Contribution to the study of the Impacts of climate change on the agricultural sector and its adaptation strategies in Forest Guinea

Mamadi DIAKITE 1 , Simon Pierre LAMAH 2 , Ansoumane SAKOUVOGUI 3 , Zoumana BAMBA 4 and Mamby KEITA 5

1 Université de N'Zérékoré, Département de Physique, BP 50, Guinée

2 Université de N'Zérékoré, Département Hydrologie, BP 50, Guinée

3 Institut Supérieur de Technologie de Mamou, BP 63, Guinée

4 Centre de Recherche Scientifique de Conakry-Rogbanè, Conakry, Guinée

5 Faculté des Sciences, Université Gamal Abdel Nasser de Conakry, Guinée

ABSTRACT

Agriculture in Guinea faces the challenge of meeting the growing demand for food as national incomes and populations increase and production becomes more uncertain due to climate change. This research, which covers the period from 2000 to 2016, focuses on the assessment of the impacts of climate change in the agricultural sector and adaptation strategies in Forest Guinea. The results obtained show that nearly 88% of the populations surveyed believe that climate change has caused rainfall to vary, with a decrease of around 30%, the disruption of the rainy season (25%), the greater frequency of pockets of drought during the vegetative cycle of crops (15%) and the drop in agricultural production (18%). Slash-and-burn agriculture, excessive cutting of wood for carbonization and marketing are, among other things, the causes of the change in rainfall mentioned by the populations surveyed in the area. Thus, following the survey conducted, we realized that certain strategies for adapting to changes in rainfall were practiced but not revealed, while others were unknown to farmers, which are: varietal adaptation, use of water and soil conservation techniques, use of organic manure, modification of sowing date, use of lowlands. Indeed, the use of short-cycle plants and the use of lowlands are strategies for adapting to seasonal variations in rainfall in the region.

Keywords : *Contribution, climate change, agriculture, strategies, adaptation*

I. INTRODUCTION

Climate change is a change in global weather patterns that results in extreme weather, erratic temperatures and fluctuating rainfall. Studies on the impact of climate change on the agricultural sector indicate that the reduction in the intensity of rainfall is the main cause of the decline in farmers' harvests [1]. Climatic variations such as prolonged droughts have a significant impact on dryland crop yields. In Southeast Asia, vulnerability due to climate change leads to a decrease of about 10% in the production of cereals and maize [2, 3].

Climate change has already affected West African agriculture by altering rainfall patterns, characterized by strong interannual fluctuations in rainfall, increased frequency of rainfall extremes and prolonged droughts [4, 5]. Agriculture in West Africa is mainly rain-fed and therefore highly vulnerable to climate change and variability, which makes agricultural production uncertain. Uncertainty about future agricultural production creates uncertainty for the food system, with consequences for economic, health and socio-cultural systems [6, 7].

It is essential to understand how farmers perceive climate change to anticipate and minimize the risks associated with climate change through mitigation and adaptation actions by adjusting agricultural cultivation techniques [8].

Farmers generally take climate change mitigation measures based on the experience and hereditary knowledge acquired through their farming activities. The farmer seeks to combine mitigation strategies with the experience he acquires. From there, farmers will try to choose the most appropriate mitigation measures to minimize the risks due to climate change [9].

Populations have always been confronted with climate variations, in particular extreme meteorological and climatic phenomena. Climate change and natural variability in the distribution and presence of water further

complicate the sustainable development of our resources. Raising awareness at this level is topical, for a better understanding of the phenomena and their consequences on resources [10].

Farmers perceive changes in rainfall through its direct effects on soils (land degradation) and vegetation cover (deterioration). The impoverishment of the flora is the first observation of a deterioration of the environment of the region. Some changes in landscapes reflect global climate change [11]. Because of their immediate and lasting repercussions on the natural environment and on man, the questions of climate change and variability have for some time been placed at the center of the concerns of scientists and political decision-makers throughout the world.

Adaptation therefore becomes a development imperative for West Africa. However, adaptation does not always produce the expected results. Some adaptation initiatives undertaken can have negative effects. In this case, we speak of "maladaptation" [12]. Incremental adaptation consists, in the context of climate change, of introducing small strategic changes in existing practices in order to maintain the functioning, integrity and values of existing social-ecological systems. But, it is possible that the evolution of climate change (expected) makes this type of adaptation totally insufficient. This is referred to as a limit to adaptation [13].

