounass' inhabitants should change their behaviours and live like people do in a big city. People tend to reproduce the same schemes of life like the rural areas they are from. Life in a big city has its own reality, if one want to settle there his has to take into account what is needed in a city.

Moreover, climate change has mostly negative impact on population but people can take benefit from these changes in climate. For instance, some basins have been erected to collect runoff waters. These basins today are places of water like lakes where there is fresh water biodiversity. Some inhabitants go fishing there and these basins are places to throw any kind of domestic waste. The inhabitants can take benefit from them by organizing management committee with the help of NGOs and the local government to take care of these spaces. Climate change can allow people to take opportunities from a disaster like flooding.

Last but not the least, the government should take their responsibilities to displace some and relocate them elsewhere even if there is Plan Jaxaay. And the place left by these people should be used to build modern infrastructures which can help the locality to look like a city with adaptation measures.

5.3. Limitations

The study conducted in Medina Gounass highlight key elements of social vulnerability of people. Nevertheless, there are many key aspects which are not tackled in this study. First of all with time constraint in data collection, many variables in the questionnaire, and the focus group guide are not deeply assessed. Second, the lack of accurate secondary data for the study area constrained me to assess only one variable in each of the vulnerability components to assess vulnerability. Finally, the MOVE theoretical framework is not fully used in vulnerability assessment. Only the vulnerability box is much used and not totally.

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APPENDIX 1: Questionnaire

I- IDENTFICATION

101. REGION		107. CODE REGION……	/_____/
102. DEPARTMENT		108. CODE DEPARTMENT……..	/_____/
103. District		109. CODE District…...	/_____/
106. Surveyer		112. CODE Surveyer……	/_____/

DATE ……	/___/__/ : /___/__/ : /___/__/
Beginning ……..	/___/__/ : /___/__/
End……	/___/__/ : /___/__/

Name of the head of the household
/_____ /

SECTION II: Household composition

201. Order number	202. Names	203-What is your sex? 1-M 0-F	204-How old are you?	205What Is your statuts ? *1=present resident ; 2= absent residente ; 3=Visitor*	206-Your links with the household leader? 1=leader ; 2=wife ; 3=daughter ; 4=brother/ sister 5=nephew/niece; 6=grandson/granddaughter ; 7=father/mother ; 8=son's wife ; 9=brother's wife ; 10=son of other member ; 11=no link ; 12=other parent	207. Ethnic group ? 1=Wolof ; 2=Sérère ; 3=Toucouleur ; 4=Diola ; 5=Maure ; 6=Peuhls ; 7=Lébous ; 8=other	208-marital statuts? 1=single; 2=Monogamous ; 3=polygamous ; 4=divorced ; 5=widow/widower ; 6=free union
1		/___/	/___/___/	/___/	/_____/	/___/	/___/
2		/___/	/___/___/	/___/	/_____/	/___/	/___/
3		/___/	/___/___/	/___/	/_____/	/___/	/___/
4		/___/	/___/___/	/___/	/_____/	/___/	/___/
5		/___/	/___/___/	/___/	/_____/	/___/	/___/
6		/___/	/___/___/	/___/	/_____/	/___/	/___/
7		/___/	/___/___/	/___/	/_____/	/___/	/___/
8		/___/	/___/___/	/___/	/_____/	/___/	/___/
9		/___/	/___/___/	/___/	/_____/	/___/	/___/
10		/___/	/___/___/	/___/	/_____/	/___/	/___/
11		/___/	/___/___/	/___/	/_____/	/___/	/___/
12		/___/	/___/___/	/___/	/_____/	/___/	/___/
13		/___/	/___/___/	/___/	/_____/	/___/	/___/
14		/___/	/___/___/	/___/	/_____/	/___/	/___/

15		/___/	/___/___/	/___/	/_____/	/___/	/___/
16		/___/	/___/___/	/___/	/_____/	/___/	/___/
17		/___/	/___/___/	/___/	/_____/	/___/	/___/
18		/___/	/___/___/	/___/	/_____/	/___/	/___/
19		/___/	/___/___/	/___/	/_____/	/___/	/___/
20		/___/	/___/___/	/___/	/_____/	/___/	/___/
21		/___/	/___/___/	/___/	/_____/	/___/	/___/
22		/___/	/___/___/	/___/	/_____/	/___/	/___/

