



## STRATÉGIES D'ADAPTATION AU CHANGEMENT CLIMATIQUE POUR LE DÉVELOPPEMENT DURABLE : ÉTUDE DE CAS D'ENTREPRISE FÉMININE DANS LE VILLAGE DE MOUIT, SÉNÉGAL

### ADAPTATION STRATEGIES TO CLIMATE CHANGE FOR SUSTAINABLE DEVELOPMENT: CASE STUDY OF WOMEN'S ENTREPRENEURSHIP IN THE VILLAGE OF MOUIT, SENEGAL

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#### Résumé

Au Sénégal, le changement climatique et ses conséquences environnementales tels que la salinisation des terres, la diminution des pluies, l'assèchement des eaux de surface et l'augmentation des sécheresses, affectent la vie et les activités de populations de plus en plus nombreuses. Alors que la plupart des études dans ce domaine sont descriptives, cette recherche analyse les stratégies d'adaptation mises en

œuvre en termes de pratique d'activités émergentes (75% des femmes enquêtées) ou de reconversion professionnelle, de diversification d'activités génératrices de revenus et même de migration, comme solutions de survie. À l'aide de données statistiques d'origine administratives et grâce à des entretiens approfondis avec des experts et des personnes cibles, il a été constaté que depuis les années 1990, plus de 80% des terres arables sont affectées par la salinisation dans le Gandiole. En outre, une enquête par questionnaire sur un échantillon de 100 individus, issus de milieux socioprofessionnels différents, révèle que l'agriculture et la pêche, principales activités traditionnelles génératrices de revenus, sont devenues impossibles pour plus de 80% des hommes dans le village de Mouit. En conséquence, il s'en suit un affaiblissement du pouvoir d'achat des ménages qui se répercute sur l'éducation. Dans ce contexte, l'entrepreneuriat des femmes se développe suivant les spécificités locales et les ressources disponibles pour subvenir aux besoins sociaux de base, un palier intermédiaire dans l'atteinte des objectifs de développement durable.

**Mots clés :** Adaptation, changements climatiques, activités émergentes, développement durable, entrepreneuriat féminin

## Abstract

In Senegal, climate change and its environmental impacts such as land salinization, changes in rainfall patterns, drying out of surface water, and recurrent droughts, are affecting lives and activities of many people. While several studies have been more descriptive, this research analyzes adaptation strategies that are implemented for the practice as emerging activities (75% of women surveyed) or professional retraining, diversification of income-generating activities, and even migration, as possible coping responses. Using statistical data from the administrative census as well as in-depth interview for climate experts and targeted participants, it was found that since the 1990s, more than 80% of arable land has been affected by salinization in the Gandiole. In addition, a questionnaire form for 100 individuals from different socio-professional backgrounds reveals that agriculture and fishing, the main traditional income-generating activities, have become difficult for more than 80% of men in the village of Mouit. As a result, there is less income for education. Thus, entrepreneurship for women has developed according to local specificities and available resources that meet basic social needs in order to achieve sustainable development goals.

**Keywords :** Adaptation, climate change, emerging activities, sustainable development, entrepreneurship for women

## INTRODUCTION

In recent years, impacts of climate change in Senegal have become clear; mostly in areas such as Saint-Louis and its surroundings. Noticeable signs such as recurrent floods, land salinization, rainfall scarcity, lowered water table, and coastal erosion have been observed (Senegalese Ministry of Environment and Sustainable Development, 2015). Therefore, a question such as “what should we expect in the coming

decades?” is important. However, the answer is not quite straightforward for many developing countries. As a matter of fact, an official report published by the Senegalese Ministry of Environment predicted that 80% of the 150,000 inhabitants of the Saint-Louis Island and its vicinities “is at high risk” to be flooded by 2080 (Senegalese Ministry of Environment and Sustainable Development, 2013). If this area is heavily inundated, a significant part of the cultural and historical heritage in Senegal might vanish (B. FALL et al., 2008, pp. 10-15). This situation is also disturbing for the inhabitants of the village of Mouit. Nevertheless, the local population intends to carry out traditional economic activities, which are rainfed agriculture and fishing. Therefore, innovative adaptation strategies that are more or less effective have been implemented. These approaches include diversification of activities, undertaking new types of employment, and even migration. Indeed, these induced social changes have resulted in the adjustment of responsibilities between men and women. Thus, this research focuses on the issue of sustainable development in the framework of climate change, but with an emphasis on women.