Transformational adaptation is adaptation that fundamentally alters the attributes of a socio-ecological system in anticipation of climate change and its impacts. It is a significant or radical change in usual practices, "in our way of acting" (for example, moving a population because of the climatic risks it incurs). Transformational adaptation has the advantage of offering adaptation options and strategies where incremental adaptation has shown all its limits [14]. Many field surveys carried out in recent years prove that the development of diseases and parasites that affect agricultural production and climate change are closely linked. The effects of climate change can also be felt in the timing of rainfall which may no longer serve as seasonal benchmarks for planting and harvesting.

Guinea in general, and in particular Forest Guinea, is an agrarian region, where the agricultural sector is the means of subsistence for most of the population. Nearly 85% of the populations of this region of Guinea live from agriculture. The strong population growth, the archaic farming method and the prospects of the mining sector are, among other factors, factors that expose natural resources to progressive degradation in a global context of variability and already effective climate change [15].

Moreover, with an economy essentially driven by rain-fed agriculture, and therefore dependent on climatic hazards, it is important for Guinea to reflect on the adaptability of this sector and on the influencing factors. In order to meet the urgent and immediate adaptation needs in the most vulnerable socio-economic sectors and geographical areas, it is necessary to deepen studies of vulnerability and adaptation to recent climate variations [16, 17].

Forest Guinea, one of the four natural regions of Guinea, benefits from a favorable climate for almost all socio-economic activities, Climate Change is increasingly felt through its impact on the environment and therefore through its effects. direct and indirect effects on the well-being of its populations. To inform decision-making processes with reliable scientific information and knowledge, it is up to scientific research to propose or even develop an evidence base on climate risks and vulnerability.

The idea is to contribute to the establishment of the scientific bases for a process of sustainable and effective adaptation to climate change in this region, given that the impacts of climate change most often take on local colors. Therefore, a number of questions arise for analysis :

- How are climate changes manifesting themselves in the region ?
- How are climate changes perceived by local populations?
- What are the effects of these climate changes on the environment and the daily lives of agricultural producers ?
- What are the indicators ?
- What are the measures taken by agricultural producers in terms of adaptation to deal with the adverse effects of climate change ?
- What are the influencing factors ?

Thus, this research aims to study the impacts of climate change on the agricultural sector and its adaptation strategies in Forest Guinea.

II. MATERIAL AND METHOD

II.2 Presentation of the study area

Guinea Forestière is located in the south-east of Guinea, it covers an area of 49,500 km², or 20% of the national territory. Its population is 1.1 million. Its current density is 22 inhabitants per km². Its stepped plateau relief gives way to a series of hills and mountains (Nimba, Ziama and Simandou). It has seven (7) prefectures: Beyla, Guéckédou, Kissidougou, Lola, Macenta, N'Zérékoré and Yomou (Figure 1). Its climate in the forest region is of the humid subequatorial type characterized by the alternation of two seasons, a rainy season from March to November and a dry season from December to February. In August-September, the monthly rainfall can reach

300 to 400 mm³ with relatively high intensities. Average temperatures are lowered by altitude and vary between 17.6°C and 25°C.

The forest region is nowadays made up of more or less extensive islets of dense deciduous forests separated by Guinean-type savannahs; these forests, often degraded and increasingly replaced by low secondary formations, still contain beautiful species. Important rivers water the region, the main ones being: Diani (Macenta) Makona (Guéckédou), Oulé à (Yomou), Gouan (Beyla), Tilé (N'zérékoré) etc. Agriculture is the main activity of the people. It is practiced by nearly 97% of the population with a large proportion of women representing 66% [18].