SECTION III : Education

300. order number	**301-Are you educated? 1 –yes 0-no**	**302-can you know read/write?** 1-yes 0-no	**303— school level?** 1=no level ; 2=Primary; 3=Secondary; 4=high education; 5=Professional; 6=Other	**304-Do you was at school last year** 1-yes 0-no	**305-Were you in school last year?** 1-yes 0-no	**306. Have you finished school?** 1-yes 0-no	**307In which class are you in?**	**308- Why you dropped?** *1 aged ; 2 too far ; 3 expensive ; 4 work; 5 useless ; 6. failure ; 7 marriage ; 8 other*
1		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
2		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
3		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
4		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
5		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
6		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/

7		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
8		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
9		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
10		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
11		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
12		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
13		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
14		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
15		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
16		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
17		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
18		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
19		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
20		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
21		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/
22		/___/	/___/___/	/___/	/_____/	/___/	/___/	/___/

SECTION 4 : Employment

order number	**401. Have you been at work these last seven days?** 1-yes 0-no	**402. if not why** *1 jobless;* *2 seasonal break ;* *3student; 4 family Obligation f ;* *5 too old/too young ;* *6 Incapacity ;* *7 other.*	**403-What is your main activity?** *1 Agriculture* *2 Mines/* *3. manufacture*	**404- Your employer?** *1 Gouvernement ; 2 public*private ;* *3private; 4=* individuals	**405 –How are you paid?** *1 salary ;* *2Cash;* *3= wages;* *4 family not paid ;* *5 other;*

			4. Construction *5. business* *6. Services* *7 Education* *8. health* *9. Administration* *10. other*		
1	/___/	/_____/	/___/___/	/___/	/_____/
2	/___/	/_____/	/___/___/	/___/	/_____/
3	/___/	/_____/	/___/___/	/___/	/_____/
4	/___/	/_____/	/___/___/	/___/	/_____/
5	/___/	/_____/	/___/___/	/___/	/_____/
6	/___/	/_____/	/___/___/	/___/	/_____/
7	/___/	/_____/	/___/___/	/___/	/_____/
8	/___/	/_____/	/___/___/	/___/	/_____/
9	/___/	/_____/	/___/___/	/___/	/_____/
10	/___/	/_____/	/___/___/	/___/	/_____/
11	/___/	/_____/	/___/___/	/___/	/_____/
12	/___/	/_____/	/___/___/	/___/	/_____/
13	/___/	/_____/	/___/___/	/___/	/_____/
14	/___/	/_____/	/___/___/	/___/	/_____/
15	/___/	/_____/	/___/___/	/___/	/_____/
16	/___/	/_____/	/___/___/	/___/	/_____/
17	/___/	/_____/	/___/___/	/___/	/_____/
18	/___/	/_____/	/___/___/	/___/	/_____/
19	/___/	/_____/	/___/___/	/___/	/_____/
20	/___/	/_____/	/___/___/	/___/	/_____/
21	/___/	/_____/	/___/___/	/___/	/_____/
22	/___/	/_____/	/___/___/	/___/	/_____/

SECTION 5 : Health

Order number	501. Have you been hurt, injured, an accident these last 4 weeks? 1-yes 0-no **if501 = 0 ➔jump health**	502. Type of illness? *1= accident ; 2 = diarrhea; 3= fiver; 4= Malaria ; 5= teeth ; 6 = nose ; 7= skin ; 8 = eyes ; 9= other*	503. How long?	504. Have you been consulted? ***1=yes 0=no*** **if 504=0➔ 5 and end if 504=1➔ 506, 507, 508,509**	505. Why can't you go to the health Centre? 1 illness not serious; 2 lack of means; 3 Lack of specialist; 4 Health Centre too far; 5 Drugs at home; 6 other.	506. Where do you go to be consulted? 1 traditional doctor; 2hospital; 3. Health Centre ; 4 Other	507. Distance from your home? *1 = less than 1 km; 2 = between 1 and 3 km; 3 = between3 and 5 km; 4= more than 5 km.*	508. How many times have been there these 4 weeks?	509. What was the main problem during your visits there? **1** no problem; 2 waiting time too long; 3 Personnel non-qualified ; 4 Too expensive ; 5 no drugs there ; 6 other
1	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
2	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
3	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
4	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
5	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
6	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
7	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
8	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
9	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
10	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
11	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
12	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
13	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
14	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
15	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/

16	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
17	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
18	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
19	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
20	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
21	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/
22	/___/	/_____/	/___/___/	/___/	/___/	/___/	/___/	/___/	/_____/