More specifically, this study aims to :

- (1) Evaluate knowledge and understanding of climate change among people from diverse backgrounds (political, scientific, religious);
- (2) Identify some of the impacts of climate variability on rainfall, land, and surface water;
- (3) Analyze the effect of climate change on socioeconomic activities;
- (4) Discuss the adaptation strategies to climate change that have been implemented by local communities.

This paper is organized in three parts. It first provides a background study of the area, which includes the state of climate change as well as institutional and regulatory context of adaptation policies in Senegal. Then it presents the results of the study. Lastly, some of the limitations of the analysis provide a basis for making some recommendations in terms of research needs.

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## 1. Background

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### 1.1. Climate change in Saint-Louis

An analysis of climate forecasts for Saint-Louis reveals more persistent heat waves that last 1.5 to 2 weeks compared to 1961-1990 (Senegalese Agency of Civil Aviation and Meteorology, 2014). Further, floods of the Senegal River have become recurrent and more violent. They result from a peak in discharge due to high tides, and slowing down of rainwater infiltration, which are both combined with spontaneous and unplanned urbanization (UNESCO, 2009, pp. 4-17). In addition to coastal erosion, salinization of the Senegal River threatens freshwater ecosystems and endangers species including fish, crabs, and turtles. The destructive intrusion of ocean water has affected inland areas and many communities have abandoned their villages (A. TANDIAN, 2016, pp. 20-45). For instance, in less than 20 years, a whole village and two tourist camps have been submerged. Hence, the consequences are dramatic for tourism, which is a major source of incomes. On the other hand, a breach created by erosion is slowly moving southwards to the site of the artificial breach opened in 2003. It is now the Djoudj National Park that is threatened by flooding. Birds and turtles' habitat is deteriorating and these animals are endangered (Senegalese Ministry of Environment and Sustainable Development, 2015). Initially used as shortcuts by fishermen, the breach, which has grown gradually, has led to the sinking of several motorized canoes triggering about 416 deaths (Saint-Louis's Regional Division of Fisheries, 2017). The villages of Keur Bernard, Pilote Bar, Mouiit, Tassinère and Mboumbaye have also been affected by these phenomena of erosion, salinization of arable land, flooding and drying up of surface water. The future of these villages is uncertain. Therefore, this study addresses issues such as (a) how can development be achieved when whole communities face an

increasingly hostile environment? (b) How to consider development while taking into account changes that are affecting living and working conditions of many people? (c) For developing countries, how is it possible to reconcile industrialization and sustainable development in the context of climate change? (d) Are climate change adaptation strategies appropriate responses to the challenge of sustainable development in Senegal? This study responds by analyses of adaptation strategies of people living in affected areas. In addition, the main hypothesis postulates that climate adaptation strategies were implemented by women in the village of Mouiit, and these approaches are effective responses of sustainable development.

### 1.2. Institutional and regulatory framework of adaptation policies to climate change in Senegal

From the Limits to Growth study (D. H. MEADOWS et al., 1972, pp. 185-198) to recent meetings on sustainable development, environmental impacts are at the center of great worldwide debates. Indeed, at various levels (international, continental, and national), meetings and frameworks for reflection and action have been conducted. Likewise, projects, policies, and programs such as "Climate Change and Development - Adapting by Reducing Vulnerability (CCDARE)" have been initiated. They have established the fundamental aspects of political and institutional emergence of sustainable development as related to climate change adaptation strategies (I. LONA, 2010, pp. 60-78).

#### 1.2.1. International and continental levels

"Climate Change and Development - Adapting by Reducing Vulnerability" (CCDARE) was launched in 2008 in Uganda, Senegal, and Tanzania. This was a joint program of the United Nations Development Program (UNDP) and United Nations Environment Program (UNEP), funded by the Danish Ministry of Foreign Affairs

and implemented in sub-Saharan Africa (M. M. WAZIRI, 2014, pp. 235-253). It aims to integrate adaptation to climate change into development policies in order to improve existing adaptation activities. National institutions, experts, NGOs or private sector representatives can request support from this program. The selection of project activities that can potentially be funded is also made via consultation of the National Focal Point of the United Nations Framework Convention on Climate Change (UNFCCC). In Senegal, the following three projects were selected:

- (1) Senegal River Delta Development;
- (2) Adaptation of agricultural practices;
- (3) Integration of climate risk into urban development plans.