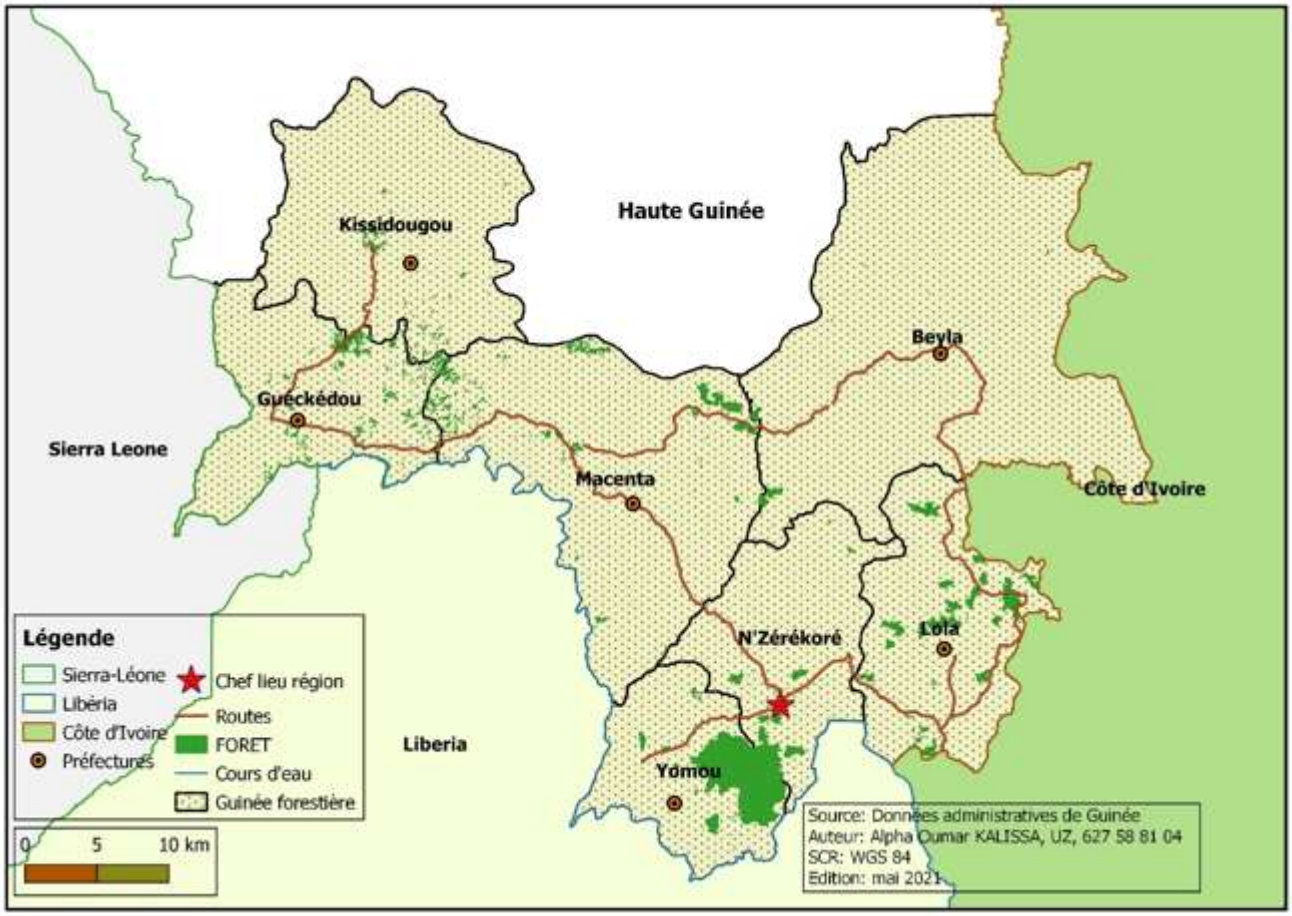

Figure 1: Map of the Forest Region [18].

II.3 Methodology

This qualitative research is a literature review of relevant research regarding the impact of climate change on the agricultural sector. The data used in this study come from field survey activities. Survey sheets have been developed for each activity encountered in the field. The questionnaires were sent to the heads of households of the groups of producers chosen at random in each site. We conducted the semi-directed interview, which allowed us to be in direct contact with the respondent(s). This interview allowed a great freedom of expression to the respondents while channeling and structuring the debate.

III. RESULTS AND DISCUSSION

III.1 Results

The results obtained during this research are illustrated by the diagrams in Figures 2, 3 and 4. They relate to the causes and adaptation strategies of climate change in five (5) towns in Forest Guinea.

