DOCTORAL THESIS

CLIMATE CHANGE IN THE MOUNT CAMEROON NATIONAL PARK REGION: LOCAL PERCEPTIONS, NATURAL RESOURCES AND ADAPTATION STRATEGIES, THE REPUBLIC OF CAMEROON

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ABSTRACT

Climate change is influencing indigenous communities in the Global South, and it is the object of a dominant global discourse. It is particularly important to pay attention to its impact on natural resources and people's livelihoods. Local knowledge on how forest-dependent households and communities, especially those in tropical areas, see, respond and adjust to climate change and events is useful in developing strategies to support livelihoods, biodiversity conservation, climate change adaptation and policies. However, local perceptions of climate change remain largely unexplored and are subject to various interpretations. This study analyses the perceptions of indigenous people around the Mount Cameroon National Park (MCNP) on the impacts of climate change on livelihoods and natural resources, and the adaptation strategies to climate change utilised by individuals, groups and communities in this regard. This is achieved through the use of quantitative and qualitative methods for data collection. The quantitative methods entail a questionnaire survey randomly administered to 200 respondents in the study villages. The qualitative methods include participatory rural appraisal (PRA) tools, analysed using MAXQDA software.

The research findings indicate that the MCNP region is endowed with fauna and flora species vital to indigenous livelihoods and the national economy, but they have decreased due to climatic and non-climate threats. The climate in the region has changed over time in terms of perceived temperature increase and rainfall decrease, but climate change is also affecting the occurrence and availability of forest products, especially those at lower altitudes and areas beyond the park's borders. In addition, climate change and extreme events are also affecting the infrastructure, culture and health of forest-dependent communities. Moreover, the study illustrates that climate change is negatively affecting access and user rights to forest resources, and inducing conflicts and tensions. The non-climatic processes influencing forest products' occurrence and sustainable livelihoods include globalisation, the commodification of forest products, increases in farming, deforestation and timber exploitation, unsustainable harvesting of forest products and the influence of non-indigenes. To ameliorate livelihoods and diminish the vulnerability to climate variability and change, the indigenous people of the MCNP region employ different adaptation strategies, and groups, governments and non-governmental organisations (NGOs) play an important role in enhancing adaptation. This study augments knowledge on the interconnectivity between local livelihoods, natural resources and climate vulnerability by depicting how indigenous people's vulnerability is related to the effects of climate change on biodiversity.

Keywords: Local Knowledge, Indigenous Perception, Biodiversity, Climate Change, Sustainable Livelihoods, Political Ecology, Adaptation.

ZUSAMMENFASSUNG

Der Klimawandel beeinflusst indigene Gemeinschaften im Globalen Süden und ist Gegenstand eines dominierenden globalen Diskurses. Von besonderer Bedeutung ist die Beschäftigung mit seiner Wirkung auf natürliche Ressourcen und die Livelihoods von Menschen. Lokal vorhandenes Wissen darüber, wie vom Wald abhängige Haushalte und Gemeinschaften – insbesondere in den Tropen – den Klimawandel und seine Folgen wahrnehmen, darauf reagieren und sich anpassen, ist nützlich für die Entwicklung von Strategien zur Unterstützung von Livelihoods, der Erhaltung von Biodiversität, des Umweltschutzes, von Anpassungen an den Klimawandel und von entsprechenden politischen Agenden. Dennoch sind lokale Wahrnehmungen des Klimawandels weitestgehend unerforscht und werden vielfach unterschiedlich interpretiert. Die vorliegende Untersuchung analysiert die Wahrnehmungen der indigenen Bevölkerung rund um den Mount Cameroon National Park (MCNP) hinsichtlich des Einflusses des Klimawandels auf Livelihoods und natürliche Ressourcen sowie die von Einzelpersonen, Gruppen und Gemeinschaften angewandten Strategien zur Anpassung an den Klimawandel. Dies wird durch den Einsatz quantitativer und qualitativer Methoden zur Datenerhebung erreicht. Die quantitativen Methoden umfassen eine randomisierte Fragenbogenerhebung unter 200 Teilnehmenden in den Studiendörfern. Die qualitativen Ansätze enthalten *Participatory Rural Appraisal* Methoden (PRA), die mit der Software MAXQDA analysiert werden.

Die Untersuchungsergebnisse deuten darauf hin, dass die Region um den MCNP eine Vielzahl an Tier- und Pflanzenarten aufweist, die unverzichtbar für indigene Livelihoods und die nationale Wirtschaft sind, die aber aufgrund klimatischer und nicht-klimatischer Bedrohungen abnimmt. Das Klima in der Region hat sich im Verlauf der Zeit gewandelt, dies wird an einem wahrgenommenen Temperaturanstieg und Niederschlagsrückgang festgemacht. Aber der Klimawandel beeinflusst auch das Vorkommen und die Verfügbarkeit von Waldprodukten, vor allem in tieferen Lagen und in Gebieten jenseits der Parkgrenzen. Darüber hinaus wirken sich der Klimawandel und Extremereignisse auch auf die Infrastruktur, die Kultur und die Gesundheit der von Waldprodukten abhängigen Gemeinschaften aus. Zudem zeigt die Untersuchung, dass sich der Klimawandel negativ auf den Zugang zu und Nutzungsrechte an Waldressourcen auswirkt und Konflikte und Spannungen hervorruft. Zu den nicht-klimatischen Prozessen, die auf das Vorkommen von Waldprodukten und auf nachhaltige Livelihoods Einfluss nehmen, zählen die Globalisierung, die Kommodifizierung von Waldprodukten, zunehmende Landwirtschaft, Entwaldung und Holz-Einschlag, die nichtnachhaltige Ernte von Waldprodukten und der Einfluss Nicht-Indigener. Um ihre Livelihoods zu verbessern und die Vulnerabilität gegenüber Klimaschwankungen und -wandel zu verringern, wendet die indigene Bevölkerung der Region um den MCNP verschiedene Adaptationsstrategien an, wobei diverse Gruppen, Regierungen und Nichtregierungsorganisationen (NGOs) eine wichtige Rolle bei der Verbesserung der Anpassung spielen. Diese Untersuchung erweitert das Wissen über die Wechselbeziehungen zwischen lokalen Livelihoods, natürlichen Ressourcen und Verwundbarkeit durch Klimaänderungen, indem sie aufzeigt, wie die Vulnerabilität von indigenen Gemeinschaften mit den Folgen des Klimawandels für die Biodiversität zusammenhängt.

Schlüsselbegriffe: Lokales Wissen, indigene Wahrnehmung, Biodiversität, Klimawandel, Nachhaltige Livelihoods, Politische Ökologie, Adaptation.

DEDICATION

Nothing is impossible with God (Luke 1:37), the champion of my destiny.
To Him I give all the Glory.

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LIST OF ACRONYMS AND ABBREVIATIONS

AR	Assessment Report
ASEA	Agro-Socio-Ecological Assessment
CBD	Convention on Biological Diversity
CB	Conservation Bonus
CC	Conservation Credit
CDA	Conservation Development Agreement
CDC	Cameroon Development Corporation
CF	Community Forest
CF	Cluster Facilitator
CM	Collaborative Management
CMA	Collaborative Management Approach
COMIFAC	Central Africa Forests Commission
COP	Conference of the Parties
CP	Cluster Platform
DED	Deutscher Entwicklungsdienst (German Development Service)
DFID	British Department for International Development
ERUDEF	Environment and Rural Development Foundation
FCPF	Forest Carbon Partnership Facility
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GNP	Gross National Product
GoC	Government of Cameroon
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HDI	Human Development Index
ICDP	Integrated Conservation and Development Project
IETA	International Emissions Trading Association
IIED	International Institute for Environment and Development
IISD	International Institute for Sustainable Development
IK	Indigenous Knowledge
IKS	Indigenous Knowledge System
IPCC	Inter-governmental Panel of Climate Change
IPU	Union Interparlementaire
ITK	Indigenous Technical Knowledge
IUCN	International Union for Nature Conservation
KPMG	Klynveld Peat Marwick Goerdeler
LNP	Lobéké National Park

MC	Mount Cameroon
MCNP	Mount Cameroon National Park
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MINEF	Ministry of Environment and Forest
MINFOF	Ministry of Forestry and Wildlife
MINEPDED	Ministry of Environment, Nature Protection, and Sustainable Development
MOCAP	Mount Cameroon *Prunus* Association
MP	Management Plan
NAPAs	National Adaptation Programme of Action
NC	National Communication
NC1	First National Communication
NEMP	National Environmental Management Plan
NGOs	Non-Governmental Organisations
NTAA	National Tribal Air Association
NTFPs	Non-Timber Forest Products
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
PE	Political Ecology
PSMNR-SWR	Programme for the Sustainable Management of Natural Resources, South West Region
RCCU	Republic of Cameroon Communication Unit
REDD	Reducing Emissions from Deforestation and Degradation
SCBD	Secretariat of the Convention on Biological Diversity
SDGs	Sustainable Development Goals
SL	Sustainable Livelihoods
SLA	Sustainable Livelihood Approach
SFM	Sustainable Forest Management
TEK	Traditional Ecological Knowledge
TIK	Traditional Indigenous Knowledge
TOUs	Technical Operations Unit
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environmental Protection Agency
USGCRP	United States Global Change Research Program
VFMC	Village Forest Management Committee
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

CHAPTER 1: BACKGROUND OF THE STUDY

1.1 General Introduction

Conducting research on local perceptions of climate change impacts on natural resources and indigenous livelihoods means telling a story about how individuals, groups and communities who are life witnesses to environmental processes understand and interact with their environment. It entails exploring in what manner those at the margins of forests, parks and mountains use and access the riches embedded in natural environments for their survival. It also requires understanding adaptation strategies employed to improve livelihoods and cope with environmental changes. Researching local perceptions is therefore a useful path via which scholars can theorise, bring to light and provide explanations on how local forest communities mostly affected by environmental changes interpret and cope with the challenges facing them. Individuals, groups and communities in this scenario are affected differently, perceive climate change effects diversely and employ different approaches to environmental changes based on their experiences, observations, culture and availability of assets.

Reading through the numerous literatures relating to this research, I deemed that this study not only requires "yes or no" responses, but it is also necessary to conduct in-depth interviews which "*produce thick descriptions [...] to produce elaborate and detailed answers*" (Rapley, 2007:15). Reflecting on how to arrive at such responses, I thought back to an interview I conducted with a woman called Mama Gentile, whom I encountered during one of my empirical research visits aimed at collecting data on commercialisation and the availability of non-timber forest products (NTFPs). Mama Gentile, in response to a question on natural resource occurrences, said the availability of certain NTFPs had altered, due to unstable seasons (Ntoko, 2015), thus implying she had knowledge of changes in her environment and perceived a certain rapport between seasonal changes and the natural resources vital to her livelihood. Hoping not to be grandiose in response to this example, what I wish to highlight is that:

> *"The entire world is faced with one challenge or the other. There is a global crisis [...] you must be conscious of its presence [...] challenge your perspective [...] realising that the environment is no longer the same.*"
>
> (Ibiyeomie, 2017:85)

It is broadly recognised that mountain forests and NTFPs contribute to the livelihoods and local development of many indigenous communities in Cameroon (Bele et al., 2010; Cosyns et al., 2011; Tingem et al., 2010; Awono et al., 2016). For the native population, forest products are a vital source of food, medicine, construction materials and income. This study focuses on local perceptions of climate change, due to increasing concerns over problems such as seasonal variations, loss of biodiversity and changing rural livelihoods. Those who, like Mama Gentile, live at the margins of forests have a story to tell – and in their own words. They are marginalised, vulnerable and more exposed to the effects of climate change (Inter-governmental Panel of Climate Change (IPCC), 2014), and they are conscious of the dynamics in their environment and produce knowledge from their beliefs, practices and personal and collective experiences. They are capable of recovering and representing indigenous accounts and positioning the effects of climate change in their livelihoods and value systems (Smith, 1999).

The crisis surrounding environmental change depicts a crisis of human livelihoods, especially of the poor – dependent on climate-sensitive natural resources and most often left with little or no alternative choices. It is a crisis which reshapes local space and the identity, culture and dignity of the poor whose voices are often not heard. The world cannot be inactive when millions of people are dying of hunger daily, conflicts over natural resources in the Global South are on the rise and climate change is reducing the pace of economic growth, affecting food security and creating new poverty traps (Olsson et al., 2014). The interconnectedness between climate variability and change, natural resources and indigenous livelihoods as depicted in this study needs to be addressed with due honesty, with the objective of enhancing the "*autonomy of local communities over their knowledge and resources*" (Escobar, 1998:59).

Climate variability and change are threatening food security in sub-Saharan Africa (Connolly-Boutin and Smit, 2016) despite the World Bank targeting the end of poverty by 2030 and enhancing affluence by promoting income growth for the 40 per cent poorest in each country's population (Olinto et al., 2013). In Cameroon, about 40% of the population is living on less than US$ 1.90 daily (Tingem et al., 2010; Fantom and Serajuddin, 2016), and in Africa as a whole, a significant proportion of people currently living in poverty are as deprived as their forebears who lived in insufficiency 30 years back. To end poverty by 2030, the international community has to mobilise resources and efforts and tap into local agency to provide highly efficient solutions (United Nations Economic Commission for Africa (UNECA) et al., 2012; Olinto et al., 2013). Poverty reduction and environmental and economic sustainability are fundamental pillars for development in the Global South, whilst natural resources, particularly forests, are vital for achieving these development goals (Sanginga et al., 2010; Niang et al., 2014).

One of the challenges facing Africa's development, particularly in Cameroon, is the fast depletion and extinction of natural resources stemming from many factors, climate change inclusive. This depletion has influenced natural resources quantitatively and qualitatively, thereby affecting poverty reduction and food security efforts and producing exceptional stresses on natural resources and indigenous livelihoods (Sanginga et al., 2010; Jalloh et al., 2011). Natural resources are interconnected with the livelihoods of most sub-Saharan African countries, contribute 26% of low income countries' wealth and are the basis of survival for human beings, especially forest-dependent communities (Bagine et al., 2010; Maranga et al., 2010). Though extreme poverty is reducing in Global South countries such as China and India (Olinto et al., 2013), the pace has been very slow in Cameroon.

Human interaction with the environment is dependent on perceptions of the socio-economic, political (Bender, 1993), environmental and climatic features which shape people's lives. In the wake of failed international responses, and governments such as the United States refusing to be signatories to the Paris Climate Accord (Conference of the Parties (COP) 21, 2015), an alternative is to return to the roots of human history, the 'decolonisation' of the vitality of local knowledge in resolving the 'climate-livelihood crisis'. It also means our beliefs in top-down approaches as best and 'untouchable' should give way to new perspectives of local perceptions as a panacea to the climate change crisis. This involves - as in this research - promoting and mainstreaming localocentric[1] perspectives, and 'bottom-up' approaches which are practicable, adaptable and suitable to capturing local realities.

The reality of climate change has shifted through human existence, according to scientific findings (Bobe et al., 2002; deMenocal, 2004; Harris et al., 2015), but the questions on how to address climate change, fight food insecurity and enhance natural resource sustainability remain unresolved in modern times. This suggests not only the inability of nations to find solutions to dealing with environmental issues in a durable manner, but also the fact that propositions

[1] *Localocentric* is coined by the researcher from the word *globalocentric* (Escobar, 1998). *Localocentric* perspectives here refers to the production of climate change and natural resources by local cultures, values, institutions, and grassroots actors. It means providing political representation of biodiversity loss and climate change impacts that emphasis on the causes of modernisation, globalization, inequality, domination and territorialisation of natural spaces.

provided by Western knowledge have proven skewed despite the available literature. The idea of climate change, though often poorly documented in the Global South, undoubtedly expresses the link between human livelihoods and the environment. Thus, changes in our natural environment have to be uncovered, since natural resources, the climate and humans coexist, i.e. they "*co-produce each other; like culture and identities they are relational*" (Escobar, 1999:5).

