



Securing Permanent Forests to Combat Climate Change and Enhance Sustainable National and Local Economies in Cameroon

ANNEX 22D

ANALYSIS OF VULNERABILITY

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ABBREVIATIONS AND ACRONYMS

BM	World Bank
CDN	Nationally Determined Contribution
AT	Far North
GEF	Global Environmental Fund
IPCC	Intergovernmental Panel on Climate Change
MINEPDED	Ministère de l'Environnement, de la Protection de la Nature et du Sustainable development
NO	Northwest
PNACC	National Climate Change Adaptation Plan
PNIAIC	Climate-Resilient Agricultural Investment Plan
PNW	Waza National Park
Ground floor	Republic of Cameroon
SCN	Second National Communication
IUCN	International Union for Conservation of Nature
ZAE	Agroecological zone

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INTRODUCTION

Global warming is a global phenomenon linked to human activities and the increase in average temperatures observed over several decades, as noted in the latest report by the Intergovernmental Panel on Climate Change (IPCC, 2018). Cameroon, like many countries around the world, is not immune to these climatic events. The country lies between the tropical and equatorial zones, giving it a wide range of climates and conditions that encourage a wide range of agricultural production. As such, Cameroon is one of the countries most vulnerable to the effects of climate change. These are manifested particularly through rampant drought, increasingly regular flooding and climate dysfunction due to its exposure, but also because of its low overall capacity to adapt (WB, 2020). As a result, Cameroon is experiencing seasonal disruption linked to climate variation. This variability of climate change has a significant negative impact on human activities (IPCC, 2018).

Today, the need for adaptation is being felt and is manifested at national level by the development of national climate change adaptation policies (the National Climate Change Adaptation Plan, national communications). Consequently, an assessment of the vulnerability and impacts of climate change are key elements in achieving the objective of combating climate change. In addition,, there are several possibilities for climate financing, such as the Adaptation Fund, the Green Climate Fund, etc. It is in the context of mobilising this funding that the Cameroon government, with the support of IUCN, has prepared and submitted the project entitled: ***"Securing permanent forests to combat climate change and sustainably strengthen national and local economies in Cameroon"***.

One of the objectives of the feasibility study is to assess the impact and vulnerability of socio-ecological systems to the effects of climate change in the project areas, in order to provide the relevant information for the implementation of this project. This vulnerability assessment provides the information needed to design and strengthen interventions around permanent forests to combat climate change. The aim is therefore to assess the vulnerability and impacts of climate change on ecosystems and populations in order to justify concrete actions to deal with climate change.

This study report begins by presenting climatic events, impacts and the vulnerability of socio-ecological systems to the effects of climate change. It also presents the various adaptation measures that should make it possible to mitigate the effects of climate change. Finally, it presents the potential obstacles to combating the effects of climate change in the various project landscapes.

METHODOLOGY

2.1. PRESENTATION OF PROJECT AREAS

The areas targeted by the project are :

- (i) Dja-Lobéké landscape (rainforests surrounded by mining operations and large agricultural enterprises - Rubber , palm and cocoa plantations, etc.);
- (ii) Bakossi - Bamboutos landscape (traditional agriculture and industrial tea plantations) and ;
- (iii) Waza landscape (Sudano-Sahelian) (cotton/rice plantations and large herds of cattle).

The choice of these project areas was based firstly on the intervention sites proposed in the project idea note, and secondly through a workshop which enabled the spatial delimitation of the project implementation sites to be refined. This workshop took place in Mbalmayo with the participation of key players from the Ministry of Forests and Fauna (MINFOF), the Ministry of the Environment, Nature Protection and Sustainable Development (MINEPDED) and certain NGOs and civil society. The selection criteria were essentially permanent forest landscapes under threat from various human activities (agriculture, poaching, livestock farming, logging). In addition to these threats, the spatial delimitation of the intervention sites was also guided by the presence of permanent forest sustainable management programmes and projects in the project landscapes.

Figure 1 shows the project's areas or intervention zones.

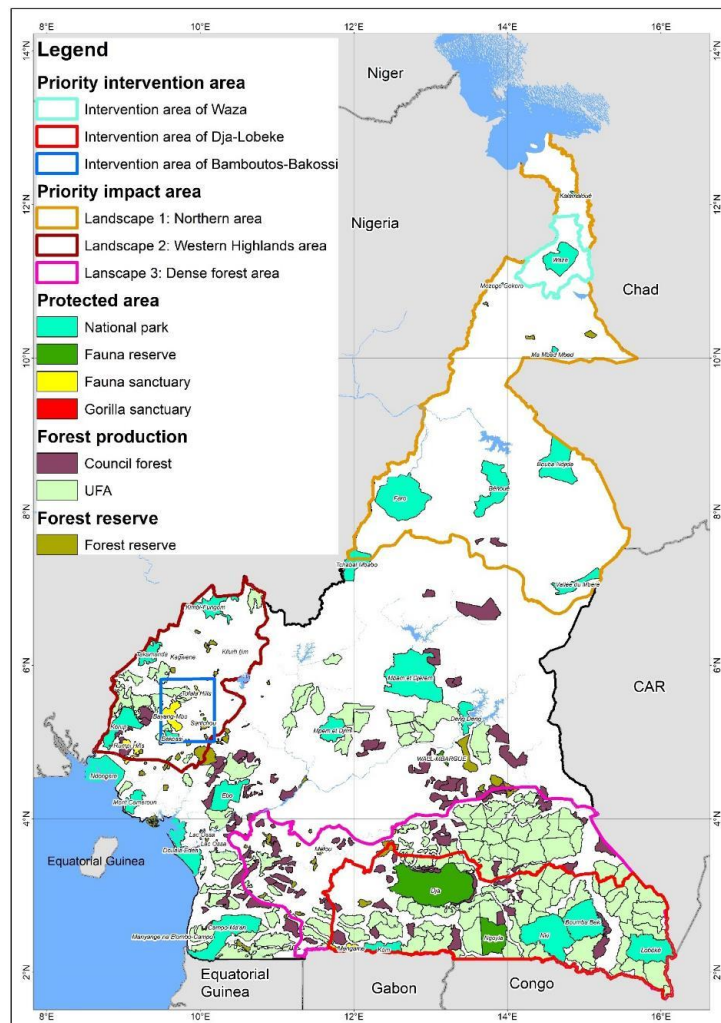


Figure 1 Geographical location of the various project areas

2.2. METHODOLOGICAL APPROACH

The preparation of this report was based on a large number of guidelines, methodological documents, examples of good practice and vulnerability analyses recommended by the IPCC, the UNFCCC, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), as well as strategic and political documents such as the National Climate Change Adaptation Plan (PNACC, 2015), the Climate Resilient Agricultural Investment Plan (PNIAIC, 2020), the Nationally Determined Contribution (CDN, 2021), the Second National Communication on Climate Change in Cameroon (SCN, 2015) and several scientific articles on the impacts and vulnerability to climate change of the various sectors (agriculture, fisheries, livestock, forestry, etc.). It was drawn up using a participatory approach based on various stages of analysis.

The section below presents the IPCC methodological framework and the methodological approach adopted for analysing the impacts and vulnerability of the

socio-ecological systems of the project intervention sites to the effects of climate change.

2.2.1. IPCC FRAMEWORK ON VULNERABILITY AND CLIMATE RISKS

The scientific principle of this study is based on the concept of vulnerability and climate change risks as defined by the International Panel on Climate Change (IPCC 2007, IPCC 2014). Figure 2 illustrates the interaction between the climate system and socio-economic processes, including adaptation and mitigation, which drive climate risks, exposure and vulnerability. Figures 2 and 3 below have been used to illustrate the risk of climate-related impacts resulting from the interaction of climate risks with vulnerability and exposure of human and forest ecosystems in the three project intervention landscapes.

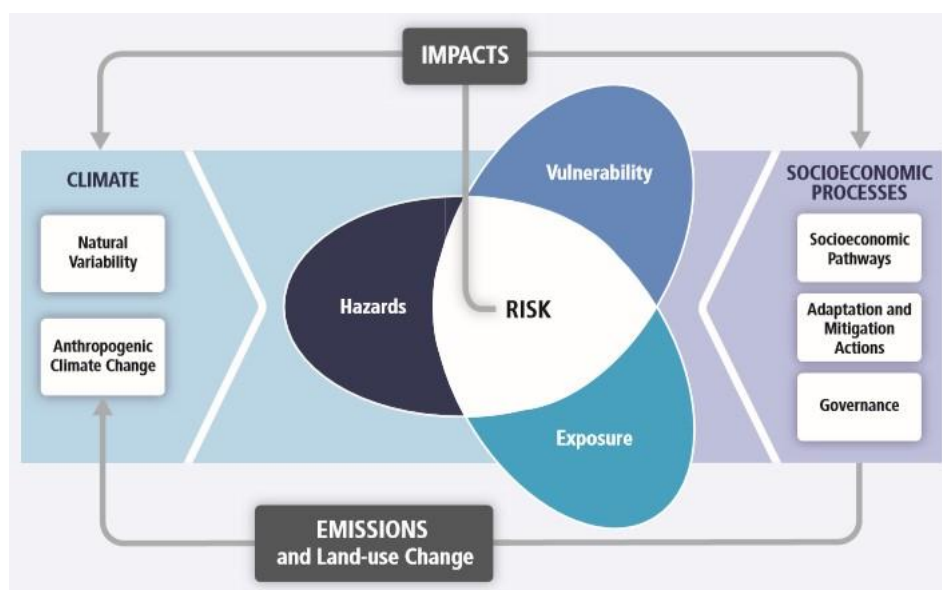


Figure 2 Schematic representation of the interaction among the physical climate system, exposure, and vulnerability to produce risk. Adapted from: Oppenheimer et al. 2014; Fig. 19.1

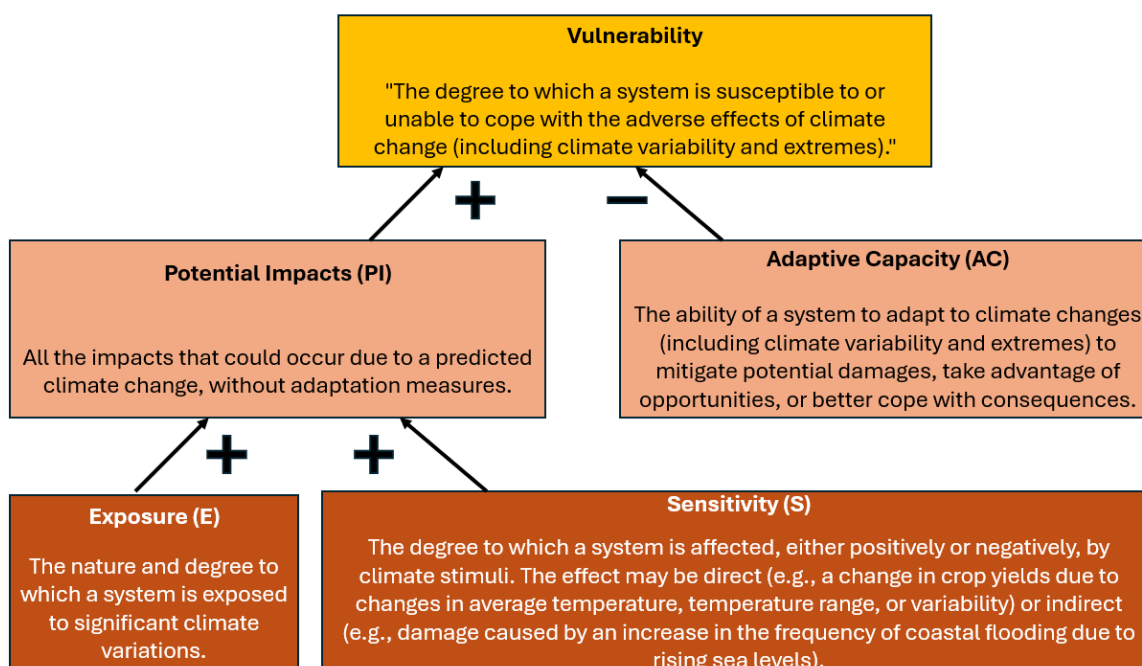


Figure 3 The components of vulnerability (definitions are from McCarthy et al. 2001). The signs under the arrows mean that high exposure, high sensitivity and low adaptive capacity induce high vulnerability.