### 1.2.2. National level

Under the UNFCCC, each signatory country has undertaken to periodically publish national communications. These reports focus on implementation of the framework convention. Further, each country is expected to develop a National Adaptation Action Plan (NAAP). The strategic document of NAAP includes a list of activities to be carried out and their associated financial plans. It also outlines a timetable with precise information on the modalities for practical implementation (NAAP, 2006). Thus, in order to succeed, Senegal prepared its first communication, which was entitled "Senegal's initial communication in the context of the UNFCCC" in 1997. This report highlighted the envisioned efforts of the country in the component of mitigation. Subsequently, in 1999, with the help of the Dutch cooperation, the Senegalese Ministry of Environment developed a national implementation strategy for the UNFCCC. This shows to the international community how Senegal aims to integrate "climate change adaptation" into its economic and social development policies. Therefore, the country performed sectoral diagnosis of

greenhouse gas emissions and an assessment of vulnerability was included. In addition, priority action areas were identified as well as the creation of a national committee on climate change. Even though the implementation of NAAP is not always effective, it still remains today the basic document in terms of adaptation strategy to climate change in Senegal (A. TANDIAN, 2016, pp. 20-45). It is important to note that in 2010, Senegal was first to receive funding from the Adaptation Fund for its adaptation program on coastal erosion in vulnerable areas (S. Benjamin et al., 2017).

### 1.3. Review of previous studies

Interest in climate change has increased from the second half of the twentieth century (D. H. MEADOWS et al, 1972, pp. 185-198). Previous research often focused on this issue on the need to reduce greenhouse gas emissions and they showed the interconnections between human activities and global warming (ONU, 2002, pp. 15-30). These studies emphasized the environmental and socio-economic consequences of climate change and highlighted the strong spatial and temporal variabilities in precipitation in Africa. The increase in the frequency of droughts in Sahelian regions of Africa are now well-known (P. GONZALEZ, 2002, pp. 21-34; P. OZER, 2010, pp. 489-492). Further, A. D. TIDJANI (2008, pp. 98-145) highlighted that drought was fairly accountable for abysmal socio-economic variations in pastoral zones of the Sahel. These studies also found that major transformation of the Sahelian landscape justifies the development of new farming systems (adapting agricultural practices, substituting crop varieties, and cultivating arable land). According to H. M. LO and A. B. KAERE (2009, pp. 3-4), climate change has led to a breakdown of cross-border resource sharing mechanisms such as watercourses and an upsurge of conflicts between communities or countries. These authors found that salinization of arable land and drought are the main hazards,

that may hinder achievement of Millennium Development Goals (MDGs) in sub-Saharan Africa, including the reducing poverty and hunger. As a matter of fact, in Senegal, agricultural land occupies 12% of its the territory and the basis of its economy. This sector employs nearly 70% of the labor force and contributes to approximately 10% of the Gross Domestic Product (GDP) (Senegalese Ministry of Economy and Finance, 2012). It is important to note that agriculture in Senegal is highly dependent on rainfall and essentially the farming activity of small rural families. The average size of farms is about 4.30 ha (Senegalese Ministry of Environment and Sustainable Development, 2015). The decrease in rainfall totals has impacted crop yields of traditional peanut and millet. New crop varieties (maize, cassava, and beans) with shorter growing cycles are being tested to cope with food insecurity, which has reached alarming proportions in recent years. Further, P. SOW (2012, pp. 125-218) analyzed climate change as a cause of food insecurity for vulnerable groups in Senegal. The results showed that low-income consumers tend to lose their jobs. Moreover, strategies for adapting to climate change have also been examined. For instance, I. AMOUKOU et al. (2016, pp. 25-37) took into account farmers' understanding of climate change. Similarly, A. A. TOURE et al. (2011, pp. 205-214) focused on the use of new seed varieties with short growing cycles (millet and sorghum) in Niger. In his study on "Climate change, drought and pastoralism in the Sahel", N. BROOKS (2006, pp. 4-9) identified that pastoralism in Africa is a form of adaptation to climate change.