Natural resource access is the subject of conflict and contestation in the struggle for survival, albeit with varied intensity depending on the value of the resource and its social, political and cultural attachments. Academically, one may ask how local perceptions relate to new challenges posed by climate change, biodiversity and access to resources. This notion is based on the assumption that there is no unified answer, since local representations of nature do not see a divide between people and nature (Escobar, 1999), and natural and human regimes are fixed in a socio-economic community exposed to the same rules (Descola, 1996), thereby implying that people's perceptions which shape their destiny are grounded in local models of nature (Ibiyeomie, 2017). The focus of this study is therefore to explore the vulnerability of humans to climate change by comprehending indigenous perceptions of the interface between climate change and natural resources, and climate adaptation strategies undertaken to protect the ecosystem and enhance livelihoods in the MCNP region. To achieve this goal, a multidisciplinary review of the major theoretical approaches (see Chapters 2 & 3) of political ecology, sustainable livelihoods, as well as concepts of (local) perceptions, adaptation and climate change, is undertaken to provide insights into the state of existing literature.

1.2 Problem Statement and Research Gap

The range of climate variability and change impacts over the past decades illustrates that the African continent is most vulnerable to climate change (IPCC, 2001). A great deal of information on climate and vegetation change in Cameroon comes from satellite images, and currently, no weather station is available in the Mount Cameroon (MC) region. Nonetheless, the virtual presence of cloud cover hinders the availability of reliable images on vegetation change (Maschler, 2011). Furthermore, vigorous approximations on changes in natural resource availability, abundance and impacts on local livelihoods over time do not exist (Linder and Oates, 2011), and little information is available from grassroots sources, i.e. from those who are really affected by climate change (Ludwig et al., 2013). Current research on climate change in Cameroon mostly centres on agricultural and physical ecosystem impacts on national and regional scales. In addition, the MCNP is relatively young, created in 2009 to meet the need for more research and to justify information gaps. Placing more emphasis on the effects of agriculture, population increase and agro-industrial plantations on the park's resources, as highlighted in the management plan (Ministry of Forestry and Wildlife (MINFOF), 2014), is problematic and does not provide a multidimensional view of threats facing protected areas. Consequently, local perceptual knowledge, including social aspects of climate change and the important role of native people affected more by climate change, is silent.

It is widely accepted that the effects of climate change are felt differently by individuals, groups and communities, due to unequal access to forest resources, power relations and lack of capital (Otzelberger, 2014; Djoudi et al., 2016). Furthermore, research shows that even though Cameroon has witnessed temperature variations since 1930 (Molua and Lambi, 2007; McSweeney et al., 2009; Din et al., 2016), policies and strategies on forestry produce generalised perspectives on sustainable forest management and do not distinguish climate variability challenges vital for inclusion in management strategies (Bele et al., 2011). The reason for this situation is that institutions have poor and weak ability to deal with environmental and adaptation issues, aligned with the non-endorsement of local agency (Adams et al., 1995). Moreover, except for the First National Communication (NC1) to the United Nations Framework Convention on Climate Change (UNFCCC), policy documents in Cameroon and Management Plan (MP) of the park are void of any tangible reference to climate change. In addition, forest policies are grounded in rigidity that hinders efficiency and does not provide specificities on climate change impacts and coping strategies (Bele et al., 2011). This approach thus fails to recognise the consequences of climate change on natural resources and livelihoods or to outline the relevance of local perceptions on climate change and local adaptation strategies. There is thus a need to document local knowledge on climate change which, according to Lema and Majule (2009), is not often recorded but is handed down through oral history and local expertise. This entails – as in this research – approaching the issue of climate change in a representative manner by exploring its positioning in the human-nature equation, as well as the manner in which it affects natural resource occurrences and utilisation and changes local livelihood strategies and outcomes, access to natural resources and the natural landscape.

Numerous researches in the MCNP region have explored the vulnerability of biodiversity by concentrating on unsustainable harvesting and the commercialisation of NTFPs, livelihoods, population increase and the territorialisation of forests (Lawrence et al., 2000; Ambrose-Oji et al., 2002; Ambrose-Oji, 2003; Lambi and Kometa, 2009; Fogwe and Tanyi, 2010; Eben, 2015; Lambi and Moto, 2016). These authors using qualitative approaches have enhanced knowledge on the importance of biodiversity in terms of local livelihoods and threats to forest products, but they fail to address the climate change dimension of the problems mentioned in Section 1.3. Moreover, Brown et al. (2010) studied institutional adaptive capacity and climate change responses in the Congo Basin Forests of Cameroon by questioning NGOs with an online survey. Though they documented that climate change is affecting the native population and biodiversity, the focus of the research and results was narrow, since the perspectives of experts could be biased and not truly reflect the views of people who are witnesses to extreme events and dependent on forest products for their livelihoods. Furthermore, MCNP is not part of the Congo Basin string of forests, and thus results in this area cannot be generalised to the MCNP region. In addition, Defang et al. (2014) studied the impacts of climate change on crop production and the development of the Muyuka subdivision in Cameroon, whilst Azong (2018) researched gender and vulnerability in the Bamenda highlands regions of the country. They both registered that climate change is a major risk to farmers' livelihoods, since farming is their principal source of food and income. Moreover, Ngane et al. (2012) studied the seasonality of NTFPs in the Kupe Mountain region, Cameroon. Using a qualitative approach, they documented that NTFPs are available either in the dry or the wet season or all year round, but they failed to address the effects of changes in seasonality on NTFPs and indigenous livelihoods.

Besides, Lambi and Ndenecho (2010) conducted a climographic inquiry and mapping of the MCNP region. The study was quantitative in nature and based on information provided by the Cameroon Development Corporation (CDC) meteorological service, accompanied by research by Fraser et al. (1998). From my field experience in the region, rainfall and temperature data from CDC are very inconsistent, in that they focus mostly on rainfall and do not represent the entire region. The authors documented that the MCNP region is undoubtedly endowed with varied and rich biodiversity, but the range of climate conditions over the mountain, and its great influence on biodiversity through complex relationships, cannot be unfolded without more climate information. Furthermore, the research revealed that climate change is a threat to biodiversity, and more climate- and biodiversity-related research is needed in the area. In my opinion, saying that climate change is a threat to forest ecosystems, without stating how and why, is too general and shallow. In addition, the authors' recognition of the need for more research is an indication that quantitative approaches are limited in providing a representative picture of the climate situation in the region. Thus, there is a need for perceptual knowledge to enhance understanding on biodiversity and climate change links, as followed in this study. Moreover, Clée et al. (2014) analysed the dynamics of the Nigeria-Cameroon Chimpanzee (*Pan Troglodytes ellioti*), revealing that climate change is affecting the species' habitat as well as the genetic and sub-species population. Their focus on only one fauna species hides the vulnerability of other species which are also part of the forest ecosystem. Although these studies explore the effects of climate change on biodiversity, the quantitative approach used is narrow in illuminating how climate change is affecting fauna and flora and the livelihoods of forest communities and adaptation strategies undertaken to mitigate exposure to climate effects. Due to the limitations of quantitative approaches to examining the vulnerability of biodiversity and rural livelihoods to climate change, some authors have suggested that indigenous perceptions of vulnerability and resilience should be the focus of new studies (Hunter 2009; Jones and Tanner, 2015).

It is evident from the literature review that in-depth and comprehensive research is lacking on local perceptions of the effects of climate change on natural resources, livelihoods and local adaptation strategies in the MCNP region, and Cameroon in general. This could thus inhibit the disclosure of the intricacies in people's vulnerabilities (Azong, 2018). The focus on local perceptions is necessary, because indigenous people interact regularly with their environment and comprehend their conditions better than others (Berkes, 2009; Jones and Tanner, 2015). Furthermore, local perceptions are diverse, since they are shaped by local economic and religious experiences, by cultural and personal values and by hybrid knowledge (Blennow and Sallnäs, 2002; Descola, 2005), thereby making them suitable for enlarging comprehension of how forest-dependent communities are vulnerable to climate change, and their adaptation strategies.

Against this backdrop, I decided to use a variety of tools and techniques (both quantitative and qualitative) – as discussed in Chapter 4 (methodology), which presents a detailed discussion on the processes, methods and techniques employed in this study. The use of mixed methods was deemed necessary, since no single approach could capture the climate change and livelihood nexus. Also, the perceptual approach was chosen for this study based on the notion that indigenous people should be given the space to narrate their personal and collective experiences, since they are capable of comprehending and presenting changes in their environment (Jones and Tanner, 2015). The vitality of local perceptual knowledge in this research is exposed in

Chapter 3 through discussions on the state of the art and conceptual frameworks. To explore effectively perceptual knowledge in this research, the questionnaire survey and PRA techniques were chosen. Despite the use of a questionnaire survey to provide a quantitative outlook for the research, more focus was on PRA techniques appropriate for indigenous perceptual studies and vulnerability analysis, in order to capture a broad understanding of local people's livelihoods (Tiani et al., 2015). Inspiration was drawn from the Climate Variability and Capacity Analysis (CVCA) framework, which makes use of scientific and local techniques applied to climate variability and change research (Dazé et al., 2009), and Community-based Risk Screening Tool-Adaptation and Livelihoods (CRiSTAL) (IISD, 2012), which focuses on participatory methods. Both frameworks and methods are elaborated in Chapter 4.

In line with the above, this study seeks to explore local perceptions, in order to comprehend the occurrence of forest products and their influence on rural livelihoods, the connections between climate change and natural resources, the vulnerability of indigenous peoples to climate change and the adaptation strategies undertaken, by using the 'Perceptions, Climate Variability and Change, Biodiversity, Livelihoods and Adaptation' (PCVCBLA) framework, a multidisciplinary approach designed for the study. As evident from its appellation, the framework was conceived by using multiple themes and concepts relevant to the study, and it is examined in Chapter 3. Furthermore, the Sustainable Livelihoods (SL) and Political Ecology (PE) approaches are also discussed in Chapter 3. The concepts and themes elaborated in Chapter 3 are used in data interpretation and discussions (Chapter 6) to provide meaning to the data. This study aims at contributing to knowledge on local perceptions and climate variability and change by means of exploring and discussing indigenous contributions to knowledge gaps in the vulnerability of humans to climate change impacts, the climate change and natural resource interface and climate adaptation strategies. The overall goal of this research is divided into the objectives and research questions outlined in the following section.

1.3 Research Goal, Objectives and Research Questions

The goal of this study is to explore local perceptions of climate change effects on natural resources and the adaptation strategies of communities dependent on these natural resources in the Mount Cameroon region. The objectives and questions are as follows:

Objective 1: Explore biodiversity availability and utilisation.

- What forest resources are used by local communities and for what purposes?

- How have forest resource availability and utilisation changed and why?
- How have changes in forest resource availability and utilisation affected people's livelihoods?

Objective 2: Analyse local perceptions and experiences of climate change

- How does the climate in the region change according to local perceptions?
- How is climate change perceived, and what are the observed factors and future expectations of climate exposure in local communities?
- What historical occurrences and major events reflect climate change in the area?

Objective 3: Explore local perceptions of climate change impacts on biodiversity and livelihoods

- What perceived changes in biodiversity are caused by climate change?
- How do climate-induced changes to biodiversity affect livelihoods?

Objective 4: Analyse power relations concerning biodiversity

- How has climate change affected forest resource access across groups and individuals?
- How are climate-induced forest resource changes reflected in social struggles and conflicts?

Objective 5: Study adaptive measures and practices taken to maintain biodiversity

- What are the short- and long-term adaptation measures and practices undertaken by groups, individuals and communities?
- How do adaptation strategies enhance people's livelihoods and the ecosystem?

1.4 Study Justification

Research on climate-related problems requires precise information since problems vary depending on the geographic location (Salick and Byg, 2007). Experience shows that actual adaptation activities do not provide expected changes, because locations encounter different challenges to adaptation (IPCC, 2007). Furthermore, current studies on climate change, livelihoods and natural resources cannot be generalised to include the MCNP scenario, due to the following reasons: people's livelihood strategies and vulnerability to climate change vary, ecological differences signify that coping strategies and the impacts of climate variability on these approaches will also differ and local climate disparities suggest that the consequences would be witnessed differently in different settings (Saarinen et al., 2012).

The Government of Cameroon (GoC) depends on natural resource assets to enhance growth and economic stability in the country. The management of environmental resources falls outside climate change adaptation and attention, and the government's main focus is on job creation and poverty reduction (Bele et al., 2009). This study, focusing on climate change and natural resources, informs stakeholders on the interdependence between poverty, livelihoods and climate change, and the need to tackle these issues from a multidimensional perspective.

The relevance of this study is further illuminated by the fact that notwithstanding various arrangements geared towards enhancing knowledge on climate variability and change in the Global South, some scholars do not acknowledge that perceptual information is vital due to its ability to produce deep appreciation and comprehension of local ecological resources by grassroots stakeholders and that such capabilities have often served as the basis for useful ecological management regimes (Bryant and Bailey, 1997). Consequently, research and monitoring are grounded on canopy cover with minimal appreciation of what is happening under the canopy (Ludwig et al., 2013). This study jointly examines climate variability and change and natural resources in relation to people's livelihoods, and from their perspectives, thereby providing a representative picture useful to scientific communities, NGOs and policymakers seeking to address issues related to climate change, livelihoods and natural resources in the Global South.

The importance of this research was illustrated in the problem statement in Chapter 1, which portrays the necessity for more comprehensive information on the vulnerability of biodiversity and indigenous livelihoods to the impacts of climate change and local adaptation strategies. In addition, in the MC region, a rapid agro-socio-ecological assessment (ASEA) was carried out in 2012. These ASEA studies may not represent the actual situation on the ground, due to a dynamic and evolving environment, so there is need for fresh research on ecological and socio-economic elements, to guide natural resources management in the region. As mentioned earlier, during my empirical field research in the MCNP region, I realised that climate data in the area are not very consistent. The weather station at the University of Buea, Cameroon, is not operational, and climate data in the region come from the CDC, which owns agro-industrial plantations in the region, and the Tole Tea Estate. These meteorological stations are not fully operational and consistent, and they focus on climate aspects relating to agriculture but not to mountain ecosystems. Though the data from CDC are often generalised to other regions, they are not representative of the different ecological scenarios. This limitation of weather data was also identified in a study by Lambi and Ndenecho (2010), and so the present study complements data and contributes to knowledge by exploring local perceptual knowledge on climate change, historical occurrences and climatic events not often recorded.

Moreover, research and monitoring techniques in most protected and forested regions are based on bio-monitoring by staff, observations using cameras and range-based monitoring using cyber trackers (MINFOF, 2014). These activities are not often carried out on a regular basis, due to lack of finances, staff, equipment and expert knowledge. In some protected areas, MC in particular, the monitoring of mammals is done every five years to estimate populations, changes over time and anthropogenic effects, but although stipulated in the MP of the park, this is not always the case (MINFOF, 2014). Monitoring is also carried out for *Prunus Africana*, a highly economically valuable plant, which implies that other less economically valuable species are not researched or monitored. Also, research and monitoring techniques are not without limitations. Therefore, information from native communities on ecosystem changes and people's livelihoods are vital for park management, the evaluation of conservation efforts and future adaptation strategies, because indigenous people interact with the natural environment on a "daily" basis and thus have "first hand" information on alterations in their environment.