Vulnerability and adaptation have been addressed at two levels: the use of forests as adaptation resources and the adaptation of forest ecosystem management practices, as shown in Figure 3.

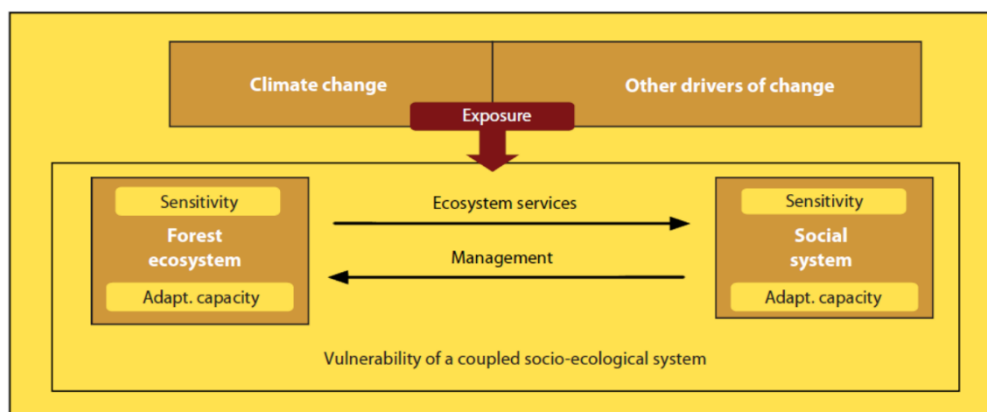


Figure 4 Vulnerability of a coupled socio-ecological system

2.2.2. ANALYSIS OF THE IMPACTS AND VULNERABILITY OF SOCIO-ECOLOGICAL SYSTEMS

1. Analysis of the impact of climate change

This analysis focused mainly on the use of primary and secondary data. Secondary data were collected from policy documents, plans, strategies and programmes on climate change and forest management in Cameroon. Using a semi-structured questionnaire (appendix xx), primary data were collected from key stakeholders in the project (decentralised services, park managers, communities, NGOs and CSOs, etc.) sites. The questionnaire contained a series of potential impacts that were identified in the various project intervention sites. The data collected on the impacts was compiled in an Excel spreadsheet in order to document the various impacts by project landscape.

2.2.2.2 Analysis of vulnerability to the effects of climate change

The vulnerability of the main sectors (agriculture, livestock, fishing and forestry) was analysed using a scale from 1 to 5. With 1, being the low value and 5 the very high value. The sum of the different values was used to assess the degree of vulnerability according to the following classes: 1 to 2 very low vulnerability, 3 to 4 low vulnerability, 5 to 6 moderate vulnerability, 7 to 8 high vulnerability and 9 to 10 very high vulnerability.

The colour codes for the vulnerability analysis are shown in the table below

Table 1 Colour codes for vulnerability analysis

Vulnerability class	Colour code
[1-2[→ Very weak	
[2-4[→ weak	
[4-6[→ Moderate	
[6-8[→ Strong	
[8-10] → Very strong	

3. CLIMATIC EVENTS

It is widely acknowledged that, according to climate scenarios, climatic events are becoming increasingly diverse and intense in Cameroon (Ndongo et al., 2015; MINEPDED, 2015). According to the literature, there are few differences between the types of climatic events recorded in the different agro-ecological zones (MINEPDED, 2015; WB, 2017; WB, 2020). Several climatic events have been identified in Cameroon's agro-ecological zones in strategic and policy documents on climate change (PNACC, 2015; SCN, 2015; PNIAIC, 2020; CDN, 2021) and scientific articles (Sonwa et al, 2012; Chia et al., 2013; Bele et al., 2013; Cheo et al., 2013; Brown and Sonwa 2015; Schroth et al., 2016; Brown and Sonwa 2018; Evariste et al., 2018; Awazi et al., 2019; Mbuli et al., 2021; Amougou, 2021). The climatic events identified and their projected intensities for each project area are presented in the table below:

Table 2 Climatic events and their intensity by agro-ecological zone

Climatic events	Sahelian Sudan	Bimodal rainfall	Western Highlands
Increase in temperature	+++++	+++	++
Heat waves	+++++	+++	++
Dust storms	++++	/	/
Violent winds	+++	+	++
Drought	++++	+	+
Rainfall variability	++++	+++	+++
Flooding	+++	+++	++
Land erosion	+++	++	++
Landslides	++	++	+++

Very low (+) Low (++) , medium (+++) high (++++) very high (+++++)

Source: Adapted from PNACC 2015, PNIAIC, 2020 and analysis of articles by Fokabs.

At different intensities, the target agro-ecological zones are affected by all the climatic events listed in Table 2, with the exception of dust storms, which specifically affect the Sudano-Sahelian zone.

For the purposes of this study, the various climatic events identified during the data collection process in the project's inventoried landscapes include: temperature increases, heat waves, high winds, dust storms, rainfall variability, drought, flooding, land movement and erosion. These different climatic events have made it possible to analyse the impact of climate change on the different sectors of activity presented below.

4. IMPACTS OF CLIMATE CHANGE BY SECTOR

In Cameroon, climate change has become a daily reality for farmers. Much of the country is significantly affected by desertification, drought, irregular rainfall and flooding. From the arid climate of the Sudano-Sahelian agro-ecological zone to the equatorial climate of the monomodal forest zone, via the high savannahs of the Sudano-Guinean zone, the equatorial climate of the high plateaux and the bimodal zone, the effects of climate change are perceptible and the nature of these climatic disturbances varies from one region to another because of the country's climatic diversity (PNACC; 2015).

Climatic events have a significant impact on the ecosystem and socio-economic activities. As part of the exposure to climate change, the technical studies for the preparation of the national climate change adaptation plan identified and prioritised several sectors, namely: agriculture, livestock, forestry/forestry, fisheries and aquaculture, water, sanitation and health, energy, mining and industry, urban development and public works, and tourism.

This study focuses on the sectors most exposed to climate change according to the hierarchy identified in the literature. The sectors considered are mainly agriculture, livestock farming, forestry/forestry, fisheries and aquaculture. Depending on the climatic events identified, the impacts of climate change on the various sectors of activity were assessed.

4.1. IMPACT OF CLIMATE CHANGE ON THE WAZA LANDSCAPE

Nowadays, the majority of people living in the Far North region of Cameroon suffer disproportionately from extreme weather events because of the region's semi-arid conditions and their heavy dependence on agriculture, livestock and natural resources for their livelihoods (Anougue, 2013).

4.1.1. AGRICULTURAL SECTOR

According to the Plan Communal de Développement de l'arrondissement de Waza (PCD, 2013), 75% of the local population, or 18,750 people, depend on agriculture for their livelihood, and 4,668 people work in the agriculture sector. However, this activity is potentially dependent on the climate and is increasingly subject to the vagaries of the weather. This dependence of agriculture on the climate, particularly rainfall, highlights the issue of agricultural vulnerability and food insecurity. This situation is becoming a recurring problem for farmers .

A survey carried out in 2004 which analysed households' ability to cover their food needs, the frequency of exposure to periods of food insecurity and incomes, showed that Logone et Chari, to which the Waza landscape belongs, is the most vulnerable of all the area. .

An analysis of the data from the focus groups with the communities and the sectoral services of the Ministries of Agriculture, Livestock, Fisheries and the Environment made it possible to gather opinions, views, speeches and ideas on the impacts of climate change in the Waza landscape. Overall, the people surveyed were unanimous on the fact that the climate is in the throes of change and that its impact on the

agricultural sector is no longer in doubt, given the frequency of climatic events in the Waza landscape.

Table 3 summarises the impacts of the climate variability observed in the agricultural sector in the landscape of waza. The impacts include lower crop yields, reduced plant productivity, food insecurity, increased poverty, school drop-out rates, agro-pastoral conflicts and conflicts over access to water. Drought, the shortening of the rainy season and torrential rains are the climatic events that cause the most damage to harvests, lowering farmers' incomes and leading to food insecurity. Between 2013, 2015 and 2017, the Far North region of Cameroon was hit by deadly floods on he populations located along the Logone River which were the worst affected. (Frédéric, 2019). In addition, the degradation of agricultural soils and the invasion of locusts and other insect pests are other climatic factors contributing to the decline in agricultural productivity in the region.

Table 3 Impacts of climate change in the agricultural sector of the Waza landscape

Climatic events	Impacts
Increase in temperature	• Productivity decline and agricultural production • Lowering the water table • Increased evaporation and reduced soil humidity • Increase in the rate of crop losses • Shortening the vegetative cycle
Heat waves	• Drying out and destruction of crops, • Lower productivity • Reducing human labour and making it harder
Violent winds	• Destruction of songs
Dust storms	• Poor germination, reduced yields • Drying out crops • Reduction, interruption of human work
Rainfall variability	• Disruption to the agricultural calendar • Decrease in rainfall and decline in productivity and agricultural production • Loss of livelihood and impoverishment • Crop flooding • Reduction in rainfed crop yields • Fall in net income from crops
Drought	• Disruption to the agricultural calendar • Lower agricultural yields • Water shortage for farms • Decline in income • Crop losses • Food insufficiency
Flooding	• Destruction of crops, soil leaching •

4.1.2. LIVESTOCK SECTOR

After agriculture, livestock farming is a very important activity for people in the Waza landscape. The impacts of climate change in this sector mainly concern: drought, which leads to the drying up of the water bodies needed for animal production. It also leads to a reduction in grazing and causes animals to move to areas with more pasture (transhumance). This is the case, for example, in the Yaéréés (a floodplain used for grazing after the waters have receded, in the Far North of Cameroon). Furthermore, the undernourishment of animals resulting from the lack of water for grazing leads to emaciation of the animals within the herds, stunted growth, abortions and greater vulnerability to various diseases (epizootics). When the dry season is very harsh and too long, herds suffer heavy losses or disappear. Floods, meanwhile, lead to the death of animals and a drop in farmers' incomes. However, it should be noted that farmers are well aware of the relationship between water resources and plant cover, and that the disappearance of water resources inevitably leads to the disappearance of plant cover.

The impacts of climate change on the livestock sector in the Waza landscape are listed in Table 4 .

Table 4 Climatic events and their impact on livestock farming

Climatic events	Impacts
Increase in temperature	• Decline in livestock productivity • Reduction in grazing land • High livestock mortality and morbidity • Increase in mountain livestock
Heat waves	• Decline in livestock productivity • Reduction in grazing land • High livestock mortality and morbidity
Rainfall variability	• Less water for livestock • Reduction in grazing land
Drought	• Increased burning, destruction of grazing land
Flooding	• Destruction of pastures and livestock
Erosion	• Destruction of pasture and livestock

4.1.3.. FISHING SECTOR

According to the information gathered, fishing appears to be the third most important income-generating activity for the communities in the region. This activity, which depends on the balance of the aquatic ecosystems, is generally practised in the Logone river or in the ponds of the PNW and in the large wet grassy savannah. The main types of fishes are catfish, mackerel, sardines, carp, eels, etc. The main impacts of climate change in this sector are the drying up of ponds and the loss of aquatic habitats for these fishes . There has also been a drop in fish production, the displacement of fishermen towards Lake Chad (temporary), an increase in poverty, conflicts between PNW managers and fishermen, and conflicts between fishermen and livestock farmers due to the installation of fishing channels that obstruct the migration corridors of livestock farmers. This is the case, for example, of the conflicts observed between the mousgoun fishermen and the Arab chao herders.