The decline in agricultural yields and the scarcity of fishery products have led to short-term responses. These responses are often damaging to the environment and can hamper sustainable development. It is important to note that after 60 years of political independence, Senegal is still a highly indebted underdeveloped country. Its economy depends largely on development aid. In

addition, Senegal has yet to take advantage of the dynamism of women, who are 52% of the Senegalese population (National Report from the Agency for Statistics and Demography, 2014). Nevertheless, Senegal is signatory of the Millennium Development Goals (MDGs), which emphasize the participation of women in the development. Similarly, this issue has long been a focus of research in social science. However, we must acknowledge the dynamics of participation will remain compromised until we take into account the significant role of women in rural economies (L. GRIGORI and A. MOULOU, 2002, pp. 250-345). Indeed, in some communities, the strong polarization of economic activities has reduced the possibilities for women to practice more activities. Yet, in any given region, the effects of climate change are the same for its inhabitants, but men and women depend on different assets and resources to cope. Consequently, the depletion of natural resources that is caused by climate change, has affected the vulnerability of women (OXFAM, 2009, pp. 27-87).

In the light of these previous studies, there is a need to analyze climate change with a perspective that takes into account the real experiences of citizens, especially women. Indeed, this dimension has not often been the focus of media and institutions that are working in this area.

#### **1.4. Study area**

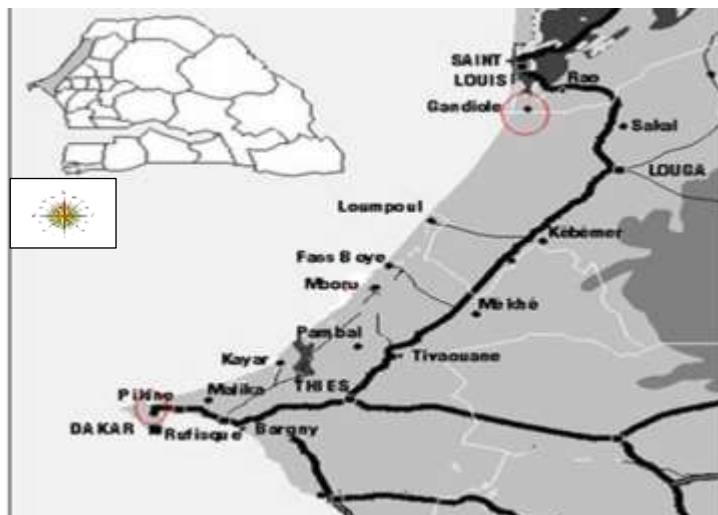
The village of Mouit is located in the Gandiole area on the Great Coast. It is situated south of the commune of Saint-Louis, not far from the mouth of the Senegal River. Near Gandiole lie both the Guembeul Reserve with its turtles, gazelles, red monkeys, oryx and the National Park of the *Langue de Barbarie*. This park hosted the first rural school in West Africa that was first located in the village of Mouit, and then transferred to another village called Tassinère.

### Map n°1: Location of Senegal in West Africa



Source: Google Map - [Vudaf.com](http://Vudaf.com), 2019

### Map n°2: Village of Mouiit in the Saint-Louis region



Source: *Regional Service of Statistics and Demography of Saint-Louis*, 2019

Market gardening and fishing are the dominant traditional deeds. In recent years, activities such as salt extraction (Photo n°1 below), dyeing cloth (Photo n°2), and sewing have emerged as responses to climate change.

**Photo n°1: Women-salt-collectors**



*Source: GERM, June 2016*

Salt extraction activity is developed by former women processors or sellers of fish and by most of the women who did not engage in any income-generating activity. To earn more money and maximize their individual income, women-salt-collectors work in pairs or larger groups. Salt ponds are open air and free access. The job does not require sophisticated tools or special training unlike dyeing clothes' job (Photo n°2). Usually, women are half naked and they use rudimentary utensils (pots, buckets, basins, shovels and rakes). For most of them, salt extraction appears to be an opportunity despite the dangers of too long exposure to the sun and direct contact with salt.