1.5 Thesis Structure

This thesis consists of seven chapters: the background of the study, contextual analysis, literature review and conceptual framework, methodology, data presentation and analysis, discussion and interpretation of findings and, finally, synthesis, conclusion and recommendations.

In addition to Chapter 1, Chapters 2 and 3 provide general inputs into the main research themes and concepts, thereby enhancing understanding of climate change and its impact on indigenous livelihoods and forest biodiversity, and the adaptation actions taken by local populations to minimise vulnerability. Chapter 2 presents Cameroon geographically on the national, regional and international scales, and it examines the importance of forests to local and national economies. Moreover, the chapter discusses climate change in Africa generally and Cameroon particularly and examines the risks and vulnerabilities it presents to the local population and the environment. Also, the review of literature specific to the MCNP region helps comprehend the location of the MCNP, the climate of the region, the area's biodiversity and importance and the socio-economic lives of the local population. It also explains biodiversity management and approaches used in the region.

Chapter 3 discusses contributions relating to indigenous livelihoods and natural resources and vulnerability to climate change. It examines concepts related to the study and their relevance. The discussions in Chapter 3 suggest that more research is essential to contextualise indigenous people and biodiversity vulnerability in terms of the impacts of climate variability and change in different societies. Due to the multidisciplinary nature of the research, I realised that the Sustainable Livelihood framework would not provide a comprehensive picture of the research problem. The PCVCBLA framework was thus designed by me, for this study. It is useful for studying the interconnectivity between indigenous livelihoods, natural resources and climate change, as well as adaptation strategies and livelihood and environmental outcomes.

Chapter 4 describes the procedure and methods used in this research. It presents the sampling procedure, criteria for study area and village selection and the rationale for taking a mixed methods approach (quantitative and qualitative methods) in the Mapanja, Likombe, Bokwaongo and Bova communities of the MCNP region. The research design and methods consist of PRA tools: stakeholder and expert interviews, focus group discussions, oral history, livelihood and vulnerability analysis, a transect walk, a questionnaire survey and triangulation. Also, this chapter explains the CVCA and CRiSTAL frameworks and tools vital to conducting research on the vulnerability and livelihoods of forest-dependent communities. The chapter also sets the background for data analysis and explains the use of MAXQDA software for qualitative data and the Excel program for quantitative data. The chapter further explains the challenges faced during the research, and the forthcoming solutions applied to enhance validity, objectivity and representativeness, and to reduce bias.

The data analysis and presentation chapter (Chapter 5) describes the study population and their perceptions of temperature and precipitation trends over the past 20 years. It examines indigenous people's understanding and reading of climate change and how they perceive future climate conditions, and it portrays that extreme events have affected the livelihoods and biodiversity of the region. Also, the chapter presents the vulnerability of livelihoods and forest products to climatic and non-climatic threats. Furthermore, it explores the influences of climate change on access and rights (use and tenure) to forest resources, social struggles and tensions, as well as group, individual and institutional efforts expended to diminish the impacts of climate change.

Chapter 6 gives more meaning to the empirical data by juxtaposing it with the existing literature and providing the implications for climate change and adaptation strategies to indigenous livelihoods and biodiversity in the MCNP region. Finally, Chapter 7 recaps the main research findings, outcomes and the contribution made by this research to understanding the vulnerability of indigenous people and biodiversity to the impacts of climate change and adaptation strategies in the face of climate change challenges. It also provides a conclusion to the study and makes recommendations for future research geared towards reducing the impacts of climate variability and changes to livelihoods and ecosystems.

1.6 Conclusion

Chapter 1 has provided the general background to the study. It sets the stage by explaining the importance of perceptual knowledge and local agency in climate change, biodiversity and indigenous livelihood research. Through Mama Gentile, it depicts that the environment and indigenous livelihoods are influenced by climate variability and change, and native people are better placed to see and present changes in their particular environment. The chapter also expresses that the poor in the Global South are most affected by climate change, since they are dependent on climate-sensitive forest products and have little or no alternatives for survival. Also, climate change is an obstacle to national and international development in current times. In addition, the chapter expresses that climate change, livelihoods and ecosystems are interlinked, and climate change influences local livelihoods through its effects on access and user rights to forest resources and conflicts induced by the need for survival.

The chapter further expresses the inability of nations to arrive at a consensus on climate change issues, whilst top-down approaches are unable to provide comprehensive answers to climate change challenges, thus the need for local perceptual knowledge and research. The chapter uses existing literature in the research area and elsewhere to identify the research problem and gap, and it depicts the need for more climate research in Cameroon and the MCNP region in particular. It expresses the limitations of both qualitative and quantitative work already carried out relating to climate change, and it justifies the study to governments, conservationists and policymakers. Finally, it presents the thesis structure, to outline subsequent information throughout the thesis. The next chapter (Chapter 2) provides the contextual analysis and framework of the study.

CHAPTER 2: CONTEXUAL ANALYSIS

2.1 Introduction

Chapter 1 expressed that climate variability and change influence the livelihoods of indigenous people who are already living in insufficiency. The effects are felt more by forest-dependent communities, due to changes in forest product availability and access, conflicts, loss of biodiversity and the limited ability to adapt to changes. The previous chapter also presented the research goal and objectives, identified the research gaps and contextualised the research problem. It expressed that local perceptual knowledge on the impacts of climate variability and change is insufficiently recognised in the Global South. This is predominantly evident in the sector of forest ecosystems vital to the livelihoods of forest-dependent communities vulnerable to climate change. Chapter 2 presents a contextual analysis of the research and is divided into six sections. In addition to the introduction, it presents Cameroon geographically, followed by a discussion of forests in the country and their contributions to local and national development. Next, the chapter describes Cameroon's climate by looking at both the African and national scenarios, and the climate risks and vulnerabilities facing Cameroon. It then examines the MCNP region by depicting its climate and rich biodiversity, the socio-economic lives of the people and the management of forest resources in the region. Lastly, the conclusion recaps on the major ideas discussed in the chapter.

2.2 Setting the Context

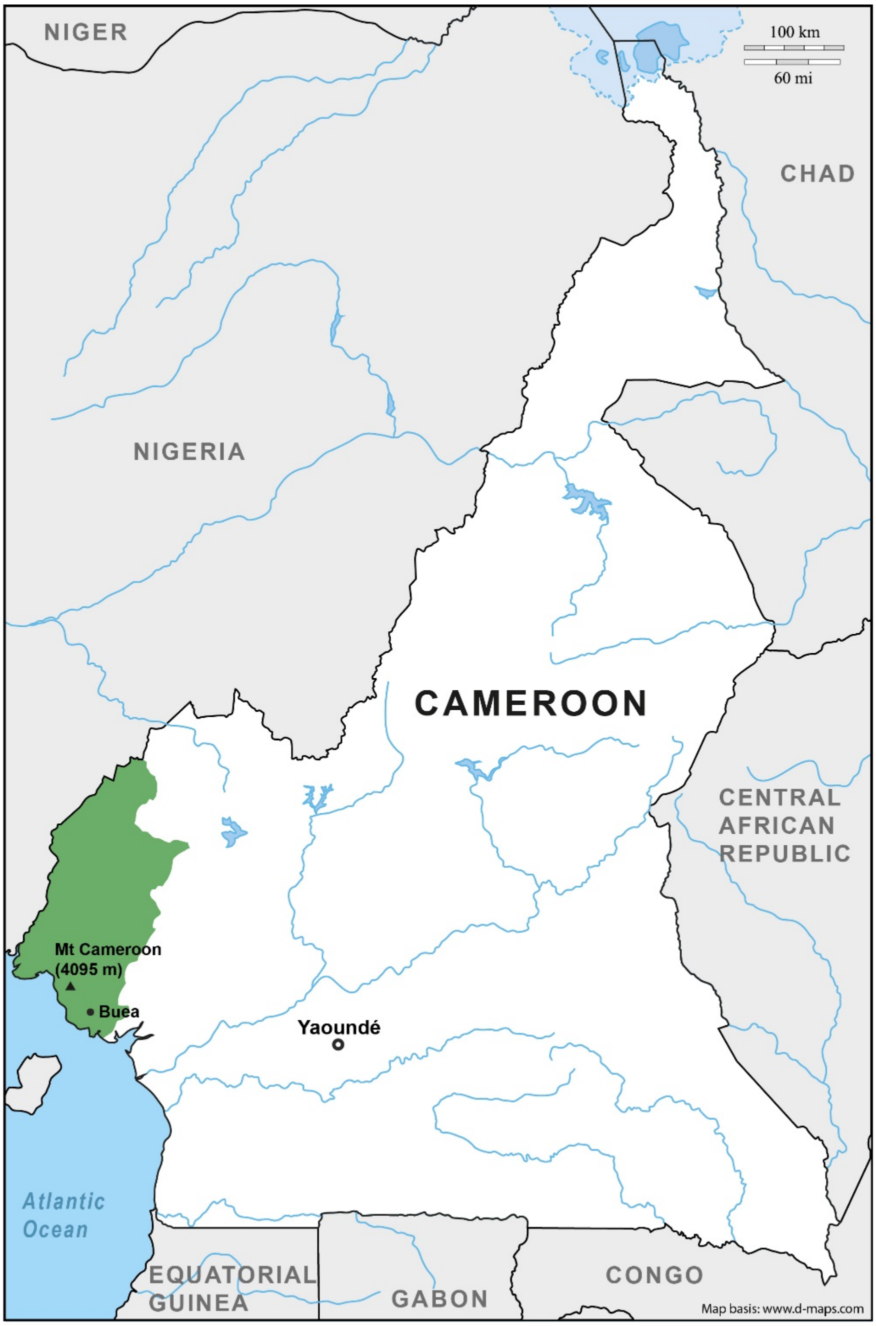
Cameroon (Figure 2.1) stretches in latitude between 1°40' to 13°05' N, 8°30′ to 16°10′ longitude east with a surface area of 475,000 km^2 (Foahom, 2001; Tchindjang, 2012; Gaymard et al., 2015). It is situated in Western and Central Africa, along the coast of the Gulf of Guinea and has the following neighbours: Nigeria, Equatorial Guinea, Gabon and Congo Republic, Central African Republic and Chad, and Lake Chad (Republic of Cameroon Communication Unit (RCCU), 2015; Taylor, 2015). It is one of the 52 nations that constitute sub-Saharan Africa (Tingem et al., 2010) and is made up of ten regions (two Anglophone and eight Francophone regions), approximately 25 million inhabitants and 250 ethnic groups, each with its own dialect, involved in varied socio-economic activities (Foahom, 2001; Tedonkeng, 2008; RCCU, 2015). Cameroon is classified as a low-to-middle-income country (Olinto et al., 2013). It is politically relatively stable but has suffered from economic crisis since the mid-1980s (Foaham, 2001). Furthermore, it is classified as 172nd out of 229 countries in the world in terms of per capita income (Fantom and Serajuddin, 2016). The next section illustrates the vital nature of forest ecosystems to local livelihoods, and the challenges facing the forestry sector in Cameroon.

2.3 Forests in Cameroon

In Cameroon, mountain forests' goods and services contribute about 80% to safety and daily nets for local communities, and they are consequently vital to the country's development, reducing poverty and enhancing climate adaptation (Bele et al., 2010; Gaymard et al., 2015). Between 2008 and 2010, the forest sector contributed 2.7% gross domestic product (GDP), NTFPs provided 76.3 billion FCFA (FCFA refers to Franc Communauté Financière Africaine) per annum, with 14 billion FCFA consumed by households, local bushmeat contributed 16.1 billion FCFA annually and tourist revenue (park entry fees) accounted for about 2.1 billion FCFA in 2009 (Eba'a Atyi et al., 2013). In 2013, state revenue from logging was about US $ 18.9 billion (RCCU, 2015). Most of the poor live in rural regions and depend on forest products and agriculture for their livelihoods (Tingem et al., 2010). Problems faced by the forests include ecosystem deterioration, deforestation, a decrease in NTFPs and wildlife, bush fires, land degradation and population increase (Bele et al., 2009; Molua, 2009; Awono et al., 2014).

Cameroon's forests are part of the Congo Basin forest system, the second largest rainforest in the world after the Amazon rainforest (Bele et al., 2010). It is home to rich and diversified natural resources: about 9,000 plant species (630 timber species of potential commercial value), 900 bird species, 280 mammal species, 168 reptile species and 542 fish species (Essam, 2001; Foaham, 2001; National Biodiversity Strategy Action Programme of Cameroon (NBSAP), 2002; Global Forest Watch (GFW), 2003; Lambi et al., 2012). Cameroon has 30 protected areas, accounting for 47% of the national territory. These protected areas cover about 23 million hectares (Tchindjang and Fogwe, 2009; MINFOF, 2014). Forest vegetation is found in seven out of ten national regions, extending to the thick tropical rainforest in the south and the Sudan and Sahel savannah in the north (MINFOF, 2014). Though defined as identified, distinct and not disturbed (17.5 million hectares), about 4.5 million is degraded (Foaham, 2001) and 2% of the total number of species become extinct or risk extinction yearly (Eba'a Atyi, 2000).

Figure 2.1: Map of Cameroon and neighbouring countries



Draft: V. Ntoko, Cartography: S. Hufeld

The forest contributes to general ecological stability by protecting watersheds, reducing greenhouse gas emissions and averting erosion and soil dilapidation. The 1994 Forestry Law recognises this importance in its expression that Cameroon's forests symbolise the nation's wealth and contribute to growth and general economic equilibrium. Despite the important role of forest resources in Cameroon, forestry is not a mainstream factor in poverty reduction and climate change policies and schemes (Bele et al., 2010). The following section examines climate change in Africa and Cameroon, and the exposure of humans and biodiversity to it.

2.4 Climate Change in Cameroon

2.4.1 The African Context

Africa's climate is greatly diverse and variable (Conway, 2009), with sustained increases in temperature documented in most regions (Seneviratne et al., 2012). The scale and occurrence of extreme weather incidents has had detrimental effects on livelihoods, natural resources and food security (IPCC, 2014). Across West Africa, changes in rainfall patterns and a rise in extreme precipitation and events have been predicted (Seneviratne et al., 2012; Vizy and Cook, 2012), and throughout the 21st century, temperatures are expected to increase quicker than the global average rise, and rainfall alteration patterns are predicted to continue alongside sea level rise and regular occurrences of droughts and floods (Joshi et al., 2011; James and Washington, 2013; Juana et al., 2013; Engelbrecht et al., 2015). Africa's climate consists of the extremely dry Saharan deserts and the humid Congo rainforest. These natural regimes intermingle with anthropogenic climate change, making it a challenge to distinguish one reason for change from another. African temperature and rainfall patterns are determined mainly by the tropical convection and oscillation of the monsoons, but the El Niño-Southern Oscillation of the Pacific Ocean, albeit relatively rare in nature, intensely impacts annual rainfall and temperature patterns on the continent (Conway, 2009).

2.4.2 Main Climate Categories in Cameroon

According to the GoC (RCCU, 2015), Cameroon comprises two climatic regions, namely equatorial and tropical. The equatorial climate is subdivided into a) the Guinea type, characterised by two rainy seasons and two dry seasons and rainfall ranging from 1,500 to 2,000 mm per annum, and b) the Cameroon category near MC, where the south-western coast extends to the Sanaga River, the Western and Bamenda Highlands. This area is moist and warm, has a long rainy season of approximately eight months and a short dry season. Cameroon is home to maritime and montane regimes. The former occurs from the coast to the Nyong River, and the seaward side of MC is prone to heavy monsoon rains and counts Debundscha (10,000 mm rainfall yearly) as the second rainiest region in the world. The montane region in the Western Highlands (Buea, Dschang and Bamenda) is characterised by colder temperatures. The tropical zone consists of the Sudanese and Sudano-Sahelian zones. The moist tropical Sudanese climatic region is about 7° to 10° north of the equator and comprises the classic Sudan and Sudano-Guinean types, characterised by low and heavy rainfall and higher than average temperatures of about 22°C, respectively.