SECTION 6: Assets and household characteristics

601	**Which materials the roof of your house?**	*1=concrete ;* *2=Slate ;* *3=Zinc ;* *4=other ;*	/___/
602	**Which materials the walls of your house?**	*1=Bricks of cement ; 2=Adobe;* *3=woods ; 4* *other*	/___/
603	**What is the main sources of water provision?**	*1= public tap ; 2= personal tap ;* *3=Neighbour's tap; 4=Protected well ;* *5=non protected well ; 6=other*	/___/
604	**Which kind of wash room does the household use?**	*1=none ; 2=chasse d'eau avec égout ;* *3=toilet flush with septic tank ;* *4=Cuvette/saut ; 5= covered latrine* *6=Latrines non-couvertes 7=Latrines ventilées améliorées* *8=autre*	/___/
605	**Main source of energy for cooking?**	*1=bore hoses ; 2=Charcoals 3=fire wood;* *4=other*	/___/
606	**Main sources of energy for lighting?**	*1=electricity ; 2=Traditional lights ; 3=candle ; 4=fire wood ;* *5=other*	/___/
607	**How much time is needed to join….**	Minutes	**The nearest water source?/_____/** **The nearest market? /_____/** **The Nearest primary school? ……/_____/** **The nearest secondary school? _____/_____/** **The nearest Health centre? __/_____/** **The nearest tarred road? _____/_____/**

608	**Are you the owner of the house?**	*1=yes ; 0 =no*	/_____/
609	**How many separated rooms do you have? Number of people per room? children under 4 years?.**		/_____/
610	**Did the household use its own lands?**	*0 = no ; 1 = rente ; 2 = free;*	/_____/
611	**Land evolution with regard last year?**	*1=Smaller; 2=same; 3= bigger; 4= no answer*	/_____/
612	**How many animals do you have?**	**1-yes 0-No if 612=0➔ 621**	/_____/
613	**Number of cattle?**		/___/___/___/
614	**Number of sheep?**		/___/___/___/
615	**Number of goats?**		/___/___/___/
616	**Number of donkey?**		/___/___/___/
617	**Number of horses?**		/___/___/___/
618	**Number of chickens?**		/___/___/___/
619	**Other**		/___/___/___/
621	**Do you have the following at home?**	1-yes 0-no	A cart _____/___/ A bicycle_____/___/ A motor Bick _____/___/ A table _____/___/ chairs___/___/ a fridge _____/___/ A television _____/___/ A radio _____/ A private telephone __/___/

SECTION 7: Reasons and awareness of climate change

701	**Are you that this area is prone to floods? (1=yes, 0=no)**	/_____/_____/
702	**When have you been aware ?**	/_____/_____/
703	**Why do you want to leave / stay?**	/_____/_____/
704	**How long have you been in this situation?**	/_____/_____/
705	**In your opinion what are the causes?**	/_____/_____/
706	**What are your strategies to live here?**	/_____/_____/
707	**Are you aware of climate change?**	/_____/_____/
708	**What do you think about it?**	/_____/_____/
709	**Have you noticed any change of your environment referring to the past?**	/_____/_____/
710	**Do you have any assistance from the authorities?**	/_____/_____/
711	**Are there any NGO involved on the field?**	/_____/_____/
712	**How many are they ?**	/_____/_____/
713	**Are You insured ?**	/_____/_____/
714	**How much do you pay for the premium?**	/_____/_____/
715	**Do you want some benefit from an insurance?**	/_____/_____/

APPENDIX 2: Descriptive Statistics

Variables	Number of observations	Minimum	Maximum	Mean	Std, Dev.
sexres	100	1	2	1.19	.394
ageres	100	23	76	45.77	12.727
stamats	100	1	5	2.00	.853
nivres	98	1	5	2.58	1.015
travail	100	1	2	1.39	.490
appeau	100	1	3	1.93	.326
toiluti	100	2	3	2.92	.273
tempeau	100	1	15	6.52	2.993
tempmar	100	5	45	19.65	6.714
temorou	100	3	20	8.62	2.824
proprio	100	1	2	1.18	.386
betail	100	1	2	1.71	.456
quitzon	100	1	2	1.52	.502
chanclim	100	1	2	1.11	.314
assists	100	1	2	1.42	.496
accesass	100	1	2	1.87	.338

APPENDIX 3: of the Focus Group Guide

A) Part of the holding of the focus group

Region	
Departement	
District	
Number of participants	
Name of the leader	
Name of note taker	
Date of discussion realisation	
Starting hour	**_____ H _____ mn**
Ending hour	**_____ H _____ mn**
Laguage used in discussion	**Wolof**