The various impacts of climate change on fishing are summarised in the table below.

Table 5 Climatic events and their impact on fishing

Climatic events	Impacts
Increase in temperature	• Loss of habitat for sensitive fish species • Increased evapotranspiration from plants can reduce the availability of surface and groundwater • Changes in species composition • Decrease in fish productivity • Depletion of fish stocks
Rainfall variability	• Increase in species habitat • Changes in species diversity
Dust storm	• Silting of watercourses
Drought	• Draining water reservoirs • Destruction of fry
Flooding	• Destruction of ponds • Loss of species habitats and productive ponds • Reduction in fish stocks
Erosion	• Loss of species habitats and natural ponds • Silting of watercourses

4.1.4. FORESTRY AND WILDLIFE SECTOR

The impacts of climate trends on the forestry and silviculture sector include: degradation of vegetation, reduced productivity of fruit trees, drying out of branches, reduced production of plant biomass (fruit, straw, firewood, gum arabic) and reduced tree size. Ecosystem services such as provisioning services (such as nutrition and medicines with products), regulating services, support services and cultural services. are also affected by climate change in the region.

The impact on wildlife is essentially the migration of certain species. The immediate consequence of this migration is conflict between wildlife. Indeed, due to the modification of the biotope of certain species of fauna by the phenomenon of interrupted rainfall and prolonged drought, certain species of fauna migrate from their natural habitat towards permanent watering points, which are generally located near human settlements. In addition, wildlife species in search of pasture move towards people's fields, leading to human/wildlife conflicts. According to the Far North Regional Forestry and Wildlife Delegate, living conditions for wildlife are becoming increasingly harsh because of climate change. As a result of prolonged droughts, herds of elephants have deserted the PNW in search of water and grass, but their return is uncertain. The migration of these animals is causing major damage to farmers' plantations. Official estimates put the area of fields devastated by roaming elephant herds in the departments of Mayo-Danay and Mayo-Kani, in Cameroon's Far North region, at 240 hectares (Cameroon Tribune, 2021). The direct consequences of this damage are reduced incomes and poverty.

The impacts of climate change in this sector are summarised in the table below

Table 6 Climatic events and their impacts on forestry/forestry and wildlife

Climatic events	Impacts
Increase in temperature	• Increased aridity and loss of species habitats • Reduction in species • Scarcity of non-timber forest products • Reducing access to wood energy • High species mortality • Reduced livelihoods • Poverty and falling incomes
Heat waves	• Water stress and reduced forest productivity • Increase in bushfires • Loss of biodiversity • Reduction in the surface area of protected areas through deforestation • Increased mortality of macro- and micro-fauna
Rainfall variability	• Disruption to the silvicultural calendar
Violent winds	• Destruction of trees • Destruction of fields
Drought	• Increased aridity and loss of species habitats • Unavailability of non-timber forest products • Reduced access to wood energy • Loss of biodiversity • Loss of seedlings planted for reforestation
Flooding	• Destruction of trees
Erosion	• Destruction of plants, Loss of biodiversity

4.2. IMPACT OF CLIMATE CHANGE ON THE NJA LOBEKE LANDSCAPE

The dense forest zone where the Nja Lobeke landscape is found is home to a large part of the Congo Basin forest. It is considered to be Cameroon's least vulnerable to climate change (RdC, 2021). However, climate change has repercussions on the livelihoods of people who are highly dependent on the climate. Surveys of communities and resource persons have enabled us to identify and analyse the various impacts of climate hazards on the different sectors of activity in the Dja-Lobéké landscape. Despite this, the effects of climate change in this ZAE are not negligible, as the indicators of the impacts of climate change are visible on the livelihoods of the populations and the resulting situation of vulnerability is problematic.

4.2.1. AGRICULTURAL SECTOR

Climate change is seriously affecting the availability of natural resources such as water, land, etc., which is having a serious impact on agriculture and people, since successful planting depends entirely on the rainfall pattern. The effects of climate change in this landscape are varied and increasingly worrying. In fact, almost 50% of the people surveyed said that they no longer knew the sowing dates and were fully aware that failure to master the agricultural calendar could lead to a delay in germination. The

immediate consequence of delayed rainfall is a drop in agricultural productivity and crop failure. Furthermore, 30% of the communities consulted in this zone claim to have experienced rainfall variability in recent years, which is responsible either for a drop in agricultural productivity and a decrease in the amount of rainfall needed for farming. Indeed, some farmers claim to have lost more than half their maize harvests due to excessive, repeated and unpredictable rainfall. These heavy rains also contribute to the leaching of soils that are ideal for farming. In addition, 20% of the communities surveyed perceive the disruption to the climate in the Dja-Lobéké landscape as an increase in temperature in recent years, characterised by early flowering and a decline in agricultural productivity.

Table 7 summarises the impact of climate hazards on the agricultural sector in the Dja-Lobéké landscape.

Table 7 Climatic events and their impacts on agriculture in the Dja-Lobéké landscape

Climatic events	Impacts
Increase in temperature	• decline in agricultural production • Increase in the rate of crop losses • Shortening the vegetative cycle • Early flowering • Proliferation of pests
Violent winds	• Destruction of fields due to uprooting of trees and reduced harvests
Rainfall variability	• Decrease in rainfall and decline in productivity and agricultural production • The disruption of the traditional agricultural calendar • Difficulty accessing fields and markets for products • Loss of livelihoods and impoverishment of populations • Decline in soil fertility • Flooding of crops • Reduction in rainfed crop yields • Fall in net income from crops
Drought	• Drainage and destruction of crops • Lower productivity • Reducing human labour and making it harder
Flooding	• Destruction of crops, soil leaching
Landslides	• Destruction of crops
Erosion	• Destruction of crops and soil • Destruction of infrastructure

4.2.2. LIVESTOCK SECTOR

Livestock farming in the bimodal rainfall landscape of Dja-Lobéké is dominated by poultry, with the occasional small livestock such as goats and pigs. The livestock farming system is traditional. It helps to supplement not only people's food requirements but also their income. Livestock farming in this landscape has been little

affected by climatic upheavals, with the exception of a few cases of animal deaths following epizootic diseases that have led to the loss of livestock.

Indeed, 65% of the communities surveyed claim to have experienced a prolonged drought in recent years, which is characterised by a rise in the proliferation of epidemics, leading over time to an increase in livestock mortality and morbidity. Some communities also see the variability of rainfall as the reason for the decline in pasture. The immediate consequences are agro-pastoral conflicts.

Table 7 summarises the impacts of climate change on the livestock sector.

Climatic events	Impacts
Increase in temperature	• Decline in livestock productivity • Reduction in grazing land • High livestock mortality and morbidity • Increase in mountain livestock
Heat waves	• Decline in livestock productivity • Reduction in grazing land • High livestock mortality and morbidity
Rainfall variability	• Less water for livestock • Reduction in grazing land • Proliferation of epizootic diseases

4.2.3. FISHING SECTOR

The fishing system around the parks in the Dja-Lobéké landscape with bimodal rainfall is traditional. The impacts of climate change are hardly visible in this sector. Nonetheless, the communities surveyed are unanimous on the fact that the climate is changing and that its impact on the fishing sector is no longer in doubt, given the drop in fishermen's incomes observed in recent years as a result of irregular rainfall patterns that are not conducive for fishing. According to the information gathered, almost 65% of the communities consulted perceive the variability of the rains as being responsible for the decline in fisheries productivity. In addition, 15% of the communities consulted saw rising temperatures as the main cause of reservoirs drying up, leading to a drop in fish production.

The impacts identified in the literature and confirmed in the field are summarised in table 8 below.

Table 8 Climatic events and their impact on fishing

Climatic events	Impacts
Increase in temperature	• Loss of habitat for sensitive fish species • Increased evapotranspiration from plants can reduce the availability of surface and groundwater • Changes in species composition • Decrease in fish productivity • Depletion of fish stocks

Rainfall variability	• Increase in species habitat • Changes in species diversity
Drought	• Draining lakes and ponds or reservoirs • Destruction of fry

4.2.4. FORESTRY AND WILDLIFE SECTOR

The effects of current climate change in the Dja-Lobéké landscape are having repercussions on ecosystems, wildlife and flora. These effects have led to the migration and loss of wildlife species, including the disruption of tree growth and the population dynamics of forest species. According to the communities (40%), the slowdown in the growth of reforested species in certain reforestation sites in this landscape is attributed to recurrent drought sequences .

As for the impact of winds on the forestry sector, 25% of the stakeholders consulted perceive strong winds as responsible for the destruction of tree branches and the rooting of certain woody species in full growth. The impact of rainfall variability on forestry/forestry/wildlife is characterised by an upsurge in pests and parasites, which are largely responsible for the fragmentation of habitats and destruction of ecosystems, resulting in the disruption of species dynamics and the loss of certain plant species. 25% of stakeholders claim to have experienced an increase in parasites on certain plant species in recent years. In addition, almost 10% of the communities surveyed claim to have experienced heat waves in recent years, which are said to be responsible for water stress and reduced forest productivity.

The impacts of climate change are listed in the table below

Table 9 Climatic events and their impact on forestry/forestry/wildlife

Climatic events	Impacts
Increase in temperature	• Increased aridity and loss of species habitats • Reduction in species • Unavailability of non-timber forest products • Reducing access to wood energy • Reduced livelihoods • Poverty and falling incomes
Heat waves	• Water stress and reduced forest productivity • Increase in bushfires • Reduction in soil microfauna • Loss of biodiversity • Reduction in the surface area of protected areas through deforestation
Rainfall variability	• Probable increase in plagues and parasites • Destruction of plants with low water tolerance • Fragmentation of habitats and destruction of ecosystems • Disruption of species dynamics and loss of certain plant species • Disruption to the silvicultural calendar
Violent winds	• Destruction of trees (windfall)

Drought	• Water deficit and reduction in biodiversity
Flooding	• Destruction of trees
Landslides	• Increased land movement and destruction of plants • Loss of biodiversity
Erosion	• Destruction of plants, loss of biodiversity

4.3. IMPACT OF CLIMATE CHANGE ON THE BAKOSSI-BAMBOUTOS LANDSCAPE

The Bakossi-Bamboutos landscape is also facing the effects of climate change. The effects of climate change in this landscape are affecting all sectors. In addition to the many problems they already face, local people are now having to cope with this new phenomenon. Climate change represents a new threat on top of the existing risks.

4.3.1. AGRICULTURAL SECTOR

In Cameroon, climate is an important factor in agricultural production. Inadequate rainfall can hamper plant development, thereby limiting productivity. In recent years, rainfall has become more unstable, leading to a disruption of the agricultural calendar and a drop in productivity. In the Bakossi-Bamboutos landscape, surface water is becoming drier. This is likely to have an impact on agricultural production.

Agricultural activity in this landscape is essentially centred on the cultivation of plantain, macabo, taro, yams, groundnuts, sweet potatoes, beans, cassava and maize. Potatoes, one of the main food crops, are grown in mountainous areas and in irrigated lowlands. These different crops are subject to adverse weather, which affect productivity.

For example, agricultural production is declining and the area cultivated by farmers is increasing. Local people say that the greatest impact is the variability of rainfall and the increase in sunshine intensity over the years, which causes a delay in germination. Normally in this landscape, rain falls between March and April. This is no longer the case. In fact, almost 50% of farmers claim to have lost their seed between 2010 and 2015.

While most of the communities consulted believe that the reduction in rainfall is seriously affecting agricultural yields, a minority are aware of the effects of prolonged drought on the proliferation of fungal diseases and its repercussions on agricultural yields. Nearly 25% of the farming communities consulted claim to have lost a large proportion of their vegetable crops to fungal diseases following prolonged dry spells that disrupt the regularity and consistency of the wet season.