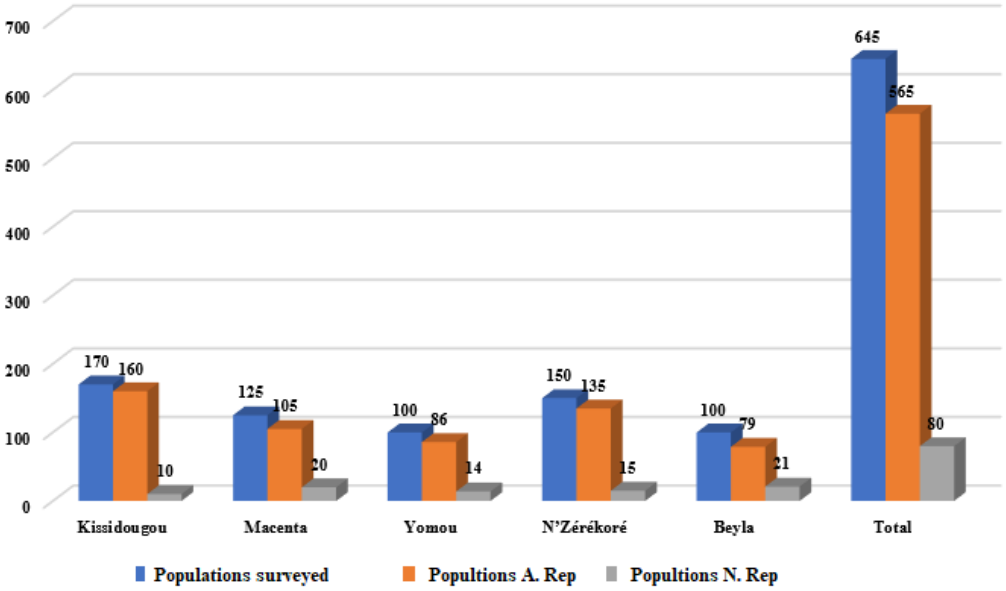

Figure 2 : Populations surveyed by city

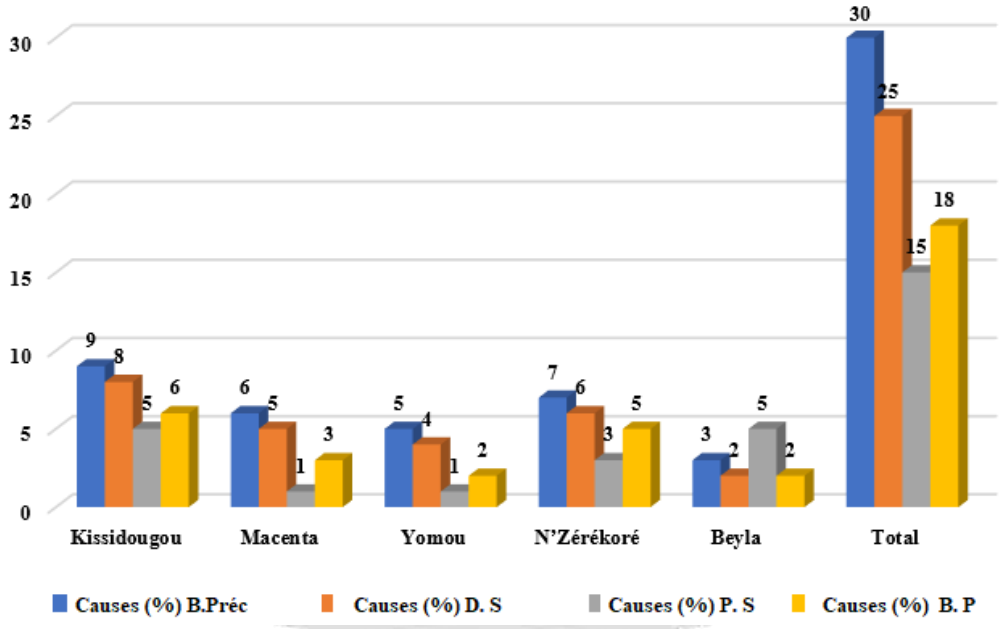

Figure 3 : Rate of causes of climate change

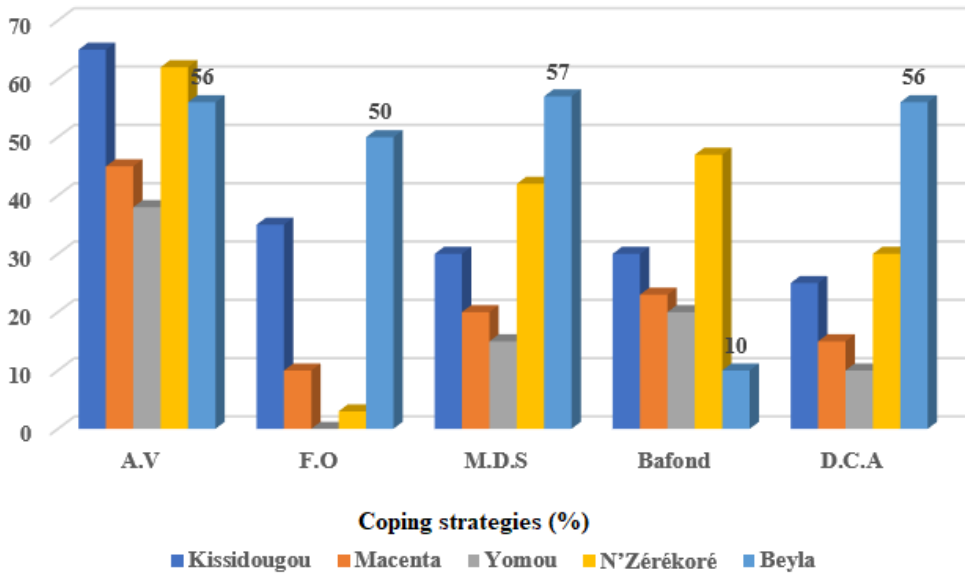

Figure 4 : Climate change adaptation strategies

Legend: *A. Ans: Responded; N. Ans: Did not answer; B. Pre = Decline in Precipitation; A.V = Varietal Adaptation; D.S= Disruption of the Rainy Season; F.O = Organic Manure; P. D= Pockets of Drought; M.D. S= Modification of Sowing Date; B. P= Decline in Agricultural Production; D.C. A= Diversification of Cultures and Activities.*

III.2 Discussions

The analysis of the results obtained show that the farmers clearly perceive the changes in rainfall. On average, about 88% of the farmers surveyed believe that rainfall has changed, with the main manifestations being the drop in rainfall (30%), the disruption of the rainy season (25%), the greater frequency of pockets of drought during the vegetative cycle of crops (15%) and the decline in agricultural production (18%).
Slash-and-burn agriculture, excessive cutting of wood for carbonization and marketing are, among other things, the causes of the change in rainfall mentioned by respondents in the area. Thus, following the survey conducted among farmers, we realized that some strategies for adapting to rainfall change were practiced but not revealed, while others were unknown to farmers, which are: varietal adaptation, use of water and soil conservation techniques, use of organic manure, modification of sowing date, use of lowlands [19].

a) Varietal adaptation