**Photo n°2: Women dyeing cloth**



*Source: GERM, June 2016*

The job of dyeing cloth is practiced by young girls who have dropped out of school and by women who are on average younger than those encountered in salt extraction. As with salt extraction, dyeing cloth is a subsistence economic activity. However, skills are required to do this job. An association providing assistance to unemployed women trained the first women dyers in the village who then trained the others. Here also, health risks are not less because chemicals used are toxic and the preliminary measures (wearing of mask and gloves) are generally not respected.

## 2. Methods

This study uses an inclusive empirical method, which focuses on a case study in the village of Mouiit. This approach targeted the experience of populations through a record of their perceptions and initiatives to improve their living and working conditions. This methodology focused more on real needs and reflects the urgency to find the best adapted solutions to indigenous specificities. The study sample included men and women ranging from a diverse range politics, religion, and science backgrounds. In total, 114 individuals were surveyed using either questionnaires and/or interviews that were conducted in French or Wolof<sup>1</sup>. It is important to note that interviews were given to 14 out of the 30 individuals that were targeted in Mouiit. The use of interviews allowed us to gather detailed data on specific aspects of the research such as beliefs of people, their knowledge and perceptions on climate change. The questionnaires were given to 100 out of 150 individuals during 2019. This population included 50 men as well as 50 women of different ages, occupations and educational level. Afterward, quantitative and qualitative data were collected from consulting administrative documents. The following variables were measured:

<sup>1</sup> The most commonly spoken national language in the village of Mouiit.

- (1) Knowledge and understanding of climate change;
- (2) Impact of climate variability on rainfall, land and surface water;
- (3) Effects of climate change on agriculture, fishing, and education;

Effectiveness of adaptation strategies that are implemented

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## 3. RESULTS AND DISCUSSION

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### 3.1. Knowledge and understanding of climate change

Different definitions and opinions on the reality and causes of climate change justify the need for research on the perceptions of populations that are directly or indirectly affected. Accordingly, the questionnaires and interviews included questions such as: How do people in Mouiit perceive the phenomenon of climate change? What do they believe are the causes? What do these people consider as consequences? Do they think about the risks of persistent climate change? How do these people adapt to climate change?

The results from interviews conducted in 2019 revealed that most people in Mouiit have faced climate change through either real experience or information channels such as the media. The participants talked about effects of climate change and explained the causes by referring to in situ or more global observations. For example, Mr. Diop (councilor in Mouiit) stated that “climate change is the manifestation I can see around me and it is caused by melting of glaciers.” Similarly, S. Diagne (president of Mouiit Youth Association) indicated that “climate change is melting ice seas that has raised sea levels.” Furthermore, A. Diop (delegate of the village of Mouiit) explained climate change by the created breach on the *Langue de Barbarie*. For him, “it is since the

breach was opened that people noted the recurrence of floods and the collapse of houses located by the sea.”

In Mouiit and surrounding villages (Bountou Ndour and Pilote Bar), descriptions were made about climate change, with varying degrees of contrasts from one locality to another. In Pilote Bar, the focus was mainly on the phenomena of “saltwater” submersion and flooding which occur during the rainy season. Thus, in addition to the advance of the sea which our respondents have told us about, the Senegal River which borders some of these coastal villages regularly emerges from its bed during this period. On the other hand, the flat and sandy topography of Mouiit and Bountou Ndour (located inland), would promote the phenomena of salinization and land degradation. According to D. Diop,

Today, to use irrigation, you have to spend a lot of money. We have invested almost one million FCFA for two wells, and water from one of them is salty. We have lost arable land because of salinization. Today, we have to go out of our village to practice agriculture (D. Diop, farmer in Mouiit).

Similarly, O. Guèye advances:

Since the opening of the breach, our lands are increasingly salty and agriculture is no longer productive. Salinization of the ground water has led to a sharp reduction of coconut vegetation, which was a great asset for our village. Lot of lands used for farming activities have been abandoned (R. Guèye, president of women's group of Mouiit).