The negative effects faced by agriculture as a result of climate change in the Bamboutos Bakossi landscape are summarised in Table 11.

Table 10 Climatic events and their impact on agriculture

Climatic events	Impacts
Increase in temperature	• Lower yields in the plains and lowlands • Proliferation of insect attacks • Drying out field crops • Less water in hydro-agricultural dams

	- Increased risk of vegetation fires - Reduced availability of water resources
Rainfall variability	- Disruption to the agricultural calendar - Loss of seedlings - Decrease in rainfall and decline in productivity and agricultural production - Difficulty accessing fields and markets for products - Loss of livelihood and impoverishment - Increased rainfall intensity, leading to soil erosion - Crop flooding - Reduction in rainfed crop yields - Fall in income from crops
Drought	- Drainage and destruction of crops - Lower productivity water shortage - The drudgery of human labour
Flooding	Destruction of crops, soil leaching
Landslides	Destruction of crops, homes, property and infrastructure
Erosion	- Destruction of crops and soil - Destruction of infrastructure

4.3.2. LIVESTOCK SECTOR

The livestock sector in the Bakossi-Bamboutos landscape is facing the effects of climate change, which are manifested in the drying up of the majority of watering points for animals, the considerable reduction in grazing and the appearance of new epizootic diseases. In general, livestock farming in this landscape involves cattle, sheep, pigs and poultry, and is mainly practised by the Bororo. However, on the whole, livestock is kept in cowsheds. According to recent studies by (Ouama, 2018), the increase in sunshine intensity is responsible for the drop in livestock production due to the lack of grazing areas and water resources to water the herds.

To meet the challenge of scarce water resources, livestock farmers practice transhumance between the months of November and December. Their return period is generally at the end of March and beginning of April. Transhumance routes include Bafou Nord, Bangang, Galim, Bafou Nord Bamenda, Kumbo Foto, Lébialem and Bafou Nord.

The table below summarises the impacts of climate change on livestock farming in Bamboutos Bakossi and the surrounding area.

Table 11 Climatic events and their impact on livestock farming

Climatic events	Impacts
Increase in temperature and Heat waves	- Decline in livestock productivity - Reduction in grazing land - High livestock mortality and morbidity - Increase in mountain livestock

Rainfall variability	• Less water for livestock • Reduction in grazing land
Drought	• Increased risk of wildfire • Destruction of grazing land
Flooding	• Destruction of pastures and loss of livestock
Landslides	• Destruction of pasture and livestock
Erosion	• Destruction of pasture and livestock

4.3.3. FISHING SECTOR

Fishing in the Bakossi-Bamboutos landscape is an activity that is practised alongside other activities by the local people. It is practised mainly in the shallows of the hillsides and sometimes in the rivers. Unfortunately, this activity in the Bakossi-Bamboutos landscape is facing extreme climatic events, including drought, which is contributing to the drying up of waterholes and rivers, the migration of fish species, the reduction in fishing catches and rising temperatures. These impacts of climate change will exacerbate the poverty of fishermen. Late rains and high temperatures will reduce the ability of fishermen to cope with the effects of climate change and are likely to increase the over-exploitation of natural resources and poverty in the area.

The various impacts of climate change on fishing activity are summarised in Table 13.

Table 12 Climatic events and their impact on fishing

Climatic events		Impacts
Increase temperature	in	• Loss of habitat for sensitive fish species • Increased evapotranspiration from plants can reduce the availability of surface and groundwater • Changes in species composition • Decrease in fish productivity • Depletion of fish stocks
Rainfall variability		• Increase in species habitat • Changes in species diversity
Drought		• Draining lakes and ponds or reservoirs • Destruction of fry
Flooding		• Destruction of ponds • Loss of species habitats and productive ponds • Reduction in fish stocks
Landslides		• Destruction of ponds
Erosion		• Loss of species habitats and productive ponds • Silting of lakes and reservoirs

4.3.4. FORESTRY AND WILDLIFE SECTOR

In the Bamboutos Bakossi landscape, the most developed ecosystems include gallery forests, agroforests dominated by eucalyptus and raffia forests in the lowlands. These ecosystems are under threat from the effects of climate change. Drought is having a

serious impact on the development of forest ecosystems, increasing the risk of bush fires in wildlife habitats and, as a direct consequence, the loss of biodiversity. This loss of biodiversity leads to a drop in rainfall and the availability of water resources in the soil. However, the impact is not only perceptible on flora, but also on wildlife. According to some communities (25%), climate change is responsible for the migration of wildlife species. Prolonged droughts mean that water sources are drying up and wildlife is migrating in search of permanent water sources. The direct consequence of this phenomenon on wildlife is a change in the spatial distribution of wildlife species and a change in the composition of ecosystems.

The impacts of climate change in this sector are presented in the table below.

Climatic events	Impacts
Increase in temperature	• Increased aridity and loss of species habitats • Reduced livelihoods • Reduction in revenue
Heat waves	• Increased risk of bush fires • Decrease in soil microfauna • Loss of biodiversity • Reduction in the surface area of protected areas through deforestation
Rainfall variability	• Disruption to the silvicultural calendar • Destruction of plants with low water tolerance • Fragmentation of habitats and destruction of ecosystems
Drought	• Increased aridity and loss of species habitats • Increase in bushfires • Unavailability of non-timber forest products • Reduced access to wood energy Loss of biodiversity
Flooding	• Destruction of trees
Landslides	• Increased land movement and destruction of plants, loss of crops • Loss of biodiversity
Erosion	• Destruction of plants, loss of crops, loss of biodiversity

4.3.5. SUMMARY OF THE IMPACTS OF CLIMATE CHANGE

Analysis of the impacts of climate change in the landscapes covered by the project clearly shows that drought, rising temperatures and rainfall variability are the most visible and spectacular climatic hazards affecting people's livelihoods. The figure below shows that drought is the most spectacular climatic hazard affecting people's activities in the Waza, Dja and Lobéké landscapes, in that it is perceived by nearly 75% of the people surveyed as one of the climatic hazards with disastrous consequences. On the other hand, in the Bamboutos Bakossi landscape, 65% of the people consulted perceived the effects of this hazard on their activities. Rising temperatures are also a major climatic hazard for all landscapes. Nearly 35% of the people consulted said that temperatures were becoming more intense.

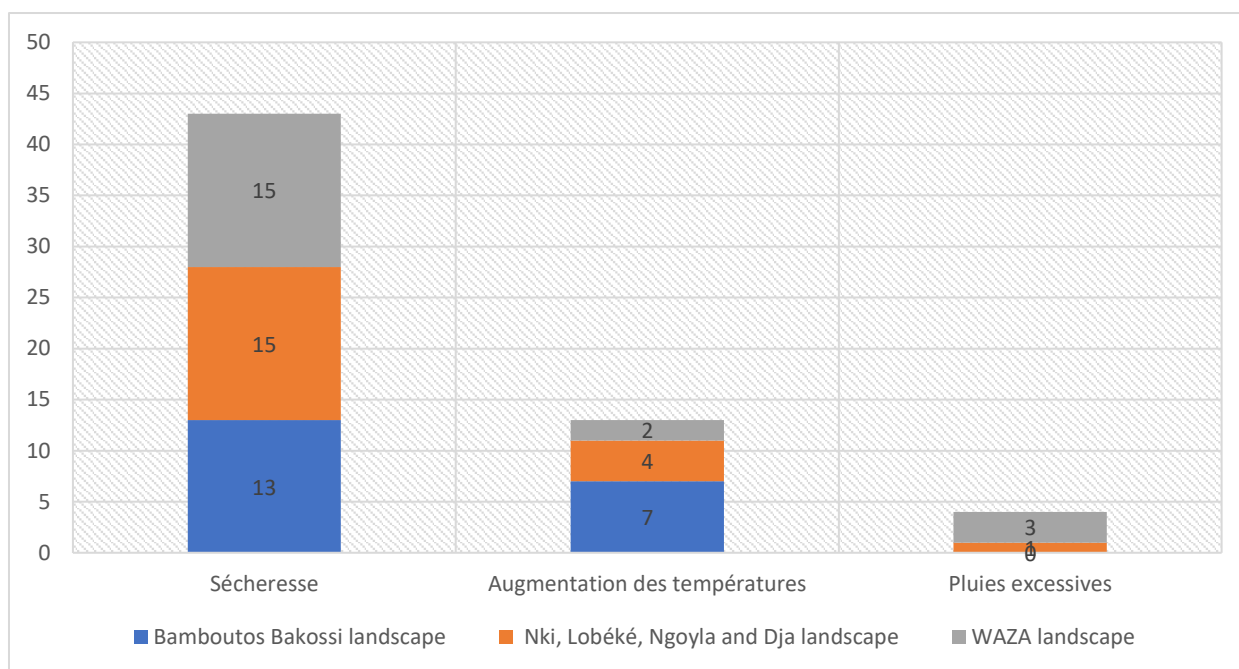


Figure 5 Percentage of respondents by landscape

5. ANALYSIS OF VULNERABILITY TO THE EFFECTS OF CC

The objective of this section is to analyse the degree of vulnerability of communities by sector on the basis of vulnerability indicators (sensitivity and exposure) in order to identify the different levels of vulnerability of populations.

5.1. VULNERABILITY IN THE WAZA LANDSCAPE

The Waza Landscape is located in the Sudano-Sahelian zone, which according to the PANACC is particularly vulnerable to climatic events such as drought, floods and heat waves. This section presents the vulnerability of people's livelihood activities in the Waza landscape.

5.1.1. AGRICULTURAL SECTOR

The agricultural sector in the Waza landscape is particularly vulnerable to climatic hazards, as agricultural production depends mainly on rainfall. Climatic events such as , rainfall variability, drought and violent winds increase farmers' vulnerability, resulting in crop losses, impoverished farmland and reduced income . The table below shows the degree of vulnerability of the agricultural sector in the Waza landscape.

Table 14 Level of vulnerability of communities in the agriculture sector

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Vulnerability class
Rainfall variability	4,2	4,4	8,6	Very strong
Heat waves	2	3,2	5,2	Moderate
Dust storms	0,7	0,8	1,5	Very low
Violent winds	3,2	3,5	6,7	Strong

Drought	4,1	4,2	8,3	Very strong
Flooding	2,7	2,6	5,3	Moderate
Erosion/landslides	0,4	0,5	0,9	Very low

According to Figure 1, almost 28.33% of the communities consulted identified the agricultural sector as being vulnerable to rainfall variability. Furthermore, according to the WFP/FAO/MINADER report (2005), insufficient and poorly distributed rainfall between 2004 and 2005 was at the root of the food crisis that hit the Far North, particularly the Logone et Chari department. In addition, the intensity of sunshine encourages the proliferation of insects, which destroy their seeds once planted in the fields, especially during the flowering period.

Overall, the Waza landscape is highly vulnerable to rainfall variability, which disrupts the cropping calendar with direct repercussions on household living conditions.