2.4.3 Climate Change in Cameroon: Risks and Vulnerability

The southern parts of Cameroon are humid and equatorial, whilst the northern sections are semi-arid. The semi-arid north is the warmest and driest section of Cameroon, with temperatures of about 27°C in the cold seasons (McSweeney et al., 2009). The wetter season generally runs from May to November, but the southern plateau area has two shorter precipitation periods, i.e. May to June and October to November. The drier periods prevail for the other months (Ngakfumbe, 1989; Ngakfumbe, 2001; McSweeney et al., 2008). The mean yearly temperature has risen by 0.7°C since 1960, and existing data portray hotter days annually, with an increase of yearly hotter nights to 21.2% between 1960 and 2003 (McSweeney et al., 2008; McSweeney et al., 2012).

Precipitation is unequally distributed, depending on proximity to the sea, latitude and altitude (RCCU, 2015). The mean yearly rainfall has declined by about 2.9 mm per month and 2.2% per decade (McSweeney et al., 2012). The northern sections encounter more drought and the south-west coastal and rainforest sections see more floods. People living in towns and villages feel that days and nights are much hotter than in the 1970s, and variations in rainfall have caused unanticipated and widespread floods in northern Cameroon and Douala (Ayonghe, 2001). Moreover, regional model research indicates the recurrent incidence of extreme precipitation over the Cameroon Mountains (Haensler et al., 2013). Despite the projected increase in temperatures, there is the lack of unanimity on mean annual rainfall figures in Cameroon, due to the absence of adequate information necessary to arrive at such conclusions (Niang et al., 2014).

Projections for 2060 show a temperature increase of 1.8°C and a precipitation decrease of 559 mm. At this rate, many plants and animal species might shift 90 kilometres polewards, and those unable to adapt will die (Ayonghe, 2001). Environmental effects of global warming and climate change in Cameroon include the drying up of streams, springs and rivers (Ayonghe, 1998), saltwater challenges in coastal regions, due to the reduced influx of fresh water, the extinction of ecosystems and heatwaves and their effects on humans (Ayonghe, 2001). Climate change presents new challenges to sustainable development, and it threatens the attainment of Millennium Development Goals (MDGs) and progress already made in the struggle against poverty and food security (Molua, 2002; Nkem et al., 2007; Organisation for Economic Co-operation and Development (OECD), 2017). Studies on climate change portray that Cameroon is affected in the sectors of agriculture, forestry, infrastructure and health (Molua, 2002, 2009;

Bele et al., 2010; Lambi and Ndenecho, 2010; Nkem et al., 2010; Balgah et al., 2015), while the Cameroon Mountains have witnessed hazards such as landslides, biodiversity loss, floods, earth tremors, eruptions, drought and insect invasions (Lambi et al., 2001; Tchindjang, 2012). The government's efforts to deal with climate change and ensure a smooth regime of sustainable development are complicated by the population's high dependence on climate-sensitive natural resources for survival and agriculture, increasing poverty and poor local governance (Molua and Lambi, 2007; Molua, 2008; Taylor, 2015; Din et al., 2016).

Furthermore, research on climate vulnerability highlights that virtually all forest sites in Cameroon are changing as a result of variations in temperature and precipitation, accompanied by food insecurity, loss of habitat, changes in the productivity and availability of NTFPs, a reduction in the water table, the disappearance of ecosystems and fragmentation (Ayonghe, 2001; Ngwa and Fonjong, 2002; Brown et al., 2010; Lambi and Ndenecho, 2010; Bele et al., 2011; Guariguata et al., 2012; Clee et al., 2014; Ndoh et al., 2016). Studies by Brown et al. (2010), Guariguata et al. (2012), Kimengsi et al. (2016) and Ndoh et al. (2016) showed that native populations are aware of climate change and realise that it is affecting their livelihoods. The effects have been seen on sources of livelihoods (forests, agriculture), with significant additional impacts on biodiversity (changes in the range, habitats and risk of extinction of plants and animal species). The authors indicate that changes in biodiversity are affecting indigenous hunter-gatherer societies differently than farmers. Also, climate change effects on biodiversity are causing population migration from the north to the south of Cameroon – with consequent pressure on natural resources (Brown et al., 2010).

Furthermore, climate change presents a risk to endangered species such as chimpanzees, as it modifies their habitats. A group of researchers studied the Nigerian-Cameroon chimpanzee (*Pan Troglodytes ellioti*), the most threatened sub-species found in the Gulf of Guinea biodiversity hotspot in Western Equatorial Africa. The population in Western Cameroon occupies the mountainous rainforest, while that of Central Cameroon lives in the forest-woodland savanna (mosaic habitat). This species is endangered by habitat fragmentation caused by climate change. The study established a link between environmental changes and genetic variations embedded in chimpanzees of this region. The *Pan troglodytes ellioti* in Central Cameroon, which denotes half of the sub-species population, is expected to encounter severe changes in ecological habitat by 2020, 2050 and 2080, due to climate. The mosaic habitat will decrease by 2020 and be extinct by 2080 (Clee et al., 2014). The preceding section (Section 2.5) further contextualises the research by presenting the location, and by examining temperature and precipitation, socio-economic features and biodiversity management in the MCNP region.

2.5 Study Area

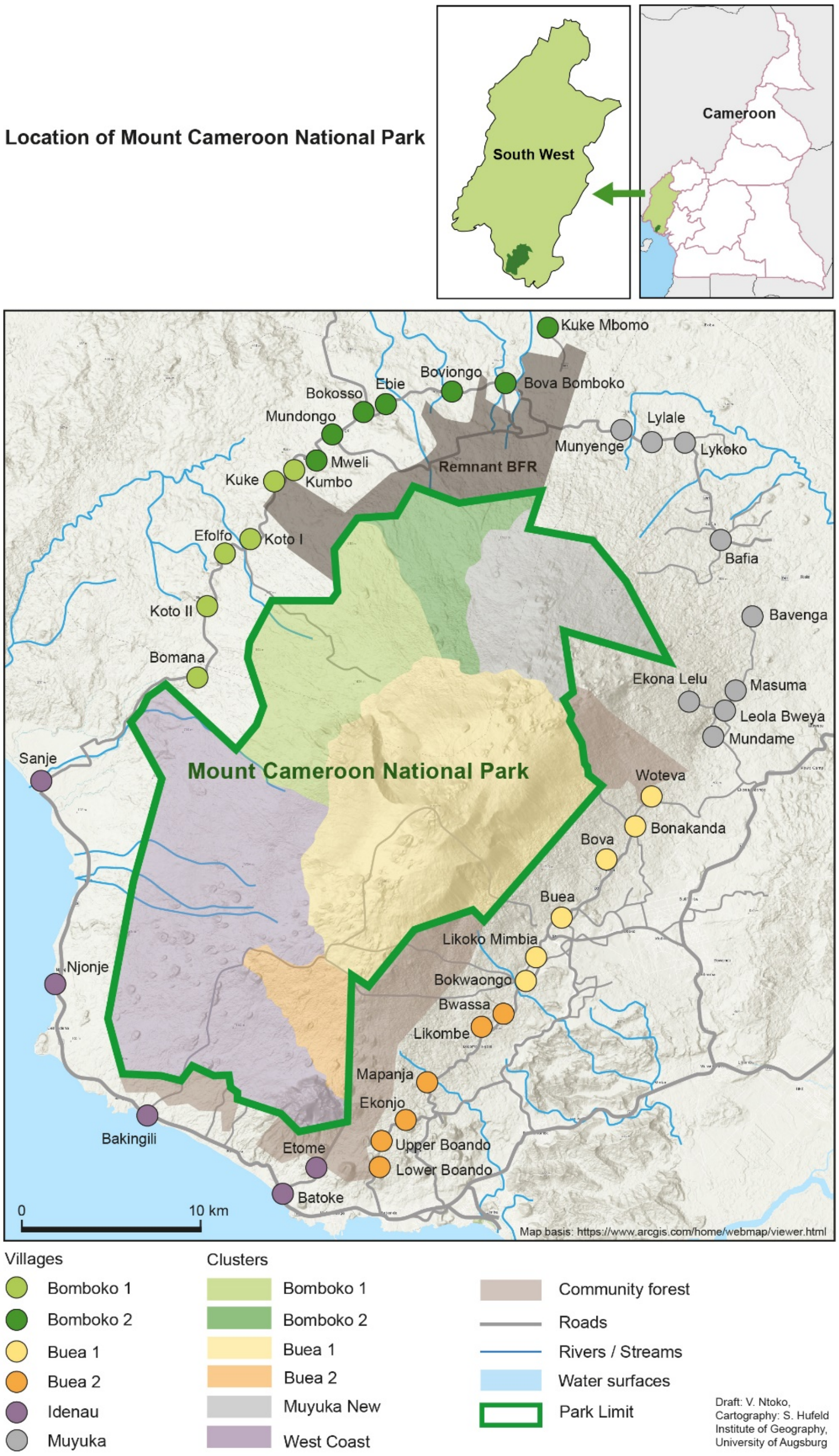
2.5.1 Location

Mount Cameroon is found in the south-western region (Figure 2.2) and situated between 4°00’ N and 4°27’ N latitudes and 8°58’ E and 9°24’ E longitudes along the coast, in the Gulf of Guinea. MC is 4,011 m above sea level (Amougou et al., 2011; MINFOF, 2014) and is part of a chain of mountains such as Kupe Muanenguba, Oku, Bambutus and the Kom mountain range (Ndenecho, 2011). Furthermore, it is part of the Cameroon rain forest extending to five regions – the Centre, East, Littoral, South and South West (Ngwa and Fonjong, 2002) –and is positioned in the Fako, Meme and Ndian Divisions, between 4°055’ - 4°378’ N and 9°031’ - 9°294’ E (MINFOF, 2014).

2.5.2 Mount Cameroon Climate

Temperature at the foot of the mountain is classed as ‘hot equatorial’ at about 23°C annual average (Molua, 2002; Tedonkeng, 2008; Ndenecho, 2011). At the summit, temperatures are low, namely about 4°C in the rainy season and 8°C during the dry season, with strong winds blowing at up to 240 km per hour and heavy cloud cover (Tedonkeng, 2008; MINFOF, 2014). The region is categorised by annual moderate-to-high temperatures, controlled by tropical and equatorial air masses (Molua, 2002). The mean yearly temperature is 25°C at sea level, with a decrease of 0.45°C at each 100 m increase in altitude (Forbosch et al., 2011). Heavy precipitation is noticeable on the seaward slopes (Tedonkeng, 2008). Mean yearly precipitation reduces in line with altitude to about 4,000 mm at 1,000 m and to less than 3,000 mm above 2,000 m (Payton, 1993; Ndenecho, 2011). The rainy season ranges from April to November and reaches its peak between July and October. The dry season reaches its peak from February to April (Kühr, 2002; Molua, 2002). Yearly precipitation varies from 12,000 mm in the south-west of the core massive to 2,000 mm in the north-east (Forbosch et al., 2011). Heavy rainfalls were registered from August to September 1996 of about 5,000 mm, above the usual maximum of 2,700 mm (Molua, 2002). Alongside several earthquakes, MC has witnessed six volcanic eruptions in the last century: 1909, 1922, 1954, 1959, 1982 and 1999 (Tedonkeng, 2008; Lambi et al., 2001).

Figure 2.2: Map locating Mount Cameroon National Park



Draft: V. Ntoko, Cartography: S. Hufeld

2.5.3 Mount Cameroon National Park

Mount Cameroon National Park has a surface area of 58,178 hectares (MINFOF, 2014). The interest in protecting the MC forest began in 1927, resulting in the creation of the Bomboko

Native Authority Forest Reserve (BFR, 1939). Due to its unique ecosystem, the British Department for International Development (DFID) created the Mount Cameroon Project in 1998, with subsequent support from the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) and the German Development Service (DED) (Awono et al., 2014; MINFOF, 2014). Intense research, monitoring and cooperation by stakeholders in the early 2000s revealed that the entire MC region was threatened and worth conserving. This led to the creation of the MCNP on December 18th, 2009 (MINFOF, 2014; Ngea, 2015), encompassing the greatest and most diverse ecology in Cameroon (MINFOF, 2014). This is justified by the following natural resources: about 2,435 plant species (49 plant taxa endangered and 50 almost endangered) (Tchouto, 1996; 1998); 22 small mammal species (International Union for Nature Conservation (IUCN), 2014), 133 mushroom macro fungi species, 15 of which are locally consumed (Tonjock et al., 2011), 86 reptile species (Gonwouo et al., 2007) and 210 bird species, with 28 restricted (Hořák, 2014).

This biodiversity, however, is endangered by illegal logging, an increasing population, unsustainable harvesting of natural resources, land grabbing and clearance, excess poaching, large-scale agro-industries, the bushmeat trade, climate change, illegal trade and poor law enforcement (Balgah, 2001; Forbosch et al., 2011; Ndenecho, 2011; MINFOF, 2014; Taylor, 2015). Furthermore, MCNP biological resources suffer from habitat alterations and break-up stemming from forest clearing, thus separating different species into minor sub-groups. This diminishes reproduction chances for plants and animals with a consequent loss in species, genetic diversity and the escalating exposure of species to diseases, poachers and arbitrary population fluctuations (Balgah, 2001).

Mountain vegetation varies as one moves from the peripheral to the core conservation zone, determined by anthropogenic factors, altitude, climate, natural hazards, soils and drainage (Tedonkeng, 2008; Lambi and Moto, 2016). The montane area has intermittent low-canopy vegetation (Thomas and Achoundong, 1994), and it is considerably dry, receives low precipitation and is exposed to fire damage stemming from hunters, lightning and volcanic events. Vegetation species at upper altitudes experience slower growth rates and rejuvenation, and as a result vulnerability to fire destruction. The numbers of tree species and their density reduce in line with elevation, with little proof of elevational effects on species turnover (Forbosch et al., 2011).

2.5.4 Socio-Economic Features

The MCNP area has an estimated population of 450,000 people, with about 80% dependent on land and forest resources for survival. The population lives up to 1,500 m in altitude. Indigenous people include the Bakweri, Bomboko, Isabu and Wovea (Laird et al., 2011), and foreigners (Nigerians and Ghanaians) make up 25% of the population (Schmidt-Soltau, 2003). The young volcanic soils are fertile and attractive for agriculture and population density (Ndenecho, 2011). Agriculture provides 80% of household income, alongside petty trading, hunting and livestock rearing. Natural resources collected include: *Gnetum africanum*, *Tetrapleura tetraptera*, *Piper guineense*, *Afrostyrax lepidophyllus*, *Ricinodendron heudelotti*, *Heinsia crinita*, *Afromomum*, *Dacryods edulis*, *Cola lepidota*, *Cola pachycarpa and Cola ficiflia*, *Tetracarpidium conophorum* and *Garcinia kola* (Tchouto et al., 1999; Ambrose-Oji et al., 2002; Ambrose-Oji, 2003). The most important medicinal plant on MC, whose exploitation began in 1972, is *Prunus Africana*, also called African cherry, *Pygeum africanum* and red stinkwood. Of the more than 200 types in the genus *Prunus*, this species is found solely in Africa, at altitudes between 900 and 3000 metres (Barker et al., 1994; Amougou et al., 2011; Betti and Ambara, 2011). These products, collected from forest and montane grasslands, have a significant influence on the local economy (Forbosch et al., 2011) and contribute to local welfare through their productive, consumptive and non-consumptive use (Balgah, 2001; Tumnde, 2001).