In addition to sporadic evocations of divine origin, most of the respondents argued that actions of men are the causes of climate change. Indeed, the overexploitation of natural resources (vegetation and sea sand), construction of the



Diamas dam on the Senegal River, and the opening of breach were mentioned.

Climate change is largely triggered by human action. The population has been increasing without any actions to sustain management of resources, which are used chaotically. You see the doors in my house; they are all made of wood like many materials. Human's way of life largely explains climate change. On the coast, for example, people extract sand for construction and this reduces the coastline and promotes advancement of sea (N. Diaw, teacher in Mouiit).

O. Guèye (agent of Senegalese Ministry of Environment) asserted that men responsibility is strongly engaged in climatic change. For him, “the Diamas dam built on the Senegal River is the cause of land salinization in Mouiit.”

For Mrs. Sarr and F. Diop (women salt-collectors in Mouiit), “it is God who is at the root of everything that is happening. But the opening of the breach had a major role in the problems of flooding and land salinization at Pilote Bar and Mouiit.”

**Conclusion 1:** The results show that climate change is known because it is experienced at first hand. People described the phenomenon through its various consequences. In spite of some evocation of divine beliefs, opinions point to Anthropocene. These include over-exploitation of natural resources, construction of the Diamas Dam and the breach opening which affect people's lives, both environmental and socioeconomic aspects.

### 3.2. Impact of climate change on rainfall, on land, and surface water

In the village of Mouiit where this research was conducted, 100 individuals were interviewed on the quality of land, and on the quantity and regularity of rainfall during the last ten years.

Their responses have been quantified and recorded in Table n°1 below.

**Table n°1: Climate change impact on rainfall, on land, and surface water**

Climate impact	Positive impact	Negative impact	No impact	Don't know
Rainfall	05	95	00	05
Land and surface water	00	85	00	15

*Source: Questionnaire results, 2019*

Regardless of their socio-professional category, all those surveyed (100%) think that climate change has an impact on rainfall. This statement is confirmed by responses obtained from in-depth interviews. Even though few people believe that the causes are of divine origin, most respondents unanimously acknowledged that these changes have a real environmental impact. Among the respondents, 90% of them think that climate change has a negative impact on rainfall. They consider that rains have been scarce from one year to another for more than 20 years. These findings were confirmed by data from the latest report of the national directorate of civil aviation and meteorology which noted that at least a 25% reduction has occurred in rainfall during the last two decades. The notable decrease in rainfall leads to increasingly severe drought which has resulted in lower crop yields.

The 5% of respondents who perceived a positive impact were women who carried out income-generating activities. These women believe that their autonomy and their contribution to households' budget result from the decline in the purchasing power of their husbands.

### 3.3. Impact of climate change on land and surface water

The effect of climate change on land and surface water quality is the second indicator that was quantified in this study. As for the first indicator, the responses of the 100 respondents are revealed in Table n°1 above.

Most of the people surveyed (85%) believe that climate change has a negative impact on the land. According to the responses, salinization has depleted arable lands. The Environmental Division in Saint-Louis (2016) assessed that salinization has reached more than 80% of lands in Mouiit and surroundings. In addition, these populations noted that ground water has become salty. Traditional farming and market gardening have been difficult or impossible to carry out for the majority of men. The effects of land salinization are also visible through degradation of vegetation and ponds. As a result, there was a noticeable loss of some species of freshwater fish. The 15% of respondents who answered "Do not know" were men over 60 years old.

Among them, ten (10) men considered that land salinization was not a consequence of climate change, but the result of "God's wrath against human behavior increasingly opposed to good morals." For them, national weather forecasts are not useful. The attitude of these elderly people is symptomatic of the lack of knowledge about the physical causes of climate change by a significant proportion of Mouiit residents.

**Conclusion 2:** Analyses show that drought and salinization have been more frequent in and around Mouiit. In this part of Senegal, people noticed a gradual transformation of their environment, which differs from what they faced 20 years ago. More than 80% of arable land is degraded and surface water, once fresh water reserves, has become salty. Rainfall hazards make living conditions more difficult and accentuate social and economic inequalities.

### 3.4. Impact of climate change on socioeconomic activities

A sample of 100 individuals was chosen at random from farmers, fishermen, young people attending or dropping out of school and teachers in Mouiit and its surroundings. Table n°2 shows the quantified responses of respondents to the

impact of climate change on the underlying socioeconomic activities.