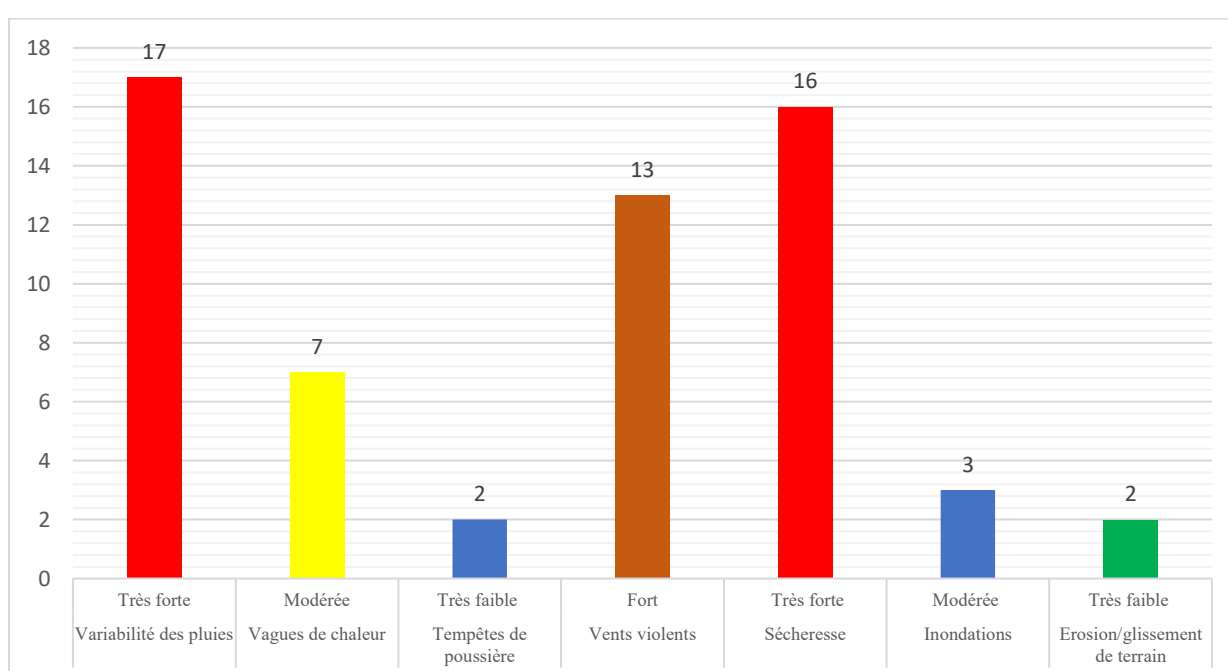


Figure 6 Proportion of communities vulnerable to climatic events in the agricultural sector

5.1.2. LIVESTOCK SECTOR

The livestock sector in the Waza landscape is particularly vulnerable to drought and heat waves. The main factors increasing the vulnerability of this sector of activity are the extension of agricultural land, the lack of knowledge about fodder production, the occupation of transhumance corridors due to the arrival of migrants and demographic pressure. It should also be noted that the development of certain activities, such as fishing, with the intensification of the construction of fishing canals, and the absence of a micro-zoning plan clearly defining the zones where pastoral activities are practised, are hampering this sector. The table below shows the level of vulnerability of the livestock sector in relation to climate change.

Table 15 Level of vulnerability of communities in the livestock sector

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Vulnerability class
Rainfall variability	2,75	2,75	5,5	Moderate
Heat waves	2,75	3,5	6,25	Strong
Dust storms	0,5	0,5	1	Very low
Violent winds	1	0,5	1,5	Very low
Drought	4,25	4,25	8,5	Very strong
Flooding	2	3,5	5,5	Moderate
Erosion/landslides	0,75	1,25	2	Low

The data collected on livestock in the Waza zone show that 52.94% of the communities consulted have a very high vulnerability of the livestock sector to drought followed by heat waves (Figure 2).

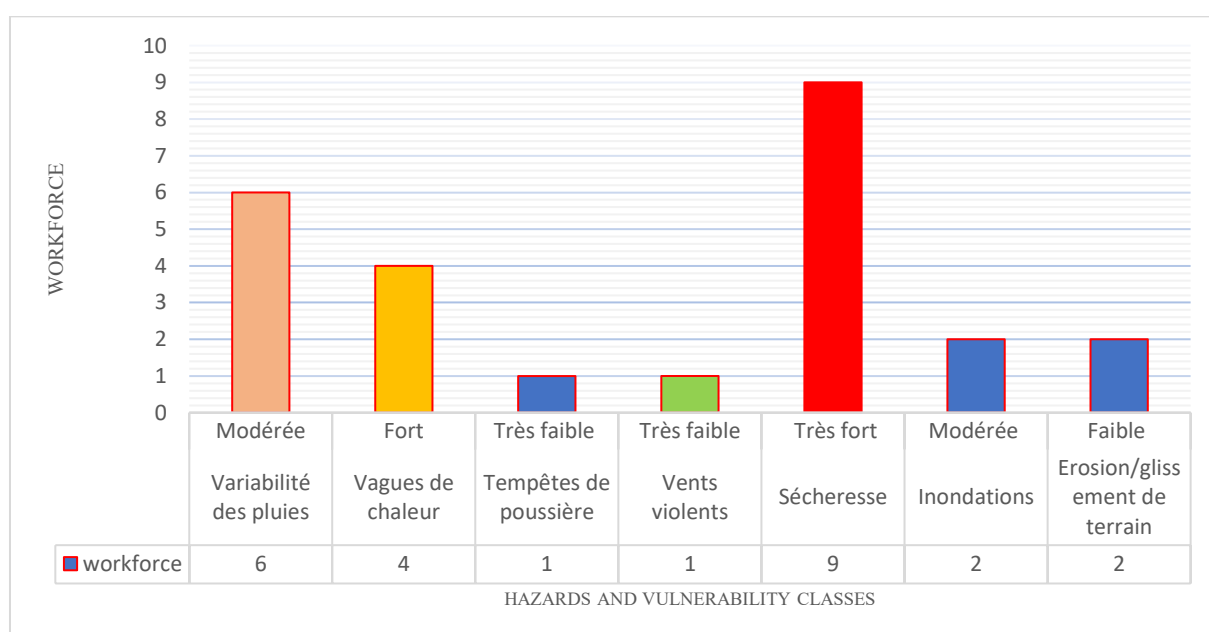


Figure 7 Proportion of communities vulnerable to climate events in the livestock sector

5.1.3. FISHING SECTOR

Fishing in the Waza landscape is mainly practised in the large wet grassy savannah and in certain pools of water in the WNP. Unfortunately, this activity, which is closely dependent on the availability of water resources, is facing the effects of climate change. The main climatic hazards increasing the vulnerability of this sector are drought, heat waves and floods. The figure below shows that 58.82% of the fishing communities consulted are very vulnerable to drought. As a result, climate change would lead to a reduction and disappearance of fish species. However, it should be noted that the vulnerability of certain activities, such as agriculture, has encouraged some farmers to convert to fishing. Some of these farmers combine farming and fishing to improve their incomes. The level of vulnerability of fishing activity is summarised in the table below

Table 16 Level of vulnerability of fishing communities

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Vulnerability class
Rainfall variability	2,75	2,75	5,5	Moderate
Heat waves	2,75	3,5	6,25	Strong
Violent winds	1	0,5	1,5	Very low
Drought	4,25	4,25	8,5	Very strong
Flooding	2	3,5	5,5	Moderate

Figure 3 describes the proportions of vulnerable communities in the Waza landscape and its periphery according to climate events for the fisheries sector.

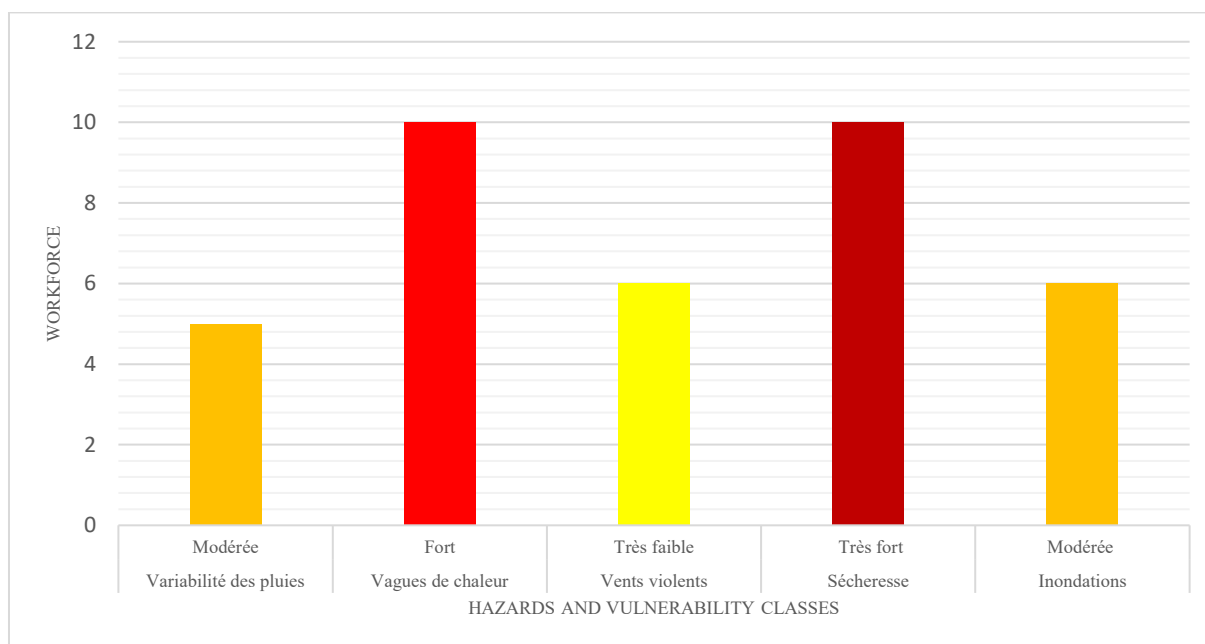


Figure 8 Proportion of vulnerable communities according to climatic events in the fisheries sector.

5.1.4. FORESTRY AND WILDLIFE SECTOR

The forestry/forestry and wildlife sector remains highly vulnerable to climate change. However, the recurrent occurrence of climatic hazards accentuates the sensitivity of this sector and its ecosystem services. The forestry sector is an integral part of the ecosystem. The forest ecosystem provides ecosystem services such as support, provisioning, regulation and cultural services. Ecological function services are the natural processes by which ecosystems function and are maintained, while services are the results of these functions. Healthy ecosystems can reduce the negative effects of climate change, just as protected areas contribute to healthy forests. Healthy forests reduce the risk of devastating fires and can retain water sources. Maintaining air and soil quality, controlling floods and disease, and pollinating crops are all regulatory services that can help people adapt to climate change. The disruption of these services makes communities whose livelihoods depend essentially on these ecosystem services very vulnerable.

Drought causes wildlife to migrate and sometimes intrude into the plantations of people living near the various permanent forests. The main factors of vulnerability in this sector

are the lack of monitoring of seedlings planted for reforestation, the lack of water for the maintenance of young seedlings, the resurgence of climatic events such as prolonged periods of drought and also conflicts which have led to the felling of reforested plots by the armed forces to make enemies visible during patrols. The level of vulnerability is shown in table 16.