Important animal species include: chimpanzee (*Pan Troglodytes elliotii*), forest elephant (*Lododenta Africana cyclotis*), greater white-nosed monkey (*Cercopithecus nictitans*), red-cap mangabey, crowned guenon monkey (*Cercopithecus pogonias*), mona monkey (*Cercopithecus mona*), Preuss's guenon (*Cercopithecus preussi*) and red-eared monkey (Page, 2003; Eno-Nku and Ekobo, 2007; Forbosch et al., 2011; IUCN, 2014). Communities also attach non-consumptive spiritual and ancestral values to the forest (Balgah, 2001; Tumnde, 2001), guided by the belief that natural resources have "existence value" because they are put there by God (Lawrence et al., 2000). These vital resources enable stakeholders to attain conservation and development goals (Ndam et al., 2000; Arnold and Perez, 2001; Ambrose-Oji, 2003), and they serve as insurance and safety nets to poor rural households (Delacote, 2009; Bele et al., 2010; Gaymard et al., 2015).

The rich biodiversity of the park and a series of volcanic eruptions have led to it being considered by researchers, the World Wide Fund for Nature (WWF) and IUCN as a biodiversity hotspot suitable for ecotourism (Ndenecho, 2011). Ecotourism on MC, as in other regions such as the Lobéké National Park (LNP), is aimed at promoting biodiversity, reducing poverty and improving the well-being of host communities, as well as reducing undesirable economic, social and environmental effects (MINFOF, 2014; Ntoko, 2015; Waterson and Tambara, 2017). Tourism activities are climate-inclined, since the seasonal tropical monsoon affects hiking and park activities (Waterson and Tambara, 2017). Despite the seasonal limitations to ecotourism, its growing importance and the capitalisation of NTFPs might consequently change its use and management, due to increased economic, political and conservation values (Kunwar et al., 2014).

Furthermore, to enhance local livelihoods and biodiversity conservation efforts, park management has encouraged communities to adopt agroforestry practices. Multipurpose nurseries have been created and training carried out on tree promulgation by the World Agroforestry Centre (ICRAF) in many villages around the park (Besong, 2016; Degrande et al., 2017; Meng et al., 2017). A total number of 11,929 trees and 10,053 other plants have been planted in demonstration plots and on individual farms (Degrande et al., 2017). In the MCNP area, about 22 villages are currently involved in cassava projects, and 11 villages' plantain projects and six satellite villages' nurseries have received planting materials from ICRAF. The Programme for the Sustainable Management of Natural Resources – South West Region (PSMNR-SWR) has distributed cassava-processing equipment to four villages (Bavenga, Lio-la Buea, Likombe, Mapanja) (Besong, 2015; 2016; 2017).

2.5.5 Biodiversity Management in the MCNP Region

According to the World Resources Institute (WRI), forest management refers to institutions, practices and laws that shape the governance of forests (Williams et al., 2012). Inherent in this definition are political processes embedded in landscape management (von Hellermann, 2015). To manage the MCNP effectively, it is divided into macro and micro zones. This zonation is based on vegetation types, fauna, flora, human activities and NTFP distribution (MINFOF, 2014). Also, the park is divided into six cluster conservation zones/villages[2] (see Figure 2.2) as follows: Buea 1, Buea 2, Bomboko 1, Bomboko 2, Muyuka, and West coast (MCNP, 2018). The connections and importance that park management place on the macro, micro and cluster conservation zones/villages depict forest governance as a pivotal concern in the struggle against

[2] Initially the MCNP was divided into four cluster conservation zones. This clusters became six during a strategic meeting held from the 7[th] to 8[th] of Febuary, 2018. During this meeting the Buea and Bomboko clusters were split into two to enhance efficiency, better management and the attainment of conservation goals. This change will be reflected in the new management plan which will normally start in 2020.

climate change. Furthermore, management actions are employed through agroforestry, the sustainable use and commercialisation of NTFPs, community forestry, collaborative management and improved farming techniques that enhance the lives of forest-dependent communities (Bokwe, 2013).

Forest management is oriented towards the reduction of greenhouse gases through the REDD mechanism. This global apparatus initially set out to reduce emissions from deforestation (RED), with degradation added later on (REDD). New concerns were raised, therefore widening the space for international agreements and introducing new paradigms such as REDD+, REDD++ and maybe REDD+++. REDD++ refers to the involvement of all changes in land cover that affect carbon storage, including flora outside forests, mineral soil, plantations and agroforestry (Bokwe, 2013). REDD+ focuses on the 41 villages bordering the MCNP and has the objectives to alleviate poverty, reduce forest loss and mitigate climate change (Maschler, 2011; Bokwe, 2013; Awono et al., 2014). REDD+ in the MCNP region is still in its preparatory phase, with just a few villages consulted to date. Despite the slow implementation of REDD+, the region will certainly benefit, since biodiversity conservation and forestry activities are strategic choices for the mitigation of and adaptation to climate change (Bokwe, 2013). Although the MC REDD+ scheme is aimed at enhancing conservation and community development (Ingram, 2014), the management of biodiversity is not integrally a green agenda point (Loris, 2015) and is often not accepted by all stakeholders (Page, 2003). The PSMNR-SWR is criticised for affecting local communities' user rights by restricting NTFP collection and local involvement in park management (Ingram et al., 2010; van Vliet, 2010).

Local forest management varies across Cameroon and determines ownership, access to resources, benefits and harvesting quantities. Before the creation of the MCNP, traditional leaders since time immemorial were custodians of the forest under Bakwerie customary land tenure (Tumnde, 2001; Ingram, 2014). Traditional knowledge regimes encouraged the introduction and regeneration of new species, building shrines in bushes to protect important species and prohibit the unsustainable utilisation of scarce, vulnerable and almost extinct species (Tumnde, 2001). Colonial leaders and institutions promised to protect traditional tenure rights, but market and economic demands resulted in the eroding of customary rights (Williams et al., 2012). Official ownership moved from the local to the state (von Hellermann, 2015), thus tying in with Schmidt's (2005) view that ecosystems have been affected by colonisation through the taking over of new regions and the occupation of unpopulated regions by new settlers, alongside the resultant implementation of new management systems. With the institution of paramountcy by the colonial administration, conflicts and questions arose especially among Bakweris living on the south-eastern section of MC, on control, access, management and ownership of land (Geschiere, 1993; Ardener, 1996). The creation of the park in 2009 was embedded with unclear conventional management and indigenous tenure rights (Nyamnjoh, 1999; Page, 2003).

Despite the effects of colonial and pre-colonial policies on customary involvement in natural resources management, MC has moved from a participatory to a collaborative management approach[3] (CMA) through which communities are mobilised and local development ensured. This includes 41 village forest management committees (VFMCs), six cluster platforms (CPs) and collaborative management (CM) activities carried out with the support of PSMNR-SWR (MINFOF, 2014). Despite the important role played by VFMCs and CPs, Kemmler and Baumgart (2014) express that these structures are MINFOF-driven, not representative of all actors and resource users and considered as apparatus of enquiry for the park. This thereby limits their role and efficiency in dealing with community-park conservation issues.

To enhance biodiversity conservation and mobilise local participation, park management has instituted 1) conservation credit (CC) for community development projects, open to villages participating in CMA, and 2) a conservation bonus (CB), i.e. a yearly reward given to villages actively participating in conservation activities (MINFOF, 2014). Both CC and CB are aimed at reducing pressure on natural resources through the provision of alternative livelihood sources and finances for community development projects. These management actions are aimed at enhancing community responsibilities, authority, rights and benefits (Tumnde, 2001).

Actors with an interest in and influence over natural resources management include hunters, farmers, NTFP collectors, women farmers, timber exploiters, elites and officials (Ndam et al., 2000; Ambrose et al., 2002; Lawrence et al., 2000). Management of natural resources is often challenging, as stakeholders use different approaches and values not often unanimously accepted (Lawrence et al., 2000). The de jure management of the forest has portrayed forest-dependent communities and user groups as "illegal" occupiers of government land and property

[3] The collaborative management approach was initiated in 2011 by PSMNR in three National Parks (Korup, Takamanda and Mount Cameroon). This approach involves the inclusion of area and resource management into institutional, social, economic and ecological regimes. It also entails involving all important actors and peripheral related processes (Dupuy, 2015).

(Alden, 2011). Stakeholders' roles and involvement in park and peripheral sector activities is guided by the Conservation Development Agreement (CDA), which has a duration of five years and is implemented by chiefs, traditional councils and all stakeholders (Kemmler and Baumgart, 2014; MINFOF, 2014). Despite the CDA, the proliferation of community associations, civil society organisations and NGOs is affecting customary tenure, instituting the equal distribution of resources, reshaping power and resources access (Ingram et al., 2010; Ingram, 2014), resulting in conflicts and contestations (Ewusi and Acworth, 2001). Also, many non-indigenes do not respect the Bakweri custom, resulting in tensions and reduced respect by some Bakweri's of traditional laws relating to natural resources (Ndam and Marcelin, 2004). On communal land, community members are allowed to collect products for household use, except highly economically valued timber and NTFPs such as *Prunus africana*. Permission for access by outsiders is obtained from the village chiefs and traditional councils (Jochem, 1995; Page 2003).

2.6 Conclusion

This chapter has provided the theoretical and contextual background of the study based on climate change impacts on natural resources and livelihoods and adaptation initiatives in the MCNP region. The chapter has shown that Cameroon's forests are important due to their contribution to local and national development. The forests' goods and services are sources of wealth, food and income to the state and forest-dependent communities. Furthermore, the chapter has presented information on climate variability and change in Africa, and Cameroon specifically. It indicates that Cameroon's climate has changed over time, illustrated by higher temperatures, hotter days and decreased rainfall. In Cameroon, the impacts of climate change are felt in the following sectors: agriculture, health, infrastructure and forestry. Also, climate change presents a risk to both fauna and flora species, with risks of extinction faced by some endangered species.

The chapter further expresses that the MCNP region is also witnessing the effects of climate change, depicted by increased temperatures and hotter days, a decrease in rainfall and the prevalence of extreme events, especially on the seaward slopes of the mountain. In addition, the park is endowed rich biodiversity useful for ecotourism, local livelihoods and national development, but it is threatened by volcanic eruptions, deforestation, population increase, climate change, unsustainable harvesting of natural resources and land grabbing for agriculture.

The majority of the people living around the park are poor, and about 80% of the population depends on agriculture and forest resources. The long presence of NGOs, alongside government efforts to protect biodiversity in the region, is testimony to the park's importance to local and national development. The government and other NGOs present in the region are promoting alternative income-generating activities and the sustainable use of natural resources to improve livelihoods and protect the ecosystem. The next chapter adds to theoretical and empirical knowledge by examining the concepts of sustainable livelihoods, political ecology, perceptions, local perceptions, environmental and climate change and adaptation, as well as theoretical and conceptual frameworks useful for elucidating indigenous people's vulnerability to the impacts of climate change on natural resources, and the adaptation actions taken to cope with climate-induced changes.

CHAPTER 3: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

3.1 Introduction

This chapter examines literature relevant to the theoretical and empirical aspects of the study, to investigate the main research goal and the specific objectives mentioned in Chapter 1. Chapter 2 provided contextual knowledge on natural resources in the MCNP region and Cameroon in general, the state of the climate and its effects on people's lives and the ecosystem. It also examined the socio-economic activities of the people and the involvement of stakeholders in biodiversity management in the MCNP region. This chapter throws more light on the research by using literature from multidisciplinary sources (Table 3.1) to explore the local perceptions and adaptation strategies to climate change impacts on natural resources in the MCNP. The study centres on the need to understand how communities dependent on the forest understand and perceive climate change in relation to natural resources important for their livelihoods. Whilst there is considerable concern about the climate change and natural resources nexus in the Global South, there has been little investigation into, or results that depict, scenarios in forest-dependent communities. Chapter 3 is divided into eight sections. The theoretical and conceptual approaches in this study place sustainable livelihoods (Section 3.2) and political ecology (Section 3.3) at the core of devolving and analysing knowledge relevant to the research objectives. In addition, critical analyses of theoretical and empirical knowledge on the concepts of perception (Section 3.4), local perceptions (Section 3.5), climate and environmental change (Section 3.6) and adaptation to climate change (Section 3.7) are provided. The chapter ends with an exploration of the interconnectedness between the different themes and concepts (Section 3.8) used herein. Reviewing these concepts and themes enhances understanding of the research, highlights their relevance to the study and guides the formulation of a theoretical and an analytical framework for the study.

Table 3.1: Linking study objectives and themes to related disciplines

Disciplines	Themes	Subjects	Research concept (s)	Research objective (s)
Human geography	-Poverty alleviation -Rural development -Climate change	-Sustainable livelihoods -Weather	-Sustainable livelihoods -Seasonality -Natural resources -Climate variability and change	1, 2, 3 & 5
Political science	-Political ecology	-Environmental change -Power relations	-Access rights -Land tenure	3 & 4
Environmental science	-Biodiversity Conservation	-Natural resources	-Sustainability -Conservation and development	2, 3, 4 & 5

Sociology & Anthropology	-Rural communities -Culture -History -Indigenous people	-Local perceptions -Natural resources use & exploitation	-Adaptation -Local knowledge -Access rights	1, 2, 3, 4 & 5
Economics	-Environmental economics	-Ecosystem services	-Forest (water & food supply)	2 & 3
Botany	-Plant botany	-Natural resources -Plants identification	-Natural resources availability, dynamics and identification	1 & 3

Source: Robbins, 2012; Ingram, 2014.

3.2 Sustainable Livelihood Approach

The 'sustainable livelihoods' (SL) concept is at the core of environmental management, poverty reduction and rural development questions (Scoones, 1998). This study will use this livelihood lens to explore from household perspectives the connections between climate change and natural resources. The concept addresses research objective two, which explains people's perceptions of climate change (seasonality and variability), objective one, based on natural resources utilisation, changes in utilisation and reasons for changes, and objectives four and five, i.e. tackling climate change effects on access to natural resources and climate adaptive measures and practices, respectively. I will begin by separately examining the nexus of sustainability and livelihoods that makes up the SL equation, elaborating on the sustainable livelihood approach (SLA), key issues and criticisms and, finally, exploring its relevance to the study.

3.2.1 Sustainability

Though the concept of sustainability is much older, it can be traced back to social justice, conservationists and international movements in the late 1980s (Gutierrez-Montes et al., 2009; Kates et al., 2016), all of which provided global recognition and developed values for sustainable development (Sanginga et al., 2010). Sustainability focuses on the notion of limited resources, conserving for future generations and meeting the requirements of economic growth and social equity (Gutierrez-Montes et al., 2009; Sanginga et al., 2010; Waqar and Yihdego, 2017). Sustainability is a mainstream concept, popular in public debates and policy arenas (Larson and Grönlund, 2014), with the objective to protect humankind (Kates et al., 2016). It emerged as a subject of concern after the release of the United Nations Brundtland Commission Report in 1987, which defined it as:

> "*Development that meets the needs of the present generations, without compromising the ability of the future generations to meet their own needs*"
>
> (Brundtland Commission, 1987).