It is practiced by approximately 45% of the operators surveyed. This adaptation consists of the use of new or improved varieties (rice and maize), generally early and with acceptable yield potential. Short cycle varieties adapt to the shortening of the rainy season. These varieties are more adopted in the region due to the greater vulnerability of this area to climatic factors. The importance of varietal adaptation is explained by non-climatic factors, such as demographic pressure, which imposed the need to intensify agricultural production in this area.
This has resulted in a multiplication of development projects in this area, which have led to the wide dissemination of agricultural technologies, including improved varieties.

b) Use of water and soil conservation techniques

These techniques make it possible to conserve water and soil and restore soil fertility (dykes, bunds and stone barriers). The use of water and soil conservation techniques increases with the vulnerability of the environment. It depends on the characteristics of the landscape. Dikes are used to treat ravines, while the choice of a bund or a stone cordon depends on the topography. Several studies have shown the effectiveness of these techniques. The stone lines can respectively induce an increase in yields of 60% and 25% compared to the field without development. The effect of these developments is particularly interesting when there is a lack of rainfall. Unfortunately, this strategy is not practiced by the population surveyed but that we had revealed to them. This requires appropriate training of farmers by the technical services [20].

c) Use of organic manure

It consists of adding manure and/or compost. Some farmers (5%) park the animals in their fields to take advantage of the droppings. The low use of manure in the region is explained by the relative richness of the soils.