Table 17 Level of vulnerability in the forestry/forestry/wildlife sector

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Vulnerability class
Rainfall variability	2	1	3	Low
Increase in temperature	3	1	4	Moderate
Dust storms	0,5	0,5	1	Very low
Violent winds	4	3	7	Strong
Drought	5	4	7	Strong
Flooding	0,5	1,25	1,75	Very low
Erosion/landslides	3	1	4	Moderate

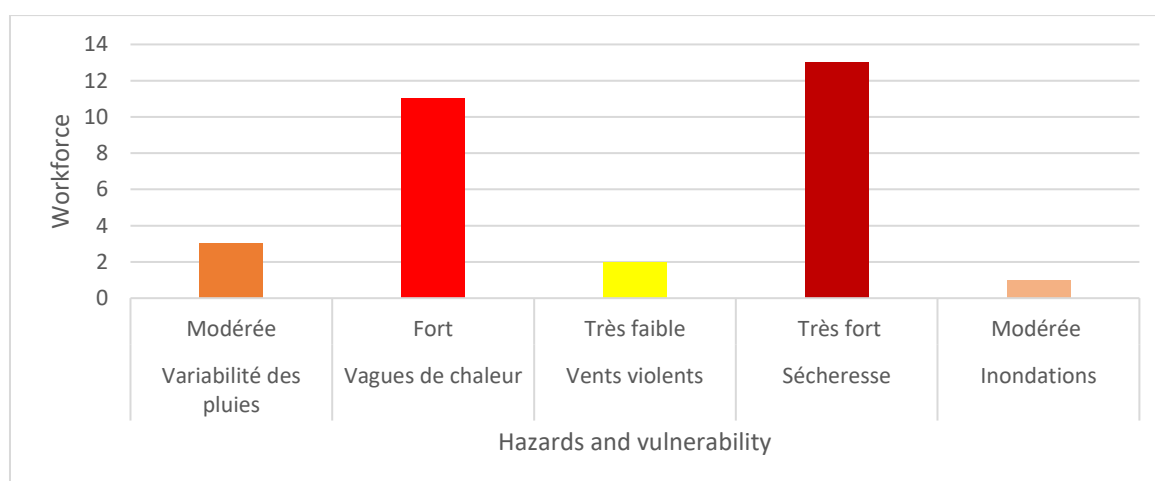


Figure 9 Proportion of vulnerable communities according to climatic events in the forestry/forestry/wildlife sector

5.2. VULNERABILITY IN THE DJA-LOBÉKÉ LANDSCAPE

The Dja-Lobeké landscape belongs to the agroecological zone of bimodal forests. According to the PNACC, it is one of the areas most vulnerable to climatic hazards such as high temperatures and strong winds. This section presents the vulnerability of the sectors most sensitive to the effects of climate change in the Dja-Lobeké landscape.

5.2.1. AGRICULTURAL SECTOR

The agriculture sector in the Dja-Lobeké landscape is highly vulnerable to strong winds and heat waves. 71.43% of the communities surveyed (Figure 4) found this sector to have moderate vulnerability to rainfall variability. This can be explained by the relatively favourable natural conditions for agriculture in this landscape. The high level of vulnerability to other climatic events (temperature increases, strong winds, etc.) is

exacerbated by the extreme poverty of the communities, their lack of knowledge of the best adapted agricultural techniques and limited access to climate information.

Table 18 Level of vulnerability of communities in the Agriculture sector

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Vulnerability class
Rainfall variability	2,6	3	5,6	Moderate
Increase in temperature	3	3,5	6,5	Strong
Violent winds	3	3	6	Strong
Drought	1,5	1,5	3	Low
Flooding	0,5	1,25	1,75	Very low
Erosion/landslides	1	1	2	Low

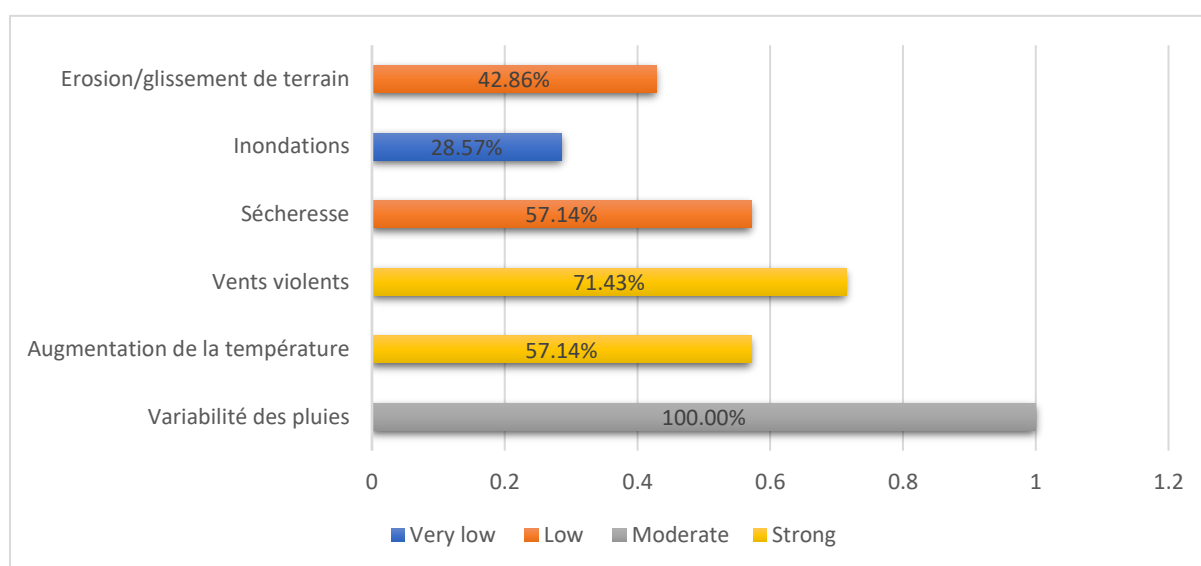


Figure 10 Proportion of vulnerable communities following climatic events in the agricultural sector

5.2.2. LIVESTOCK SECTOR

Unlike the agricultural sector, the livestock sector in the Dja Lobeke landscape is mainly vulnerable to climatic events such as excessive heat and heat waves (Table 21). The main factors accentuating vulnerability in this sector are the extension of agricultural areas, the absence of a micro-zoning plan clearly defining the zones where pastoral activities are practised, the proliferation of bush fires which destroy grazing, and the low level of technical support for livestock farmers.

The level of vulnerability in this sector is shown in Table 20 and the proportions of respondent in the communities according to climatic events are shown in Figure 5.

Table 19 Level of vulnerability of communities in the Livestock sector

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Vulnerability class
Rainfall variability	1	1	2	Low
Heat waves	3	2,5	5,5	Moderate
Violent winds	1,25	1	2,25	Low

Drought	3	2,75	5,75	Moderate
Flooding	0,5	1,25	1,75	Very low

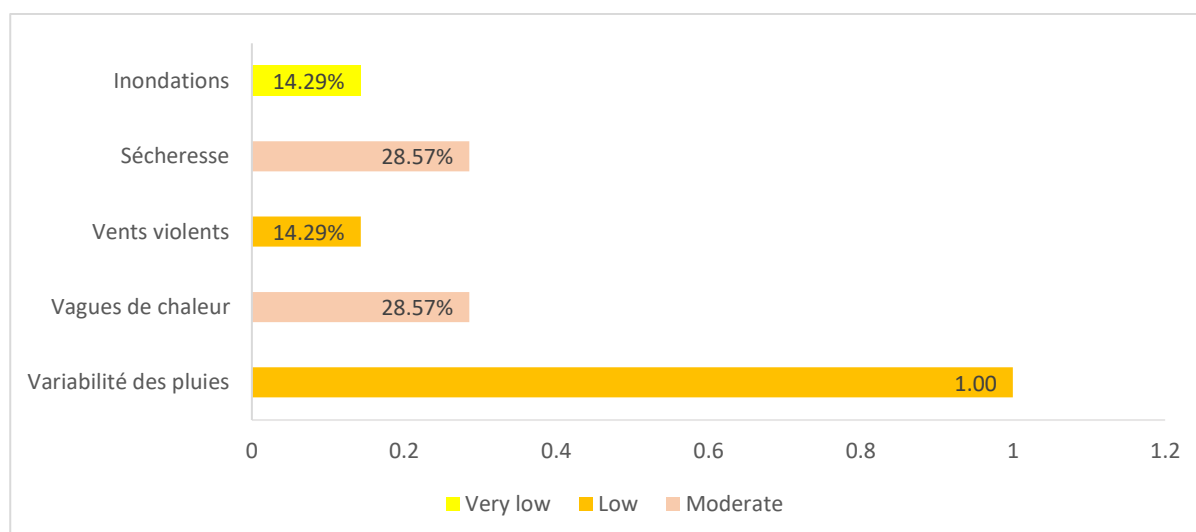


Figure 11 Proportion of vulnerable communities according to climatic events in the livestock sector.

5.2.3. FISHING SECTOR

Fishing in the Dja-Lobéké landscape is traditional and contributes not only to feeding the population but also to supplementing their income. An analysis of the vulnerability of fishing activity in this landscape shows that fishing is highly vulnerable to drought, according to 85.71% of communities surveyed (Figure 6). Fishing is moderately vulnerable to climatic events such as rainfall variability and temperature increases. The vulnerability results for the fishing sector are summarised in the table below.

Table 20 Vulnerability of fishing to climate change

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Level of vulnerability
Increase in temperature	2	3,75	5,75	Moderate
Rainfall variability	4,25	2	6,25	Moderate
Drought	4	4	8	Strong
Flooding	3,25	2,75	6	Moderate
Erosion	2	1	3	Low

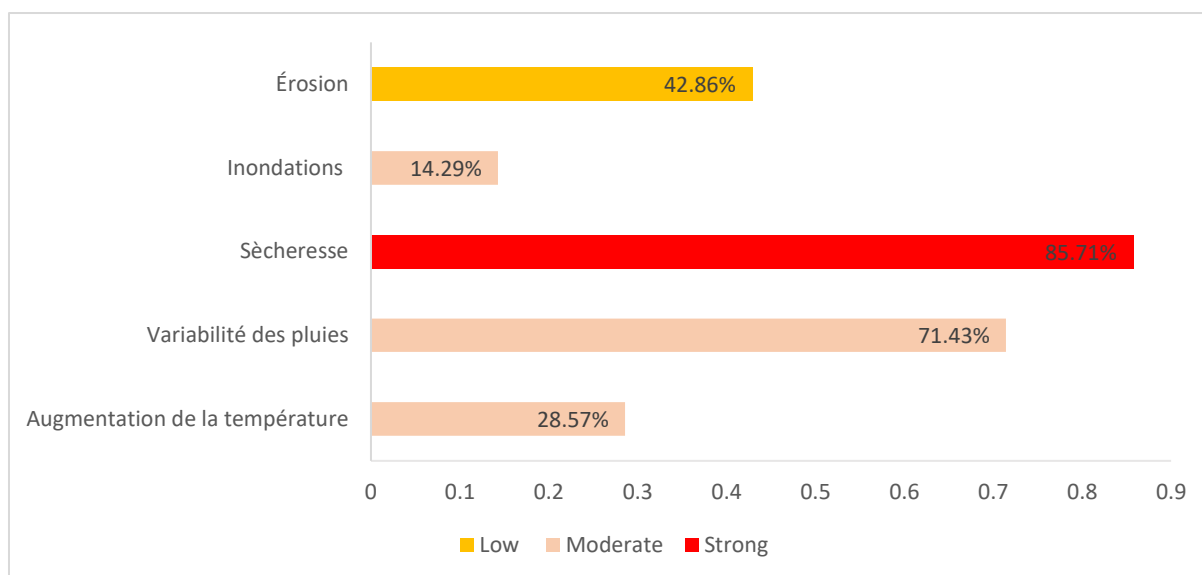


Figure 12 Proportion of vulnerable communities according to climatic events in the fisheries sector

5.2.4. FORESTRY/FORESTRY AND WILDLIFE SECTOR

The forestry, silviculture and wildlife sector is highly vulnerable to rising temperatures and drought. Rising temperatures and drought disrupt the regeneration of certain plant species and can lead to a loss of biodiversity. They also lead to the migration of certain species of wildlife. Violent winds uproot and topple trees (windfall). Factors that exacerbate vulnerability are the lack of improved seedlings and monitoring of tree plantations. The level of vulnerability of this forestry/forestry and wildlife sector is shown in Table 20.

Table 21 Vulnerability of forestry, forestry and wildlife to climate change

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Level of vulnerability
Increase in temperature	3,75	2,75	6	Strong
Variation in rainfall intensity	2,75	1,75	4,5	Moderate
Violent winds	3	5	8	Strong
Drought	4	2,75	6,75	Strong
Flooding	2	1,5	3,5	Low
Landslides	1	1	2	Low
Erosion	2	3	6	Low

5.3. VULNERABILITY IN THE BAKOSSI-BAMBOUTOS LANDSCAPE

The Bamboutos-Bakossi landscape is located in the High Plateaux Agroecological Zone, which according to the NCCP is vulnerable to climatic hazards such as rainfall, flooding and land movement. This section presents the vulnerability of the most vulnerable livelihood activities in this landscape.