The Report emphasised the economic, social and environmental dimensions on which we all depend (Occupational Safety and Health Administration (OSHA), 2016). They stem from the "*triple bottom line*" concept, which, from an economic perspective, explains that these dimensions are interlinked and jointly required to achieve progress (Sanginga et al., 2010; Chasin, 2014; Larson and Grönlund, 2014). In addition, they remain fundamental and principal pillars of the UN (2015)-adopted Sustainable Development Goals (SDGs) as part of the 2030 Agenda for Sustainable Development (Lange et al., 2015; OSHA, 2016). A key challenge is the integration of these dimensions, using a comprehensive approach and coping with disciplinary, sectorial and ideological obstacles (Sanginga et al., 2010). Critiques on sustainability argue that much attention afforded to sustainable development is uni-dimensional (Escobar, 1998; Sen, 1999) and focuses more on either of these dimensions, instead of letting an individual live a life that she/he values (Sen, 1999). Furthermore, sustainability has not brought about lasting solutions but a debate on values between stakeholders (Ratner, 2004), due to the inability of actors to unravel power relations that hinder change (Bullard, 2011). Thus, sustainability is a contextual, time-specific and dynamic process, which is an illusory, impractical and unattainable goal within current economic structures and has little left to sustain (Bullard, 2011; Escobar, 2011; Larson and Grönlund, 2014; Kates et al., 2016). While Escobar (1998) proposes that sustainability should involve local identities, rights, knowledge, territorial attachment and local capacity, Bullard (2011) expresses the need to focus discussions on regeneration and restoration. Despite criticisms of sustainable development, it is grounded in fundamental principles and values stemming from the Brundtland Commission's standard definition, namely meeting people's needs now, in the future, for socio-cultural and human development and within the confines of "Mother Earth" (Kates et al., 2016).

3.2.2 Livelihoods

The second side of the equation is livelihoods. 'Livelihood' refers to the control individuals, groups and families have over resources that can be used or exchanged to satisfy needs (Blaikie et al., 1994). It also refers to the use of assets in activities to achieve outcomes to meet people's immediate and future needs (Dorward et al., 2009). These assets, resources and control over resources (Ambinakudije, 2011) are instituted by fragile measures within households and communities (Dijk, 2011). Rural livelihoods consist of varied activities and social network capabilities vital for existence and increasing living standards (Ellis, 1998). Livelihood activities and end products are shaped by vulnerability and institutional features, with the former characterised by shocks, stress, seasonality and critical trends that people face in their daily struggles (de Haan, 2000; Serrat, 2017). Also, livelihoods are influenced by complex forces such as globalisation, conservation politics, the commodification of agriculture and natural resources and climate change (Ambinakudije, 2011). Secure and reliable access, elemental to the livelihoods of forest-dependent communities, is affected by changes caused by climate change consequently affecting the sustainability of livelihoods (International Institute for Sustainable Development (IISD), 2003). This might culminate in new institutional arrangements – in some cases to the disadvantage of indigenous communities. Therefore, there is a need to comprehend these forces, to enable stakeholders to protect humans and nature in an era of global environmental change. Thus, in this study, exploring the livelihoods of communities around the MC region and their adaptation strategies is vital.

The livelihood idea became popular in the 1980s and is central to poverty reduction approaches worldwide. Its emergence has enhanced understanding on how poverty, and people's ability to come out of deprivation, mirrors a lack of assets and capabilities, comprising financial, material, human capabilities, social and political factors (IISD, 2003). For forest-dependent communities, nature and livelihoods are interconnected (Ambinakudige, 2011). A poor person's livelihood consists of reliance on common property resources (gathering fuel wood, collecting and harvesting NTFPs, access to water, land) (IISD, 2003; Nguyen et al., 2019), but it also involves food and cash crop farming and hunting. Diversifying activities is the main way to distribute livelihood risk, because it enables local people to carry out different activities, depending on the situation (Wright and Priston, 2010; Yap, 2019). Household livelihood trajectories differ, in that while some may maintain current activities in the face of adversity, others will seek to accumulate capital to engage in new activities or expand current activities (Dorward et al., 2009). Households with more capital and assets are more likely to adapt to challenges presented by environmental change, by engaging in alternative activities, while those with limited capital might intensify natural resource exploitation despite resource-restricted access. In either situation, however, people may continue to live in hardship (Wright and Priston, 2010). Despite challenges faced by households, community development projects considered as a panacea to ameliorating livelihoods of the poor have failed, by associating people's needs with financial payback and economic exchanges (Berkes, 2012), thereby concealing the complications embedded in indigenous livelihoods.

3.2.3 Origin of the Sustainable Livelihood Approach

A brief recollection of past times is necessary to understand the origin of this approach. Early works by the Rhodes-Living Stone Institute in Zambia on dynamic rural systems and their development challenges (Scoones, 2009), the actor-oriented approach elaborated by Norman Long (Long, 1984) and research on the impacts of the Green Revolution on agriculture and forms of household accumulation (Walker and Ryan, 1990; Farmers, 1997) were all livelihood studies, albeit they were not considered as such. The dominance of modernisation beliefs on the development discourse brought to the fore mono-disciplinary thinking. Expert economists dominated policy by providing an interpretation (inputs and outputs, demand and supply) which fitted the demands of the time (Scoones, 2009). Institutions such as the World Bank, United Nations, development agencies and newly sovereign nations worldwide "*reflected the hegemony of this framing of policy, linking economics with specialist technical disciplines from the natural, medical and engineering sciences*" (Scoones, 2009:5). This in turn relegated other social science knowledge and livelihood philosophies to the background. Subsequently, a micro-direction was pursued, with livelihood studies exploring droughts, famine and coping strategies for people in crisis situations. The outcome for some of these studies was pessimistic, portraying growing poverty, although they did highlight people's initiatives and actions taken (de Haan, 2008). Furthermore, social anthropologists, geographers and socio-economists carried out a series of studies (gender and social differences, changing ecologies, cultural settings) which shaped environmental and development fields. These studies corresponded with scholarship from Marxist political geography, later on branded "political ecology" (Forsyth, 2003).

Environmental and development movements of the 1980s and 1990s, alongside increasing optimistic research on livelihoods, raised awareness of the link between poverty and development (de Haan, 2008; Scoones, 2009), and they thrust into the limelight the term "sustainable livelihoods," introduced by the Brundtland Commission on Environment and Development following the release of the Brundtland Report in 1987 (Krantz, 2001; Scoones, 2009). Later, in a conference organised by the International Institute for Environment and Development (IIED), in 1987, sustainable livelihoods was top on the agenda and the focus of Chambers' (1987) overview document. A widely used definition of sustainable livelihoods only emerged in 1992, in a Working Paper by Chambers and Conway for the Institute of Development Studies. According to Chambers and Conway:

> "*A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term*" (Krantz, 2001:6).

This paper marked the beginning of what, from the 1990s on, would be called the 'SLA', well-suited with bottom-up development (Massoud et al., 2016). The SLA concept was expanded later in Agenda 21 of the 1992 United Nations Conference on Environment and Development (Krantz, 2001; Scoones, 2009). In addition to its conceptual roots, it has developed within institutions and been promoted by NGOs, donors and governments (British state development cooperation agency), with goals and rules directing interventions in the form of integrated conservation and development projects (ICDP) (Ashley and Carney, 1999; de Haan, 2008, 2012), in their promotion of sustainable development at grass roots level (Krantz, 2001). These attributes thus make it attractive for PRA approaches and methods used in about 40 countries worldwide (Chambers, 1995).

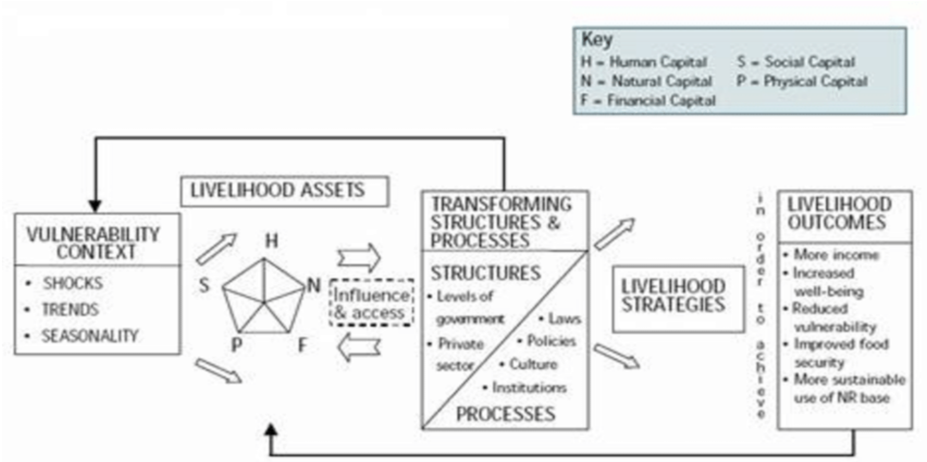
3.2.4 Description of the Sustainable Livelihood Approach

The SLA is centred on the way vulnerable people live, and the significance of institutions and policies. It provides a link between people, the environment and development, and it shapes the design of people-centred, integrated, dynamic, durable, inclusive and responsive development projects on all scales (Krantz, 2001; Sanginga et al., 2010; Nee and Mansur, 2015; Massoud et al., 2016; Serrat, 2017). In addition, it is an analytical approach taken to understanding the intricacies of livelihoods and poverty and ascertaining where interventions are most appropriate, based on the supposition that people pursue a series of livelihood actions jointly, to earn a living (Krantz, 2001; Sanginga et al., 2010; de Haan, 2012). The SLA (Figure 3.1) incorporates structures, assets, vulnerability contexts and processes employed to understand poverty and the ability of households to cope with stresses (Ellis, 2000; Ingram, 2014). It identifies six 'capitals' or 'assets' (natural, economic or financial, social, human, physical, political) on which people depend to earn a living (Chambers, 1995; Scoones,1998; Bebbington, 1999; Ellis, 1999, 2000; de Haan, 2000; Krantz, 2001; IISD, 2003). Adding to this list in the

21st century is information capital (information and communications technology), which is essential in the functioning of the other forms of capital (Nee and Mansur, 2015).

The utilisation of assets changes over time, depending on opportunities, context and constraints (Farrington et al., 1999). The multiple inputs that people use to build livelihoods signify that the SLA engages a comprehensive perspective on the various resources vital to poor communities (Krantz, 2001). These inputs determine how people's livelihoods work and are the basis for understanding how they respond to climate-induced vulnerabilities. This in turn means that assets are the basis for the development of adaptation strategies (IISD, 2003). They not only enable people to earn a living, but they also influence their decisions and assign meaning to the person's world through numerous livelihood portfolios (Bebbington, 1999).

Figure 3.1: Sustainable livelihood framework



Source: DFID, 2000.

Capital not only builds livelihoods, but it also provides peoples with the aptitude to be and to act. Labelling resources as 'capital' gives livelihoods an economic and a neo-liberal outlook (de Haan, 2012), thereby diminishing its place as a source of people's power to question rules of access, control and use of resources (Bebbington, 1999). Natural resources such as forests and water are essential for many livelihoods in the Global South and are often held as common property. Scientists estimate about 1.2 to 1.4 billion people are reliant on forest resources, and approximately 1.6 billion persons globally exploit forest products for their livelihoods (Chao, 2012; FAO, 2014). Such natural resources are 'safety nets'[4] and 'daily nets'[5] for forest dependent communities during hard times. An important factor here is whether the poor have access to them, when desired. Considering their place in rural communities, they unescapably occupy a vital position in SL discourse, since people worldwide are afraid of environmental degradation (de Haan, 2000, 2012) and any resulting effects on natural capital. Those who depend on natural capital, and who suffer the effects of climate change, did not choose to live where they do (Chambers, 1995). Climate change and its resultant effects on people seem to be robustly sustainable. Rural communities are encountering greater levels of climate change effects on livelihoods, access and rights to natural capital. In addition, traditional methods of gathering and sharing food dependent on their culture are also affected by climate change (Lal et al., 2011). Documenting the climate and livelihood nexus requires analysing the reasons for changes in our environment. Some authors suggest that SLAs should start with ecosystems (Hyden, 1998), thereby placing considerable emphasis on natural resources and locality in livelihood studies, since natural resources are place-specific (de Haan, 2000).

The SLA addresses sustainability by placing emphasis on household resilience and natural resources (Sanginga et al., 2010). Natural assets (forests) are often used by rural communities to achieve livelihood outcomes, and people's choices of natural assets are influenced by their resilience or vulnerability towards shocks, resource trends, seasonal variations and access to assets (Farrington et al., 1999; Sanginga et al., 2010). For example, NTFPs are natural assets often exploited by the poor from the forest, and they are often institutionalised as common pool resources (Timko et al., 2010). The exploitation of forest resources is driven by people's perceptions of their environment, preferences and priorities (Farrington et al., 1999), which means that exploring the natural capital of MC, it's use and abundance or scarcity is important in understanding the link between natural resources and indigenous livelihoods. Furthermore, people's access to natural assets and livelihood options are determined by different bundles of property rights (*de facto* or *de jure*): "*They affect the incentives individuals face, the type of actions they take and the outcomes they achieve*" (Schlager and Ostrom 1992:256). Despite the critical role of property rights in determining access to capital, the SL framework does not include them, and therefore property rights are neglected in the SL analysis.

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[4] Safety net is when other sources of family income such as plantations do not resolve nutritional deficiency or when an urgent financial alternative is needed (McSweeney, 2003). Also called emergency nets, they barely offer a sustainable livelihood and usher the indigenous people out of poverty (Shackleton & Shackleton, 2004).

[5] Daily net is the regular use of forest products to meet instant family necessities and offering a reliable channel of income to acquire farming inputs (Shackleton & Shackleton, 2004).

Another important factor is human capital, not only linked to people's productivity and efficiency, but also providing people with the ability to be meaningful and fruitful (Sen, 1997). For example, people's knowledge of their environment is not only limited to the level of education. Continuous interaction with the environment provides experiences of livelihood strategies embodied in individuals and entrenched in the social relations through which they become efficient (de Haan, 2000, 2008, 2012). Moreover, this human agency "*[...] enhances people's ability to engage in discussions, to negotiate, to debate, to add their voice to the multitude of voices influencing household, local and national discourses on development*" (Bebbington, 1999:2034).

Central to the SL approach are livelihood strategies with the objective to attain livelihood outcomes. These livelihood strategies may be reactive or anticipatory, short- or long-term (Serrat, 2017), but they are dependent on people's preferences and priorities and are influenced by exposed vulnerabilities (de Haan, 2012). The outcome of livelihood strategies among forest-dependent people is grounded on structures, institutions (Scoones, 1998; Agrawal and Perrin, 2008; de Haan, 2012) and socio-economic, political and policy arrangements (Ellis, 2000). Institutions are the pivot via which people employ command over natural resources and ecological systems (Young, 2008), and institutions provide a ground for sustainable natural resource management by offering locally suited and context-specific solutions to socio-ecological concerns (Epstein et al., 2015). The 'environmental entitlement' paradigm expresses the key role of institutions in normalising individual and group attitudes in reconciling ecology and society. Additionally, people's endowments and entitlements are shaped by formal and informal institutions (Sanginga et al., 2010). Functioning on all scales (public and private spheres), institutions affect the conditions of exchange between assets and livelihood outcomes, and they influence the realisation of livelihood strategies (Ingram, 2014).

Examining climate change effects on natural resource access by individuals and groups links it to environmental, economic and political processes on different scales (Dietz, 1996). In exploring how people shape policy, the contention that 'political capital' must be added in the SL framework (Baumann, 2000) becomes an urgent issue (Karl, 2002):

> "*The notion of political capital is critical in linking structures and processes to the local level and understanding the real impact these have on sustainable livelihoods.*

Political capital explains where local people are situated – in terms of balance of power in relation to other groups" (Baumann, 2000:5).