**Table n°2: Climate change impact on socioeconomic activities**

Impact	No impact	Positive impact	Negative impact	Don't know
Agriculture	00	00	92	08
Fishing	00	00	98	02
Education	24	00	57	19

Source: *Questionnaire Results, 2019*

In Mouiit, more than 90% of respondents believed that agriculture and fishing are affected by climate change. The dominant activities are agriculture or market gardening, salt extraction, and fishing. The first two are practiced by the majority of men. Oyster harvesting and salt extraction are emerging activities. These new activities are a palliative to the decline in crop yields or market gardening. Further, as surface water dries up, salt ponds are formed and some are invaded by a significant quantity of oysters. Women, who usually stay at home, are now engaged in income-generating activities. However, with regard to fishing, the respondents said that they suffer from changes in the sea and rarity of fish: "We were fishing a big fish called "lion fish" or "dry fish". We made a lot of money but nowadays we do not find this fish anymore." (T. Faye, woman salt-collector)

In the opinion of some respondents, agriculture and market gardening suffered more from salinization and land degradation following the opening of the breach on the *Langue de Barbarie*. Fishing is also affected by the breach that causes salinization of the Senegal River and disappearance of many fish species, as evidenced by this farmer's opinion:

Before the breach, the mouth of the Senegal River brought fresh water for six

to seven months. During this period, the conditions were very good for market gardening. But this is no longer possible because freshwater can no longer arrive in the area (Mr. Dieng, farmer in Mouiit).

Fish processing activities are disappearing due to scarcity and high price of the fish. The fishing sector is increasingly neglected by young people who dream of migrating.

### 3.5. Impact of climate change on education

Quantified responses from interviewees show that climate change has a collateral impact on the education of children (Table n°2). In fact, 57% of respondents thought that flooding and destruction of infrastructure prevent school programs from running for several weeks. During rainy seasons, schools are sometimes shelters for families whose homes have been destroyed. This situation can delay schooling in many areas of the country. Similarly, the decline in economic activities such as agriculture and fishing affect income for supporting education. In some families in Mouiit, people have only one meal a day. Thus, many children go to school hungry in the morning. There are reported cases where some girls have dropped out of school to help their mothers or to work as maids in the city of Saint-Louis, far from their families. According to a teacher, “with the decline in their income, parents have problems to safeguard the education of their children. The failure of many students is caused by this problem of means.” (Mrs. Guèye, teacher in Mouiit)

However, 24% of those interviewed believed that climate change has had no impact on the education of children. For them, the situation in Mouiit has rather been good as compared to the surrounding villages (Pilote Bar and Bountou Ndour), which are closer to the sea. These villages are regularly flooded and affected by coastal erosion. Thus, schooling is more disturbed than in Mouiit. Overall, education is

seen as a way to improve knowledge about climate change and to modify more traditional attitudes in order to better adapt to climate change impacts.

**Conclusion 3:** Economic activities are affected by climate change. Agriculture and market gardening suffer from salinization and degradation of over 80% of arable lands. Fishing has become difficult and even risky because of the breach that has so far killed more than 400 fishermen (I. NIANG, 2007, pp. 24-55). Additionally, decline in household income is seen as the main cause of dropping out of school.

### 3.6. Climate adaptation strategies

Today more than in the past, the reality of climate change is no longer questionable. Extreme weather events have become more frequent and endangered lives worldwide. Different societies try in their own way and according to their means and beliefs to adapt to climate change. In Mouiit, about 10% of the respondents organize prayer sessions and offerings to overcome difficulties. These social and cultural practices have intensified since the year 2000. For the organizers of these prayers, climate change is “the result of God's wrath against loss of religious values.” Although these prayers are considered effective, their sustainability is disputed. Beyond religious practices, women contribute to the survival of their families. They engage in income-generating activities and set up economic interest groups to promote various forms of mutual and social assistance such as microcredit. Thus, out of the targeted households, 75% of women in the village are engaged in a new economic activity in which 25% in dyeing cloth and 50% in collecting salt. Some women work as maids in large cities and commute between their residence and cities such as Saint-Louis, Kébémér, Potou and Kayar.