5.3.1. AGRICULTURAL SECTOR

The agricultural sector is highly vulnerable to drought and rainfall variability. Rainfall variability leads to severe disruption of this key subsistence activity and a sharp drop in production. The vulnerability analysis revealed that all the communities surveyed in this sector (100% integrated) are highly vulnerable to rainfall variability, while 75% are very highly vulnerable to drought (Figure 7). Lack of climate information and awareness of irrigation practices exacerbate communities' vulnerability. The table below shows the level of vulnerability of agriculture to climate change in the Banboutos mountains.

Table 22 Level of vulnerability of agriculture to climate change

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Level of vulnerability
Rainfall variability	3,75	2,5	6,25	Strong
Drought	4,25	3,75	8	Very strong
Flooding	1	2		Low
Landslides	2	1	3	Low
Erosion	1	0,5	1,5	Very low

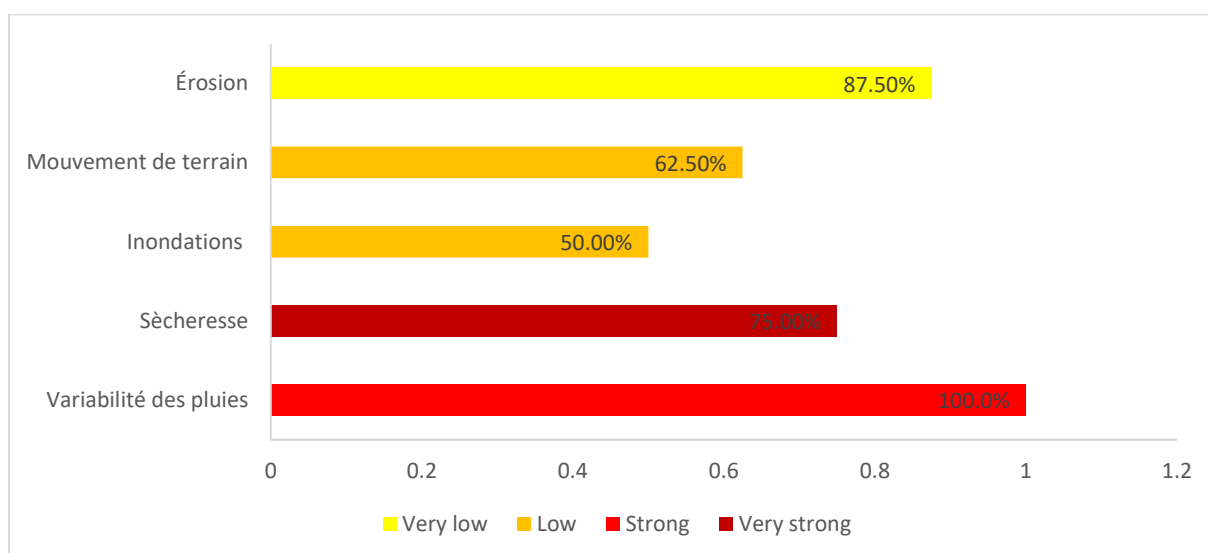


Figure 13 Proportion of vulnerable communities following climatic events in the agricultural sector.

5.3.2. LIVESTOCK SECTOR

The vulnerability assessment shows that the livestock sector is highly vulnerable to rainfall variability and drought. Nearly 25% of the communities surveyed said that this sector is vulnerable to drought and rainfall variability (Figure 8). The absence of a micro-zoning plan clearly defining the zones where pastoral activities are practised, and the low level of technical support for livestock farmers are factors of vulnerability in this zone. The vulnerability assessment of the livestock sector is presented in the table below.

Table 23 Level of vulnerability of livestock farming to climate change

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Level of vulnerability
Increase in temperature	2	1	3	Very low
Rainfall variability	3,75	2,5	6,25	Strong
Drought	5	3,25	8,25	Very strong
Flooding	3	2	5	Moderate
Landslides	3,75	2	5,75	Moderate
Erosion	4	1,25	5,25	Moderate

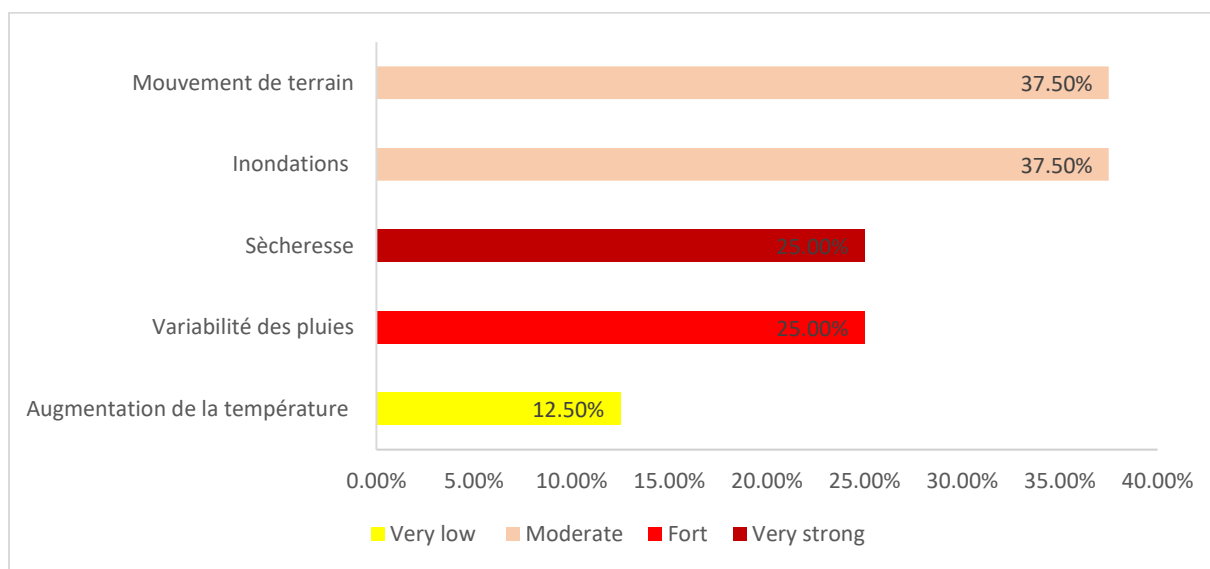


Figure 14 Proportion of communities vulnerable to climate events in the livestock sector

5.3.3. FORESTRY/FORESTRY AND WILDLIFE SECTOR

The forestry, silviculture and wildlife sector in Banbouts-Bakossi is highly vulnerable to temperature increases, drought and erosion. The fragility of this particular ecosystem and demographic pressure are factors that exacerbate its vulnerability.

Table 24 Vulnerability of forestry/forestry and wildlife to climate change

Climatic events	Exposure (0-5)	Sensitivity (0-5)	Vulnerability (0-10)	Level of vulnerability
Increase in temperature	5	2,5	7,5	Strong
Heat waves	5	2,5	7,5	Strong
Variation in rainfall intensity	4,5	1,25	5,75	Moderate
Violent winds	3,5	2	5,5	Moderate
Drought	4	3	7	Strong
Flooding	2,5	2	4,5	Low
Landslides	2,5	1,25	3,75	Low
Erosion	3,5	3,25	6,75	Strong

6. RESPONSES OF POPULATIONS TO THE IMPACT OF CLIMATIC EVENTS

In Cameroon, the population's capacity to adapt to climate change is low (Bele et al., 2011). In the areas most vulnerable to climate change, such as the Sudano-Sahelian zone, very poor populations have difficulty coping with extreme weather events and climate variability. The frequency and severity of these climatic events ultimately undermine people's ability to adapt in all agro-ecological zones (Bele et al., 2011). One of the resilience strategies adopted by local people is to diversify their subsistence activities. Surveys show that local people are developing ways of adapting to the effects of climate change, but these are difficult to put into practice because of social representations of nature that are influenced by beliefs, attitudes, stereotypes and opinions that guide their behaviour through prayers, invocations of ancestors and magico-religious practices (Noumbissié, 2019). Adaptation options were identified with the local population and decentralised administrative services in the different project landscapes

6.1. WAZA LANDSCAPE

The responses of local populations to the various climatic events were recorded during the interviews with the communities. These responses are summarised in Table 26 .

Table 25 Population responses to climate change in the Sudano-Sahelian zone

Climatic events	Responses from the public
Increase in temperature and Heat waves	• Systematic reforestation • Use of improved and more resistant varieties and seeds • Use of improved fireplaces • Cereal preservation practices • Distribution, planting and use of Moringa • Manufacture of improved fireplaces using local materials • Construction of bunds to retain rainwater
Dust storm	• Living hedges and tree curtains to protect crops
Rainfall variability	• Changes to the agricultural calendar • Sacrifices and prayers
Violent winds	• Living hedges and tree curtains to protect crops and homes
Drought	• Reforestation and construction of boreholes and wells • Improved and short-cycle seeds • Use of drought-resistant varieties • Distribution of improved fireplaces • Transhumance of livestock • Storage of agricultural residues for animal nutrition • More fishing channels

Flooding	• Use of impregnated mosquito nets • Building granaries high up or on stones • Transhumance of livestock • Construction of water collection structures from roofs • Building the dykes • Planting species that fix the soil
Erosion	• Water control and restoration of eroded land (backfilling) • Develop other anti-erosion systems in catchment areas (dykes, sandbags, etc.)

6.2. DJA-LOBÉKÉ LANDSCAPE

The responses of local populations to the climatic events observed in this landscape are presented in Table 27 .

Table 26 Population responses to climate change in the bimodal forest zone

Climatic events	Responses from the public
Rising temperatures and heat waves	• Use of improved seeds to counter the decline in agricultural production • Combating bush fires to prevent the destruction of plantations by land clearing • Agroforestry, introduction of associated crops, agricultural diversification • Creation of community forests • Reducing slash-and-burn
Rainfall variability	• Changes to the agricultural calendar • Reforestation
Violent winds	• Felling during field preparation of any tree whose fall could pose a risk to the destruction of the fields
Drought	• Dispersal of livestock in the event of prolonged drought • Reproduction practices for fry kept in wooded areas
Flooding	• Use of impregnated mosquito nets • Diversification of livelihoods • Building dykes with sandbags
Erosion	• Restoration of eroded land (backfilling)

6.3. LANDSCAPE BAKOSSI-BAMBOUTOS

The strategies developed by local people to cope with the effects of climate change in this landscape are presented in the table below:

Table 27 Responses of populations to climate change in the High Plateaux zone

Climatic events	Responses from the public
Increase in temperature	• Use of improved seeds to counter the decline in agricultural production • Irrigation and creation of off-season nurseries • Reforestation • Combating bush fires to prevent forage destruction

	• Creation of cereal processing units Tree nurseries • Agroforestry, introduction of associated crops, agricultural diversification • Creation of community and communal forests • Reducing slash-and-burn
Variation in rainfall intensity	• Changes to the agricultural calendar • Reforestation of riverbanks
Violent winds	• Living hedges and tree curtains to protect crops and homes
Drought	• Transhumance to regions with pastoral potential (pasture and water) • Irrigation • Production of off-season produce • Improved fireplaces to combat wood harvesting
Flooding	• Use of impregnated mosquito nets • Reforestation of river valleys • Diversification of livelihoods
Landslides	• Reforestation of steep mountain slopes • Introduction of improved seeds and fast-growing varieties • Terraced crops • Living hedges to protect crops
Erosion	• Reforestation and shoreline protection • Building hedges • Terraced crops • Controlling water and restoring eroded land

7. WITHOUT-PROJECT SCENARIO

Cameroon's population, currently estimated at 28 million (2023) and projected to reach 42 million by 2050^[1], exerts rising pressure on land, forests, and water resources. With over 70% of people dependent on agriculture and forest resources for livelihoods, the country's natural capital is crucial for local subsistence and national development^[2]. Yet, unsustainable land conversion, weak governance, and a changing climate have led to worsening poverty, food insecurity, and ecosystem degradation, especially in forest and highland regions. Without project intervention, communities in and around Permanent Forest Areas (PFAs)—notably the Waza (Sudano-Sahelian), Dja-Lobeke (Bimodal Rainforest), and Bakossi-Bamboutous (Western Highlands) landscapes—will face deepening livelihood insecurity, including declining agricultural productivity, livestock mortality, and fishery collapse, which will be exacerbated by climate change and poverty, driving further dependence on forest exploitation.