Political capital is therefore significant in shaping people's livelihoods – it is not fixed, and it is influenced by external and internal factors (participation, changes in tenure rights, legislation). For example, changes in tenure rights may alter the balance of power from traditional to state level, and it may meet with resistance from losers in the game.

Understanding and dealing with poverty is also central to the SL approach (Krantz, 2001), and poverty level has become the main criterion for assessing rural livelihoods (Scoones, 1998). It can be the result of people's livelihood strategies, especially those with very few assets finding difficulty in ameliorating livelihood outcomes (Olaf, 2011). Conventional approaches address poverty in economic terms and absolute income and material well-being, expressed relative to living on less than $1 or $2 a day for individuals, or as Gross National Product (GNP) per capita for countries (IISD, 2003; Coad et al., 2008; de Haan, 2012). The Human Development Index (HDI), used since the 1990s by the United Nations Development Programme (UNDP), is a multidimensional alternative to the conventional one-dimensional monetary measure (Olaf, 2011) and adds to the monetary approach to poverty by taking into account intersecting deprivations (health, education) to which people are exposed (Peet and Hartwick, 2009; Olaf, 2011; UNDP, 2016b). The United Nations Millennium Goals, in addressing poverty, emphasise health, education, gender and environmental sustainability (IISD, 2003). The income alone perspective has been substituted by views on poverty as dynamic, variable, complex (IIDS, 2003), multi-dimensional and grounded on participatory research (Krantz, 2001; de Haan, 2012). Amartya Sen's (1999) '*Development as Freedom*' sees poverty as an aspect of the lack of freedom.

Alternatives to the income perspective to poverty are the well-being (Chambers, 1995) and capability approaches (Sen, 1984). According to Sen (1997), income and HDI or GDP measures severely under-report changes brought to people's lives as a result of human capital. One can also assert that income and HDI also do not report changes brought to people's lives as a result of natural capital. Monetary poverty data are usually not time-specific, and often give a poor picture of poverty in rural communities (Olaf, 2011) by not providing in-depth detail (Olinto et al., 2013); thus, the livelihood approach serves as the best option (Olaf, 2011). Aggregations can conceal individual beneficiaries and losers in terms of environmental change, by undermining differentiated access to natural resources, people's specific capacities and knowhow and local understanding of well-being, and by providing generalisations on the link between poverty and natural resources (Daw et al., 2011).

3.2.5 Challenges of the Sustainable Livelihood Approach

The SLA embraces economic, institutional, social and environmental factors as elements of sustainability. A livelihood is sustainable if it is socially inclusive, and it is exclusive if it is not sustainable (de Haan, 2000). The concept of social exclusion only entered SL studies through Chambers (1995) in his explanation of how people earn a living through the use of tangible and intangible assets and their capabilities. Social exclusion refers to when the powerful and privileged in a community exclude others from resource access, in order to maximise gains (Gore, 1994). This in turn creates a situation of "eligible" and "ineligible" (de Haan, 2000). Furthermore, Farrington et al. (1999) present a wider view which sees sustainability as attained when physical assets and institutions (traditional, governmental, commercial) are maintained. This does not, however, capture the entire sustainability picture. In my opinion, people's capacity to respond to needs and opportunities is also shaped by land tenure and access rights. People's rights to resources will depend not only on capital, vulnerability, processes and structures, but also on maintaining rights of access, withdrawal and management. Sustainability is to be attained if land tenure and access rights are stable, fair and if those with exclusion and alienation authority do not use it for their own benefit. In the case of exploiting resources such as NTFPs, tensions may arise between those who want to guard against vulnerability, gain immediate income and attain general livelihood objectives, and those – especially new arrivals – who do not want to take into consideration the livelihood interests of others. The SLA acknowledges these trade-offs, but it offers no solutions to address them.

Formerly, sustainability was limited to dealing with shocks and stress by supporting local agency and capacity. With the climate change threat, adaptation studies emerged addressing long-term change (Adger et al., 2003). The term 'SL' implies that "*livelihoods are stable, durable, resilient, and robust in the face of both external shocks and internal stresses*" (Scoones, 2009:19). This is not visible in severe vulnerable situations when communities do not have the capacity to cope. Those at the margins of society unable to manage or adapt are certainly vulnerable and will not attain sustainable livelihoods (Scoones, 1998). Understanding if livelihoods are sustainable entails assessment of the natural capital used and changes in resources – as is the case in this study. These issues have originated from fields of forestry, ethno- and economic botany, in guidelines developed for the sustainable harvesting of fauna and flora (Medicinal Plants Specialist Group, 2007; Ingram, 2014), and they show that it is paramount to understand natural resource availability and occurrences (Secretariat of the Convention on Biological Diversity (SCBD), 2001).

The SLA has also been criticised for not taking into consideration the effects of climate change on people's livelihoods at the micro level. Climate change only entered development thinking in the late 1990s and early 2000s (Scoones, 2009), and much attention was centred on the macro global level to deal with the issue (IISD, 2003), with a lack of commitment by stakeholders involved in environmental conservation in the Global South (Agarwala et al., 2014). The big question is whether sustainable approaches were up to the challenge. Despite data showing the effects of climate change in the Global South, where development activities had focused on poverty and livelihoods, "*livelihood approaches as originally conceived ignored the big picture: fiddling while Rome burned*" (Scoones, 2009:12). They therefore failed to deal with environmental changes which affected people's lives. With the increasing realisation of the effects of climate change on development in the Global South, livelihood approaches began to examine the link between climate change and poverty. The latter was attributed not only to a lack of employment, but also to the likely effects of climate change (IPCC, 2013), including a reduction in livelihood options and opportunities, stresses on social institutions and greater instability and unpredictability in flows of livelihood benefits (Agrawal and Perrin, 2008). Changes in temperature and rainfall patterns influence livelihoods by creating alterations in ecosystem distribution and species range, as well as a decline in the water, NTFPs and plants on which rural livelihoods are dependent (IISD, 2003). They further affect the composition and range of native fauna and flora through changing breeding patterns, habitats, food and water availability (Feng and Hug, 2007, cited in Lal et al., 2011). Changes in the availability and abundance of forest resources will consequently affect people's rights to access, withdrawal and management. These changes in property rights, according to IPCC (2013), will create new poor between now and 2100, especially in medium- and low-income countries.

The SLA recognises the role of power and politics in determining people's livelihoods, and it places analytical focus on governance, social differences and their implications. Moreover, livelihood studies have concentrated on how people combine and access different assets to carry out their livelihoods (Scoones and Wolmer, 2003). However, the approach has been criticised for paying insufficient attention to power and politics, to which poor people are predominantly vulnerable (Ashley and Carney, 1999; Agarwala et al., 2014). The influence of politics and power is not well understood, since the SLA mirrors livelihoods on a micro scale (Pasteur, 2001) and consequently limits a complete appreciation of climate change impacts, as these range from individual, household and community, to macro levels. To close this gap, a critical approach, integrating policies and politics as interactive and dynamic, is helpful (Blaikie and Soussan, 2001) in thereby examining politics and power in people's interactions (Ingram, 2014). In reality, any endeavour to enhance people's management and access to natural resources often meets with tensions. It is difficult to overlook the presence of power relations between different actors (Karl, 2002). The SL concept in this study is useful in identifying how seasonal changes can lead to changing natural resource utilisation, management and access rights, with inherent tensions. Political Ecology (PE) (see Section 3.3) addresses this issue by providing explanations on the political environmental issues and occurrences. PE is helpful in explaining the social, economic and political actors and factors alongside ecological variations and issues (Bryant and Bailey, 1997).

3.2.6 Relevance to the Study

The SLA provides an alternative view of carrying out climate change research from the top-down scientific traditional approach, matching with the notion of research from the perspective of those who are living witnesses to climate change (National Trust for Nature Conservation (NTNC), 2012) and are conversant with their environment and situation (Nee and Mansur, 2015). These people have pertinent first-hand knowledge of rainfall patterns, and events representing coldest and hottest times, which affect their livelihoods directly and indirectly (IPCC, 2013). Local perceptions are the only reliable source of "*micro climatic trend analysis*" (NTNC 2012:21), since there is lack of scaled-down evidence (Dazé et al., 2009) on climate variabilities in the MC region. Researchers should therefore listen to people's perceptions (social data) on weather changes and link them with other associated and important parameters such as changes in natural resource productivity, growth, availability, spatial distribution, geographic distribution, threats to endemic species and effects on habitat quality resulting in shifts in species movements. This is possible through the use of mixed methods (see Chapter 3, methodology) which generate results that depict differences in control over, access to and knowledge of resources (Nightingale, 2003).

Furthermore, the SL concept is grounded on three main principles: a focus on poor people, the holistic approach and macro-micro links (Ashley and Carney, 1999; Farrington et al., 1999). These principles are in line with the objectives of this study (see Section 1.3) and help analyse the livelihoods, vulnerability, adaptation and local perceptions (Ashley and Carney, 1999; Dazé et al., 2009; IISD, 2012) of people living around the Mount Cameroon National Park. This ties in with the view that an SL analysis should "*start with an analysis of people's livelihood and how these have been changing over time [...], and acknowledge the multiple strategies that people adopt to secure livelihoods*" (Farrington et al., 1999:4). Also, it acknowledges vulnerabilities, seeks to uncover relationships and adaptation and examines capabilities in forest-dependent communities in an unbiased manner necessary for sound development policy (Batterbury, 2011). Finally, the natural assets of forest-dependent people and livelihood strategies are elements of the SL framework. Conducting research on natural resource assets through participatory methods provides a micro orientation to the study, and the recommendations at the end of the study, according to Ashley and Carney (1999), will inform dialogue at the macro level on the need for policy and institutional change. Despite the relevance of the SLA in this study, it only addresses some of its objectives, and thus it is unable to provide a comprehensive picture; therefore, it is necessary to use other concepts, in order to achieve the goal of this study. The concept of PE (see Section 3.3) is deemed necessary, since it provides an appreciation of the political and economic constraints to climate vulnerability and adaptation.

3.3 A Political Ecology of Climate Change and Natural Resources

The dominant image of the Global South is a world entombed in recurrent crisis (Bryant and Bailey, 1997). Attention to the role of politics, biodiversity loss and changing rural livelihoods has been growing in recent times, with issues such as access and conflicts relating to natural resources included in environmental change debates and research. Section 3.2 elaborated on the SLA and framework, and their incorporation in climate change, natural resource and livelihood research. This section examines the development, central research fields and criticisms of PE. Furthermore, it explores the relationship between PE and climate change. The section ends with the relevance of PE to the study.

The rise in the prominence of ecological issues in political arenas and the media has been complemented by research on the environment in both the North and South (Schubert, 2005). Most literature fails to address the economic and political features that contribute to ecological problems in the Global South. This study contributes to the literature by using PE, an approach which focuses on the idea of a politicised environment (Bryant and Bailey, 1997), and it embraces the view that ecology is embedded with politics and follows the notion that PE is predominantly focused on the politics of struggle over the governing of and access to natural resources (Jones, 2006:482). The study employs a PE approach to investigate the effects of climate change on access to natural resources and the embedded social struggles and conflicts reflected in natural resources changes caused by climate change in the MCNP region.

3.3.1 Development of Political Ecology

Cultural ecology draws on anthropology and first appeared in the 1960s (Taylor, 1999). It focused typically on cultural adaptation and management practices in different ecosystems (Bryant and Bailey, 1997; Taylor, 1999), comprising forms of behaviour and cultural and social practices formed by environmental conditions (Forsyth, 2003; Taylor, 1999). Moreover, it provided generalised notions of human-environment interactions, and it explained and understood change in a complex contemporary economy. Nonetheless, the tools of cultural ecology and hazard research in describing environmental systems and crises were considered inadequate for interrogating and answering the vital questions surrounding environmental change. The explanatory challenges faced by cultural ecology later became the platform on which PE would be ejected to prominence (Robbins, 2012).

The early development of PE was also influenced by a Marxist political economy, with knowledge enhancement stemming from the world systems theory, dependency theory and peasant studies of Frank (1967) and Wallerstein (1974). Marx and Engels attributed environmental degradation to capitalism and environmental politics to class struggle, industrialisation and capital accumulation (Neumann, 2005). Marxist ideas influenced the development of PE in the following ways: 1) socio-cultural structures are grounded in historical and varying material associations and circumstances and 2) capitalist production necessitates the extraction of excesses from employment and the environment (Robbins, 2012). Furthermore, the Marxist political economy likewise intended that our appreciation of human-environment association should be conceived as a dialectic harmony, instead of a set of relations between two separate objects (Neumann, 2005). According to materialistic views, the features which help the contemporary economy flourish are paradoxically embedded with grains of the present social and ecological crisis (Robbins 2012). PE, as a consequence, was concerned with the state role, which is usually in support of privileged groups and individuals, thereby buttressing their ability to build-up wealth, albeit to the disadvantage of the less privileged, through land tenure, food, taxation and resource distribution policies (Blaikie and Brookfield, 1987). Though most PE works did not pay loyalty to materialism, some implicitly assumed materialist principles. Moreover, the consequences of this way of reasoning on PE were diversionary. Despite the weaknesses of historical materialistic studies, the materialistic philosophy brought out evident areas of inequality, with the most convincing theory being the dependency theory offered by Latin-American economic experts in the 1960s (Robbins, 2012).

The word 'PE', before the 1970s, was used in studies on land use and political economy, but it did not generate a "new" approach (Peet and Watts, 1996). Science in the mid-1970s to the mid-1980s was constructed on Neo-Marxism and highlighted structural descriptions of human-environment nexus. Environmental progress during this period was slow, because Marxist intellectuals had a nonchalant attitude towards the ecology, and also due to the drastic link of Neo-Malthusian accounts of ecological problems connected with environmental approaches to comprehend ecological change (Adams, 2009). Most authors did not use the term 'PE' and did not class it as a method. For example, Hewitt (1983) made no mention of the word, though some scholars positioned his work within the PE oeuvre (Blaikie, 2007). Early employment of the term did not complement methodological propositions for studying political and ecological connections (Neumann, 2005). However, in the 1980s, the political economy was stressed by critiques of Neo-Malthusianism and made a major contribution to the development of PE (Robbins, 2004).

As traditional modernisation and dependency constructs marking scholarly work on development in the 1970s (Greenberg and Park, 1994) were progressively seen as outmoded, PE began to surface as a new discipline to human-environment relations in development discourses (Schubert, 2005) and "*emerged as a research agenda*" (Bryant, 1992:12). PE was fashioned historically within a wide environment and development agenda, mainly in the Global South, and with much attention still in the South (Blaikie, 2012). Geographers, sociologists and anthropologists began to pay more attention to the political role of nature for societies: "*Later uses of the term by anthropologists more closely approximated the type of approach that has come to characterize the field of political ecology*" (Neumann, 2005:32). Thereon, scholars such as Bryant and Bailey (1997) began to shape ecological problems as an expression of wider political and economic concerns, reasoning that the remote causes of these problems have to be solved by deep transformations on all levels. Further research by Zimmerer and Bassett (2003), Peet and Watts (2004) and Neumann (2005) participated in delineating PE (Blaikie, 2012).