However, droughts and reduced rainfall have caused a loss of plant cover, resulting in a decline in soil fertility. Soil degradation is more felt by farmers in a climate crisis context. This is why organic manure must be used in response to the decline in fertility and revealed to farmers as an adaptation strategy to rainfall change [20].

d) Changing the sowing date

The date of sowing and the duration of the rainy season are two essential parameters for rainfed agriculture, since they determine, on the one hand, the date of sowing and therefore the position of the crop cycles, and, on the other hand, the duration of the period during which crops can benefit from rainfall. Following the disruption of the rainy season, farmers modify the sowing dates in order to carry out the crop cycle during a favorable period.

This avoidance strategy allows crops to reduce or cancel out the effects of water stress. Early sowing helps to avoid the effects of early rain breaks. About 25% of farmers surveyed use this strategy. The modification of the sowing date varies inversely with the rainfall intensity and the vegetative cycle of the plants.

e) Use of lowlands

Practiced by 30% of farmers, farmers are increasingly using naturally rice-growing lowlands for rice cultivation in the rainy season and market gardening in the dry season.

f) Other coping strategies

Other adaptation strategies are little used by farmers, such as the diversification of crops and activities, practiced by 15% of farmers as well as irrigation not practiced but revealed to the surveyed farmers. In short, the main strategies for adapting to rainfall variation implemented by the populations of Forest Guinea are integrated into the adaptation options encountered in the literature. The modification of sowing dates and cultivated varieties, the transfer of crops (case of the use of lowlands), better land management (fight against erosion) constitute, according to GIEC, adaptation measures to climate change for the agriculture sector [21].

Indeed, the use of short-cycle plants and the use of lowlands are strategies for adapting to seasonal variations in rainfall in the region. It is therefore obvious that the decrease in rainfall leads farmers to adopt varieties with shorter cycles.

IV. CONCLUSION

Research on climate change impacts and adaptation requires a multidisciplinary and integrative approach. A field survey was conducted to characterize the factors influencing the local climate in Guinea and particularly in the forest region. The results show that without minimizing the natural factors contributing to global warming, the pressures on natural resources linked to various anthropogenic activities such as agriculture, livestock breeding or fraudulent wood cutting represent essential factors contributing to the generation of greenhouse gases. Greenhouse effect. The trend needs to be reversed in order to essentially conserve key ecosystems and protected areas that are essential for human survival. To deal with such threats, local authorities must take adequate damage limitation measures but also prospects for sustainable forest management. To this end, the participatory approach to the management of natural areas must be taken into account, to win the bet of sustainable development for the communities and by the communities.

This implies that the involvement of surrounding local populations in the development and management of key natural areas would guarantee their viability. Regular reforestation activities are also to be promoted to win the bet against global warming.

REFERENCES

[1]. Boko M, Niang I, Nyong A, Vogel A, Githeko, Andrew, Medany M, Osman-Elasha B, Tabo R, Yanda and Pius Z, Africa Climate Change 2007: Impacts, Adaptation and Vulnerability, 2007.

[2]. Sumaryanto, Strategi Peningkatan Kapasitas Adaptasi Petani Tanaman Pangan Menghadapi Perubahan Iklim Forum Penelit. Agro Ekon. 2016, 30-73.

[3]. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Tanzania: University of Dar-es-salaam) Salack S, Klein C, Giannini A, Sarr B, Worou O N, Belko N, Bliefernicht J and Kunstman H, Global warming induced hybrid rainy seasons in the Sahel Environ. Res. Lett. 11 104008, 2016

[4]. Sultan B, Defrance D and Iizumi T, Evidence of crop production losses in West Africa due to historical global warming in two crop models Sci. Rep. 9 2019, 1-15.

[5]. Sultan B and Gaetani M, Agriculture in West Africa in the twenty-first century: climate change and impacts scenarios, and potential for adaptation Front. Plant Sci.7, 2016, 1-20.