Participants characteristics

N°	Sexe	Age	Education level	matrimonial situation	Ethnic group	Occupation	Religion[6]
01							
02							
03							
04							
05							
06							
07							
08							
09							
10							
11							
12							

P = Participant

[1] 1 = single, 2 = Marided, 3-Divorcé, 4- Widow or widower

[2] 1 = Male, 2 = Female

[3] 1 = 18-24 years, 2 = 25-34 years, 3= 35-44years, 4= 45-54 years, 5 = 55-64 years, 6 = 65 and plus

[4] 1 = Non educated, 2 = Primary school, 3 = Secondary school, 4 = University, 5 = other

[5] 1 = Agriculture, 2 = Trader, 3 = Transf. Agro-, 4 = Art, 5 = = Civil servant, 6 =other

A) INTRODUCTION

Hello, be the welcome (s) in this focus group. My name is _____
My (Ma) colleague here with me is called _____. I'm a student who want to know more about flooding in Medina Gounass. Thank you for agreeing to participate in this meeting despite your many duties.

We will discuss about the floods and their impacts. You are invited to discuss freely, but one after another. There is no right or wrong answers, all answers are welcome. The information you provide is important. That's why we ask you to answer honestly and truthfully to questions. During the discussion, my (my) colleague try to take notes. You will be designated by the numbers in front of you in the allocation of speech.
Because he cannot log everything and as we do not want to lose any of your ideas, we would like to record our discussion with permission. I want you to know that anything said will remain confidential and will be treated anonymously.

C. Perception and Attitudes For floods and climate change.

Themes	Questions	Responses
1- Historical aspect of floods in the area	1.1 (Precise the locality name), The date you have experience flooding for the first time and the types of disasters in your locality?	
	1.2 Do you think that flooding is a major problem? Why?	
	1.3 Effects on your health	
	1.4 According to you what are the causes?	
	1.5 Can you tell us the year in which flood events started in Medina Gounass?	
	1.6 According to you what are the consequences?	
2.The period you noticed changes	2.1 Have you ever heard the word climate change?	
	2.2 Is there a link between climate change and flood events?	
	2.3 What is your perception about climate change?	

Themes	Questions	Responses
	2.4 Can you tell us if there is a link between climate change, land occupation and flooding?	
3. How they explain climate change	3.1 What do you do to face floods?	
	3.2 Are you sufficiently tooled to face floods? Have you some propositions of solutions?	

Themes	Questions	Responses
4. Climate change and manifestations	4.1 Social have changed with environment (parents, neighbours in the locality	
	4.2If yes, What is the justification of these changes	
	4.3 Have you noticed discrimination of your children at school or within your neighbours?	
	4.4 Have you the assistance of your parents and neighbours?	
	4.5 If yes, which kind of assistance?	
	4.6 Since the beginning of flood events can you tell us what your have gained or lost	

Thèmes	Questions	Réponses
5-The perception of flooding	5.1 Do you think that flooding affect household assets? If yes how? (list the effect or impacts)	
	5.2 Pensez-vous que les inondations ont affect la sécurité alimentaire et nutritionnelle du ménage ? Si oui, comment ? (lister et décrire les effets ou impacts)	
	5.3 Pensez-vous que les inondations ont aggrave la pauvreté ou les conditions de vie du ménage ? Si oui, comment ? (lister et décrire les effets ou impacts)	

D) Flood Impacts on the community subsistence means

The objective of this part of the interview with the community is to assess the impact of flooding on the community.

Indeed, although the immediate impact of floods or chronic disease is felt on individuals, households and families afflicted, their combined effects are felt as an aggregate of individual household effects. The nature and extent of the effects on the community will depend on how the community is organized socially, economically, culturally.

Thèmes	Questions	Responses
6- Effects on the human capital of the community	6.1 Do you think floods and chronic diseases affect young people in your community?	
	6.2 If so, how? (describe the effects or impacts with emphasis on the implications on cost, quality and quantity of labour)	
	6.3 Pensez-vous que les inondations ont provoqué une augmentation du nombre de placés dans votre localité ? justifier	
7- Effects on the financial capital of the community	***Evolution of savings (tontine & local bodies) global community*** 7.1 Do you think that the floods have affected the level of savings and tontine in your community?	
	7.2 If so, how? (explain and give evidence and examples)	

Other comments :

_____

_____

_____

VITA

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