Women need to be supported because they are doing well. They wake up early and spend their day collecting salt and

harvesting oysters. This work is not easy because their health is threatened. In addition, some women with babies endanger the health of their children (D. Diop, husband of a woman salt-collector).

In the same village, adaptation strategies differ from one family to another and even from one person to another within the same family. Professional occupations that are as diverse as sewing or transportation are developed by local communities. Among emerging activities, the breeding of chickens, sheep, and goats should be included. Raising livestock or animal husbandry is mainly undertaken by men aged 50 and over who have been forced to abandon fishing or farming. A former fisherman says: "since fishing no longer allows me to feed my family, I try sheep breeding. This work does not bring daily income like fishing, but it allows at least to work." (S. Diène, former fisherman in Mouiit)

In some cases, if they are not abandoned, agriculture and fishing are combined with other activities like breeding of chicken or sheep, small trade, and masonry to increase income. Diversification and adjusting to new activities are thus adaptation strategies for providing basic social needs such as food and education. Despite damages caused by climate change in the sectors of agriculture and fishing, people believe that these economic activities can be revitalized by policy makers. For the populations of these villages, it is necessary to enhance market gardening that could be supported by well drilling and desalination efforts. Proposals such as developing crop varieties with short growing cycles can be better adaptation to rainfall deficits. In addition, fodder for livestock could also be promoted. Further, dredging and stabilization of the breach on the *Langue de Barbarie* are projected solutions for safer and more profitable fishing activity. According to a former fisherman, "the Government must solve the problem of the breach because there is only that

to do to solve all environmental problems in Mouiit." (B. Guèye, former fisherman in Mouiit)

It is important to note that for solutions that require means that local communities do not have, they could make proposals and ask for public support. Still, the intervention of policy makers on the ground does not always meet the requirements of the local communities. In the opinion of many, the two great achievements of the Senegalese government, namely the breach and construction of the Diama dam, have never solved the problems. Often left to themselves, people usually activate old survival reflexes. For example, in the area of Ndiébène Gandiole, migration is an ancient phenomenon that is especially related to fishing. Most of those surveyed acknowledged to have migrated at least once.

To have good returns, you have to go further and further out to sea. I have just spent two months on the high seas with my team. We went to Joal. Then we went to Gambia and Mauritania. It is not easy and even risky, but you have to do it. Fishing is a legacy for us to protect (F. Diaba, young fisherman in Mouiit).

In recent years, migration to Europe has been at the center of international issues and has highlighted the precariousness of economic activities and youth unemployment (TANDIAN A., 2016, pp. 20-45).

**Conclusion 4:** Apart from collective prayers being considered as response to cope with the consequences of climate change, adaptation practices are based on economic activities. Diversification and adjusting to new activities as well as migration to a lesser extent, are ways to fight against the precariousness of traditional activities such as agriculture and fishing. In the collective mobilization, women play an important role in food security for families and education of children. Despite the collateral impact of climate change on education, teachers

among the respondents believed that promoting "education for sustainable development" in primary school could be a solution to change attitudes and help develop practices that are more respectful of environmental sustainability.

#### 4. Limitations of this study

Some difficulties emerged in this study, especially during the data collection phase. Indeed, the realization of this work from South Korea did not make it possible to test the effectiveness of the collection tools before administering the survey. The lack of information that could have come from direct observation, can be considered as a methodological bias even if data from GERM Laboratory survey (2016) on *climate change in Saint-Louis* were available. As for interviews, there were difficulties in translating some French words (e.g. *vulnérabilité, risaue*) into Wolof.

## CONCLUSION

The objective of *this* study was to show that adaptation strategies implemented by local communities to fight against climate change do represent effective responses for sustainable development. The analysis of the role and place of women in emerging economic activities shows that they are key players. In light of the results from this study, the main hypothesis of this research is confirmed. Indeed, the study shows that, at the village level and even beyond, women create economic interest groups and organize microcredit activities. However, their incomes are too low for reinvestment in other income-generating activities or construction of community infrastructures. The study reveals that women are rather in a more subsistence economy that allows them to adapt to climate change as long as the economic and environmental consequences do not require responses beyond their means.

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