[6]. Zougmoré R, Partey S, Ouédraogo M, Omitoyin B, Thomas T, Ayantunde A, Ericksen P, Said M and Jalloh A, Toward climate-smart agriculture in West Africa: a review of climate change impacts,

adaptation strategies and policy developments for the livestock, fishery and crop production sectors Agric. Food Secur. 5, 2016, 1-16.

[7]. Tony W Carr, Siyabusa Mkuhlani, Alcade C Segnon, Zakari Ali, Robert Zougmoré, Alan D Dangour, Rosemary Green and Pauline Scheelbeek, Climate change impacts and adaptation strategies for crops in West Africa: a systematic review, Environ. Res. Lett. 17 (2022) 053001, 14p.

[8]. Lilyk Eka Suranny, Evi Gravitiani and Mugi Rahardjo, Impact of climate change on the agriculture sector and its adaptation strategies, The 7th International Conference on Climate Change, Earth and Environmental Science 1016 (2022) 012038, 2021.

[9]. The Impact of Expanding Artisanal and Small-Scale Mining on Small Holder Agriculture in West Africa. A Case Study of Burkina Faso, Ghana and Sierra Leone, Synthesis Report october, 2017, 42p.

[10]. GIEC, Cinquième rapport du Groupe Inter-Gouvernemental sur l'évolution du Climat (GIEC) : contribution du groupe de travail II., Génève (Suisse): Secretariat du GIEC, 2014.

[11]. GIEC, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II du GIEC,, New York: Cambridge University Press, 2012.

[12]. Demba Aïssata Samoura, Bolanle Wahab, Olalekan John Taiwo, Alpha Issaga Pallé Diallo, Ahmed Younis Ibrahim Younis. Barriers and adaptation strategies to climate change among farming households in Guinea Savanna, Journal of Applied and Natural Science, 14(3), 2021, 702 - 710.

[13]. Antwi-Agyei, P., Abalo, E. M., Dougill, A. J. & Baffour-Ata, F. Motivations, enablers and barriers to the adoption of climate-smart agricultural practices by smallholder farmers: Evidence from the transitional and savannah agroecological zones of Ghana. Regional Sustainability, 2 (4), (2022), 375-386.

[14]. Guinea-United Nations Framework Convention on Climate Change (UNFCCC). Republic of Guinea: Intended Nationally Determined Contribution under the United Nations Framework Convention on Climate Change (UNFCCC) (Vol. 15, Issue 2), (2015).

[15]. Guinean Government. Contribution nationale volontaire à la mise en œuvre des ODD au forum politique de haut niveau New York, Juillet 2018, Issue Version 3.

[16]. Alpha Arsida Barry, Lansana II Soumah, Ouo-Ouo Balamou and Ibrahima Sory Sow, Demonstration of the circulation of coxiella burnetii (Q fever agent) in cattle in Kindia and in Guinea Forestier, World Journal Of Pharmaceutical And Medical Research, 2022, 8(8), 22-26

[17]. René Tato Loua, Hassan Bencherif 1,4, Nelson Bègue 1, Nkanyiso Mbatha, Thierry Portafaix , Alain Hauchecorne, Venkataraman Sivakumar and Zoumana Bamba, Surface Temperature Trend Estimation over 12 Sites in Guinea Using 57 Years of Ground-Based Data, MDPI, Climate, 2020, 8, 68, 24p.

[18]. Loua, R.T.; Beavogui Maoro; Bencherif Hassan; Barry Alpha Boubacar; Bamba Zoumana; AmoryMazaudier Christine Climatology of Guinea: Study of Climate Variability in N'zerekore. J. Agric. Sci. Technol. A 2017, 7, 115-223.

[19]. Bush ER, Jeffery K, Bunnefeld N, Tutin C, Musgrave R, Moussavou G, Mihindou V, Malhi Y, Lehmann D, Edzang Ndong J, Makaga L, Abernethy K. Rare ground data confirm significant warming and drying in western equatorial Africa. DOI 10.7717/peerj.8732, 2020, 29p.

[20]. Hirpha, H. H., Mpandeli, S. & Bantider, A. Determinants of adaptation strategies to climate change among the smallholder farmers in Adama District, Ethiopia. International Journal of Climate Change Strategies and Management, 12(4), 2020, 463–476.

[21]. GIEC, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II du GIEC,, New York: Cambridge University Press, 2012.