In Waza, the population is growing rapidly—from 4 million in 2000 to 9.3 million by 2025 (5.8% annual growth)—driving cropland expansion from 117,025 ha (2000) to 205,939 ha (2021), and accelerating loss of wet savannah ecosystems. Projected temperature increases of 1–4.8°C and annual rainfall declines of 2–14 mm, along with delayed onset and shorter wet seasons, intensify droughts—expected every two years—reducing vegetation cover by 30% and groundwater recharge by 15–20%. Reduced and erratic rainfall will push communities to clear additional forested areas in search of more productive agricultural land, further accelerating ecosystem degradation.

In the Bakossi-Bamboutous Highlands, with population densities reaching 400 inhabitants/km², forest decline from 574,148 ha (2000) to 558,644 ha (2021) has been accompanied by rainfall reductions of 8–25 mm by 2090 and temperature increases of 2.2–4.2°C, exacerbating soil erosion, landslides, and biodiversity loss.

In Dja-Lobeke, although 97.6% forest cover remains, population growth and agricultural expansion converted 25,709 ha of forest to cropland (2010–2021), increasing reliance on NTFPs and shifting cultivation. Average annual temperatures have already increased by 0.8–1°C (1950–2015) and are projected to rise by up to 4.8°C by 2090, while annual rainfall could decline by 2–14 mm, reducing soil moisture and increasing forest stress. Across the three landscapes, declining rainfall, delayed wet seasons, and rising temperatures are expected to intensify pressure on forests as communities seek higher yields, worsening vulnerability, food insecurity, and exposure to climate hazards for millions of people.

Nationwide, Cameroon has experienced significant forest cover loss, including within Permanent Forest Areas (PFAs), with a notable loss of 1.53 million hectares of tree cover between 2001 and 2020, including 47% in primary forests^[3]. Annual forest cover loss is currently 0.12%; projections show that it may double by 2028 and triple by 2035. Projected temperature rises of 2–3°C by 2050 and erratic rainfall patterns—including delayed onset, shorter wet seasons, and intense downpours—will exacerbate soil degradation, declining soil moisture, and yield reductions of 20–25% in key crops

(millet, sorghum, maize, and cowpea). Anticipated reductions in agricultural productivity will drive further expansion into forested areas, accelerating loss of non-timber forest products (NTFPs) and rangeland productivity, and deepening poverty for forest-dependent populations. Across the three landscapes, these dynamics are expected to directly and indirectly affect an estimated 2,300,000 people living around PFAs, exposing them to droughts, floods, and resource scarcity by mid-century. Without coordinated restoration, sustainable forest management, and livelihood diversification, ecosystem collapse will accelerate, carbon sequestration will decline, and vulnerability will become entrenched, affecting Cameroon's long-term resilience and ability to meet national climate and development goals.

^[1]<https://population.un.org/dataportal/data/indicators/49/locations/120/start/1990/end/2030/bar/barvertical?df=77bb8851-3242-4b55-b16a-cc8c5219b266>

^[2]Enoman, L.D. et al. 2024. Urban expansion and the loss of agricultural lands and forest cover in Limbe, Cameroon. Available [here](#).

^[3] <https://dicf.unepgrid.ch/cameroon/forest>

8. OBSTACLES AND NEEDS TO IMPROVE RESILIENCE

8.1. OBSTACLES

Adaptation measures that can strengthen people's resilience to the effects of climate change do exist, but they face a number of political, technical, institutional and legal obstacles. The individual and group interviews combined with the literature review enabled us to identify a number of obstacles to the implementation of adaptation options. These obstacles are as follows:

8.1.1. The institutional and regulatory obstacles

During the vulnerability study process, a number of obstacles were identified through the literature and interviews with communities and stakeholders. These include : Bad governance Poor governance is hampering the implementation of adaptation measures within communities. Failure to respect the principles of governance leads to anarchic management of resources and exacerbates the pressure on the exploitation of natural resources (illegal felling of trees, poaching, carbonisation, illegal fishing techniques). The signing of the Lake Chad Basin Commission (LCBC) convention has authorised the free movement of transhumance, making it difficult to control the movement of livestock.

Land tenure insecurity and limited rights of access to land, as well as insufficient capacity for resource use, planning and monitoring.

Any robust response to deforestation and forest degradation depends heavily on access to land and security of rights. Field visits to the project areas revealed that land access rights are based on haphazard and insecure practices. Although the institutional framework for land rights remains Ordinance no. 74-2 of 6 July 1974, creating a land tenure system based on land registration is imperative. The formalisation of land ownership (ownership and use rights) is a serious problem in Cameroon, due to administrative bottlenecks. This problem needs to be resolved to

enable land acquisition and registration. An accompanying ministerial decision is needed to remedy the slowness of the administration and sanction failures in implementation. Access and security rights still have many limitations, particularly for local communities and indigenous peoples.

Weak compliance with regulations:

Cameroon has a number of laws governing the management of resources and the preservation of the environment. These include the 1994 forestry law (Law no. 94-01 of 20 January 1994 - governing forests, wildlife and fisheries) and all the laws governing environmental management, such as Law no. 96/12 of 5 August 1996, the framework law on environmental management. For example, there is a regulation limiting the establishment of fishing channels, which is not respected by local people.

The lack of resources and understaffing limit the deployment of agents in the field. MINADER, for example, reveals that the distribution of improved seeds to deal with climate change is very limited and inadequate. MINFOF points out that resources (equipment, human resources) are very limited to meet the need to restore the landscape, which is necessary because of the pressure on forest resources (Waza area and its periphery).

Fragmented approach to action to combat climate change. This can be seen in the level of collaboration between decentralised government departments. The lack of synergy between actions at sectoral level leads to their fragmentation and consequently weakens the sustainability of climate change projects.

(i) Poor processing and dissemination of climate information.

Access to quality climate information is an essential element in decision-making and planning for adaptation and resilience. Weaknesses in the processing and dissemination of climate information are a barrier to the availability of warning systems. The climate information communication system is limited and needs to be improved in order to make the information usable and accessible at local and community level. Climatic information linked to the agricultural calendar currently made available by the ONACC is not accessible to people in remote .

The weakness of the organisational and decision-making process for the early warning system limits the delivery of effective climate information services. Climate information is most useful when it is produced and understood following a dialogue between climatologists, local forecasters, intermediaries providing related support services and users such as farmers, livestock breeders, project and programme staff,

8.1.2. Technical obstacles

(ii) Poor access and technological mastery. Despite drought and climate variability, local people have no control over irrigation or the technologies that can promote irrigation and permanent access to water resources for communities. So adaptation to climate change opens the door to the use of new, innovative, sustainable technologies to adapt people's means of survival, such as the introduction of climate-resilient agriculture.

Poor mastery of restoration practices that are resilient in the face of climate change, resulting in poor execution of site restoration techniques.

8.1.3. Socio-cultural barriers

The cultural obstacles identified in the implementation of adaptation options are those linked to the perception of climate change by communities living near protected areas, a very low level of education and community conflicts.

People's perception of climate change differs from one culture to another. They may favour adaptation to climate change. The perception of climate change in some communities is based on superstition, so the solutions to late rains and drought are prayers and sacrifices (such as offerings to small children, animal sacrifices, etc.).

Inter-community conflicts are most often linked to the management of natural resources such as land, water, grazing, etc. There are conflicts between herders and farmers. Particular emphasis needs to be placed on the governance of land development plans.

Economic and financial obstacles

The economic and financial obstacles identified in the context of the implementation of adaptation to climate change are linked to the perception of green investment in sectors of activity such as agriculture as being high-risk. This perception favours : (i) Insufficient or lack of financial resources

(ii) Difficulties in mobilising financial resourcesThe f aiblesse or absence of a national budget allocated to climate change, these financial barriers in the Bakossi-Bambotos, Waza landscapes increase the vulnerability to climate change of the communities bordering the protected areas in these landscapes.

The weak development of the agricultural value chain and non-timber forest products, as well as the isolation of the three landscapes, make market access at national, regional and international level complex. Weaknesses in the processing of agricultural products and non-timber forest products are linked to poor mastery of processing and insufficient resources to access innovative technologies.

8.2. NEEDS TO IMPROVE RESILIENCE

To address the different categories of barriers to the implementation of adaptation options identified in the three landscapes (Waza, Dja-Lobéké, Bakossi-Banboutsos), several needs were identified during the primary and secondary data collection process.

At institutional level, this will involve :

- Improve the governance system to encourage the proper implementation of adaptation options. Compliance and monitoring of compliance with regulations are crucial to the implementation of adaptation actions around and within protected areas. The integration of adaptation options into management plans are tools for the sustainable management of forest ecosystems.
Building institutional capacity in terms of knowledge about adaptation to climate change.
- Technical aspects

Tackling technical obstacles means making knowledge and innovative technologies available to communities and institutions to help them become more resilient in the face of climate change. Agroforestry techniques and innovative irrigation technologies are being used by communities to make agriculture more resilient in the face of climate change. In the three intervention landscapes, agroforestry is still practised traditionally and could be improved to generate greater added value, particularly from non-timber forest products.

Agro-climatic information needs to be developed and disseminated for agriculture and land use activities in the three landscapes. To deal effectively with weather and climate risks through adaptive management and planning in land restoration activities, farmers need information on available water resources. The ONACC and other relevant stakeholders must have the appropriate resources to produce and disseminate climate information. The information must be translated into local languages to facilitate appropriation by the communities.

Financial and economic

- To deal with the lack of financial and material resources, the focus must be on opportunities for accessing climate financing in order to achieve the climate change adaptation objectives. There is an urgent need to seek sources of funding from international financial partners, such as the Green Climate Fund, the Adaptation Fund, etc. The development and modernisation of the agricultural value chain and non-timber forest products, will improve people's incomes and reduce their level of vulnerability to climate change.

Socio-cultural

- To deal with the socio-cultural obstacles linked to adaptation options such as reinforcement and awareness-raising, community awareness-raising on climate change issues will focus on the challenges and opportunities associated with climate change. The link between climate change and economic concerns needs to be clearly established to help people better understand the importance of climate action.
- Incentive or motivation systems must be developed for tree planting in order to encourage the restoration of forest ecosystems and degraded forest areas.
- Raising farmers' awareness of the use of climate-smart farming practices and building their capacity in this area in order to move them away from unsustainable farming practices. This activity will contribute to changing farmers' behaviour in order to improve the adoption of climate-smart farming practices. In this way, farmers will be able to guarantee their productivity.

CONCLUSION

This study on assessing the vulnerability and impacts of climate change in project landscapes involved identifying climatic events and their impacts on the agriculture, livestock, fisheries and forestry/forestry/wildlife sectors. This study is part of the *"Securing permanent forests to combat climate change and sustainably strengthen national and local economies in Cameroon"* project initiated by IUCN. It was carried out on the basis of field investigations and an in-depth literature review. The information obtained made it possible to assess the level of vulnerability by sector, identify adaptation measures, obstacles and needs to strengthen resilience. Levels of vulnerability vary according to sector and project landscape. The obstacles and needs related to improving people's resilience identified in this project are elements to be taken into account in the preparation and implementation of climate change resilience projects, so it is important to take into account the information available in this report in the preparation of projects in the study landscapes.

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