Political ecology, described by as "*a means of criticizing the scientific discipline of ecology*" (Page, 2003:358), therefore originated from the 1970s and 1980s (Bryant and Bailey, 1997; Blaikie, 2007) when experts became exasperated with the apolitical explanations provided to environmental problems (Peet et al., 2011) and the increasing concern over human-environment interactions in public discourses in the Global North (Robbins, 2012). Apolitical ecologies are non-political, without context and neutral in their ideas on the ecology (Robbins, 2004:5). Prevailing apolitical approaches in international discussions around the environment are "eco-scarcity" and "modernisation" interpretations (Robbins, 2012). PE did not come to prominence due to its attribution to the works of Garret Hardin's (1968) "*Tragedy of the Commons*," Thomas Malthus' "*Essay on the Principles of Population*," the "*Population Bomb*" by Paul Ehrlich (1968), to the Club of Rome's "*Limits to Growth*" (Meadows et al., 1972), by the political left (Robbins, 2012). These works were criticised for providing apolitical explanations (population growth, inappropriate technology, poor management, degradation) to environmental problems (Peet et al., 2011, Robbins, 2012) and an apolitical theory of environmental commons (Robbins, 2004, 2012). Hardin's (1968) apolitical theory of the commons was considered as inadequate, leaving different actors and players unexamined and ignoring the historical paths of socio-economic changes (Robbins, 2012). The apolitical and non-partisan manner of ecological populism, and its inherent recognition of the market economy and capitalism as the main structures of the economic and social order sidelines the "*politics of the possible*" (Swyngedouw, 2010:229), frames diverse environmental and social features and brings about struggles, differences and conflicts. PE thus presents an explicit alternative to addressing apolitical ecology and contesting these views (Swyngedouw, 2010; Robbins, 2012). The difference between political and apolitical ecology is in "*identifying broader systems rather than blaming proximate and local forces, [...] viewing ecological systems as power-laden rather than politically inert [...] taking an explicitly normative approach rather than one that claims the objectivity of disinterest*" (Robbins, 2012:13).

Towards the end of the 1980s, the growth of PE centred mostly on the position of social actions and local stakeholders (Bryant and Bailey, 1997). This period witnessed increasing consciousness of the discursive scope of human and nature interfaces (Peet and Watts, 2004), and authors became conscious of PE and saw themselves as shaping the field (Blaikie, 2007).

Events such as the Sahelian famines in the1980s, human-induced climate change in the 1990s, hurricane Katrina in 2005, the immense Haitian earthquake in 2009 and Pakistan's inundations during the heavy rains in 2010 revealed the fierce injustices of an entirely global political economy, which opened the way for the extreme, unfair and trembling destruction of the world's most disadvantaged communities (Robbins, 2012). Such events – "natural" and "inevitable" – were subject to new forms of interpretation, as reflected in the Brundtland Report, 1987, and they led to the advent of Green Politics and the Sustainable Development sermons transmitted and promoted in the media (Peet and Watts, 1996).

3.3.2 Characteristics of Political Ecology

According to Blaikie and Brookfield (1987:17), PE "*combines the concerns of ecology and a broadly defined political economy*." Additionally, it is a combination of theoretical suggestions and philosophies, on the one hand, and social contestations denoted as environmental movement and later the Green movement (Atkinson, 1991) on the other. It covers a broad range of explanations obtained from the political right to the political left (Neo-Marxism) and grounded on notions from political economy (Taylor, 1999), and it also emphasises the uneven relations between different stakeholders and power imbalances in explaining societal-environmental interactions (Bryant and Bailey, 1997). Political ecologists are interested in access rights, control over natural resources and governance regimes that determine conditions under which natural resources are used and managed (Belsky and Siebert, 2016; Loftus, 2017). PE thus offers a suitable agenda, as ecological concerns become progressively prominent in global debates and local struggles (Bixler et al., 2015).

Political ecology addresses social and natural relations contending that ecological and social conditions are intensely and inseparably linked. Moreover, it stresses that the manner in which nature is comprehended is also political (Adams, 2009), thereby evaluating the consequences of a politicised ecology (Bryant and Bailey, 1997), embraces a broader appreciation of politics than is customarily the case in ecological politics and explores multiple non-state political concerns and advocates in those communities abandoned by ecological politics (Bryant and Bailey, 1997). In addition, PE sees the environment as "politically and socially situated" (Harris, 2004: 4) and places political concepts into ecological debates in a different manner to political science. Furthermore, it addresses wider issues relating to the interaction between governmental and non-governmental actors and the areas in which they live. It understands politics as the struggle between people over the distribution of resources and explores different ways by which stakeholders use power to attain goals. In addition, PE puts struggles and differences between stakeholders into a historical framework of structural alterations in the political economy, the objective of which is to place ecological problems in a political economic setting. Political scientists are interested in the effects of Green movements and lobby organisations on recognised political processes and the government's role in ecological conservation (Bryant and Bailey, 1997).

On another level, political ecology seeks to address the following objectives: 1) describe the socio-political circumstances surrounding the origins, understandings and management of ecological problems, and provide fundamental and generalised political interpretations for ecological change and degradation (Forsyth, 2003), and 2) comprehend and take part in all processes connecting people, nature and development. In line with these objectives, this study seeks to enquire how PE can be situated in the realm of changes in access to natural resources. This requires that scholars explore the motivations that bind us to our environment, reinforced by our day-to-day utilisation of particular biodiversity regimes, including our belief systems (Escobar, 1999).

Finally, political ecology is trans-disciplinary and diverse, and it comprehends ecological situations as an artefact of socio-political processes, connected to a continuum of scales from the local to the global (Bryant and Bailey, 1997; Wisner, 2015). Levels and scales are profoundly interwoven (Bayrack et al., 2013), and ideas emanating from different scales are shaped, distributed and used in ways that are integrally political (Escobar, 1999). According to Blaikie and Brookfields' (1987) "*regional political ecology*," emphasis should be placed on scales when studying alterations in human-nature relations. They labelled this method "*chains of explanation*" (p.27) and explained the link between land use and the environment in a context of soil erosion – not caused by anthropogenic factors, but initiated and brought about by precise and distinctive societal arrangements (Peet and Watts, 1996).

3.3.3 Central Research Fields

Political ecologists adopt different approaches in applying political-economy perspectives to the study of human-environmental interactions in the Third World. These different approaches mirror varied research concerns within the field (Bryant and Bailey, 1997). The first approach is actor-oriented and seeks to comprehend power and conflicts as products of different actors interacting and following different objectives to attain specific intentions (Long and Long, 1992; Svarstad et al., 2018). Conflicts stemming from resource use and access have been of major concern in ecological studies, particularly those examining the effects of conservation policies (Neumann, 1998; 2000) and the role of state and non-state actors (Svarstad et al., 2018). These studies explain how people resort to illegal livelihood activities to meet livelihood outcomes (Bloomer, 2009). The second approach, mainly used by geographers, focuses research on a precise area or group of environmental problems (soil erosion, deforestation, biodiversity loss, water pollution, climate change). For example, Blaikie (1985) described these issues in relation to connected political, economic and social factors effective at different levels. The third approach examined political-ecological interrogations of class, gender and ethnicity (Bryant and Bailey, 1997). Finally, the fourth approach investigated inter-related environmental and political questions within a particular geographical area. This area style took into consideration ecological and area changes in vulnerability and exposure of land, models of local progress and decline (Blaikie and Brookfield, 1987). A study by Adams (2009) on "*Sustainable or Green Development*" adopts these approaches. He studied if sustainable development resulted in fundamental political schemes and policy outcomes of diverse, important alternatives. It is worth noting that these approaches to Third World PE are not mutually exclusive (Bryant and Bailey, 1997). As expressed by Schmink and Wood (1987), philosophies are not irreproachable but either maintain or contest current social and economic arrangements. Thus, understanding PE involves analysing the manner in which different stakeholders cultivate and appreciate knowledge, and the manner in which related discourses are established to ease the way for particular stakeholder concerns (Escobar, 1996).

3.3.4 Political Ecology Contentions

Despite PE's multidisciplinary nature, and numerous contributions made to its development, it is not without criticism. Academicians from ecological sciences condemned it for placing a great deal of emphasis on socio-political facets of resource access, while neglecting the environmental and biophysical realities of the natural environment (Schubert, 2005). PE critics emphasise that ecology should be seen not as a theatre where people take decisions on resource access, use and management (Zimmerer and Bassett, 2003), and they question PE works that refuse to consider ecology agency and capability influence on human behaviour (Schubert, 2005). The term 'PE' has been used by some researchers to refer to the politics of ecological problems devoid of particular reference to ecology (Forsyth, 2003); for example, Bryant (1992) explained it as an investigation into the political pressures, circumstances and results of ecological change. In addition, Bryant and Bailey (1997) proposed that while PE discourse emphasises connections between the natural environment, government and other stakeholders, ecological politics as a discourse is focused on a government's position. Despite these criticisms, Robbins (2012) stresses that no study on environmental change is comprehensive without a major focus on who benefits from changes to resource control, or without examining who gets what – and from whom. Robbins' view is in line with this study, which seeks to examine natural resources exploited and used by communities, changes in resource management, access and utilisation and effects on people's livelihoods.

3.3.5 Climate Change in Political Ecology

Marx and Engels (1998) explained the role of capitalists' productive power in clearing continents for cultivation. Capitalist productive energies have led to species loss, resource reduction, environmental pollution and land degradation (Taylor, 2015). Their argument reflects how humans have become agents of environmental change (Gadjil and Guha, 1993; Crutzen and Steffen, 2003), and climate change has added to these risks, affecting nations across the globe and raising concerns about people's ability to shape their future (Hulme, 2010). This issue has become a major concern and important not only in science, but also in politics and society (Weber and Schmidt, 2016). The PE of climate change posits the practices and processes through which climate change is exercised and discussed (Little, 2013). Additionally, PE offers explanations for the reactions, reasons and effects of climate change, with roots from cultural ecology on people's adaptation to extreme climate conditions and political economy of hazards which presents the significance of a colonial past and an inequality to propagate exposure to hazards (Perreault et al., 2015).

Climate change is shrinking opportunities for the poor and widening the gap between the "haves" and "have-nots" (Human Development Report, 2007/2008). Moreover, it represents a strong force of anti-development that is watering down the existing unequal realisations of this contemporary period (Taylor, 2015). In response to these setbacks, PE is central to exploring how people and communities are affected by climate change, from a local to a global scale, by interlacing the physical environment with the causes of emissions and vulnerability, including the abilities of stakeholders and their perceptions on why the climate is changing and how it can be addressed (Perreault et al., 2015). Studies on global warming have a common historic foundation with PE in the development of a political economy perspective on food scarcity and threats, with primary attention given to promoting equality and mainstreaming sidelined populations (Hewitt, 1983; Blaikie et al., 1994). For example, in Piers Blaikie's co-authored book *At Risk: Natural Hazards, People's Vulnerability and Disasters* (Blaikie et al., 1994), climate threats (floods, drought and severe storms) were examined from a political economy viewpoint. Other political ecologists have addressed climate vulnerability from the perspective of neoliberal processes (land tenure, free trade and structural adjustment), explaining how peasant farmers in Mexican communities have been affected (Eakin, 2006), following which vulnerability has become central to the work of the IPCC and climate researchers (Perreault et al., 2015).

Alarcóns' (2012) work, entitled *Forests: Capital accumulation, climate change and crises in Chile and Sweden*, expressed that new forms of conflicts in today's ecological development are grounded in inconsistencies stemming from climate change politics. Climate change and energy shifts have placed natural resources in a conflicting situation in the following ways: 1) forests are primary factors in the carbon cycle and are equally important in the industrial carbon cycle, which denotes variations in the net carbon restoration ascribed to natural resources, and 2) although forestry and deforestation are major causes of greenhouse gas emissions, trees and forests may also possibly store carbon and are the bases for energy. As a result, forests are provided a dual role in climate change politics, with the utilisation of natural resources perceived as problematic and a means to resolve climate change. However, the binary role of forests intersects with the broader scope of climate change and other uses of fauna and flora, so it is therefore important not to examine natural resources separately from broader progressions of climate change.

The IPCC (2007) recognised these contradictions in their explanations on vital environmental positions. On the one hand, long-running sustainable natural resource conservation policies geared towards enhancing forest carbon stocks are also aimed at generating annual timber planting, to create huge sustainable mitigation gains. Conversely, the elongated mitigated scenarios beyond 2030 in the environmental sector could affect the interlink between intricate political, ecological and socio-economic features, which have been conceived in terms of contradictions and encounters in natural resources management. The work of the IPCC was greatly influenced by the Stern Review (2006), *The Economics of Climate Change.* This review suggested that REDD is the low-cost approach to coping with climate change (Stern Review, 2007) and eventually led to the Eliasch Review (2008), sponsored by the British government, which upheld Stern's view that about US$ 17-33 billion yearly is needed, if comprised in global carbon trading, to reduce forest emissions by 2030.

However, critiques of the Stern Review pointed out that his valuation of the reduction in greenhouse gas concentrations was considerably greater than climate science appraisals. Also, Stern depended on market processes, though climate change was seen as the market's paramount disappointment. Furthermore, the author failed to take into consideration forces within the global capitalist economy (e.g. market complications), which can alter cost variables on a daily basis. In an accurate scenario where costs take into consideration legal, practical and market constraints on logging, costs are less than US$ 6.5 billion per annum. This figure is approximately US$ 1.5 billion greater than that presented in the Stern Review (Grieg-Gran, 2008). PE contributes to REDD and carbon offsets in the manner in which it explores the relationship between institutions across scales (Perreault, 2015).

3.3.6 Relevance to the Study

Although forest-dependent communities have a close connection with their environment, as expressed in the paradigm of communalism (Descola, 1996), natural resources have stopped being seen as vital for indigenous people and are no longer considered to hugely important in the protection of the environment. It is not by chance that the present climate change crisis has engendered a new way of studying the human-environment nexus (Escobar, 1999). In my view, using a PE lens in this study is necessary, since PE research explores nature-society phenomena, and it pays attention to power relations and resource control (Kull et al., 2015; Håkansson, 2019), winners and losers in society and different components of the environment (Robbins, 2012). Furthermore, PE reveals the interactions between the different groups, individuals, powers and political processes involved in accessing and utilising natural resources and livelihood activities, and how personal and economic interests may compete in this regard (Bloomer, 2009; Bixler et al., 2015; Belsky and Siebert, 2016). Livelihood strategies and ecological processes are interconnected and jointly change over time, but they have been neglected and deliberately disregarded in appreciating people's livelihoods. PE provides the rationale behind a local understanding of traditional practices and accrued socio-environmental knowledge (Belsky and Siebert, 2016).

Political ecology draws attention to people's dependence on natural resources for food, water, medicine and spiritual values. Significantly, the political domain comprises the management of natural systems (water, climate and ecosystems), but formerly, changes in natural systems were believed to be beyond the sphere of human agency (Hulme, 2008). Nevertheless, in a period where human activities compete with worldwide geophysical practices in altering the environment, the trend, degree and magnitude of changes to these systems is seen as an issue of collective choice and therefore must be tackled within the sphere of politics (Steffen et al., 2011). PE addresses nature-society phenomena on the local, regional and global scales. It enables researchers to pay attention to the ecology, science and agency relating to the ideas and actions of different actors.

The place of politics in determining ecology in the Global South's ecological problems is currently dominant, and it is solely through political responses that answers can be conceived (Taylor, 1999). The state is in charge of reformatting space. Taking into consideration tenure arrangements and involving indigenous forest management practices in climate change plans, a balance between biodiversity and conservation can be struck. To some scholars, however, this is an illusion, since access to natural resources is influenced by internal and external stakeholders, and capital and power are influential forces (Bayrack et al., 2013). There is therefore no doubt why PE has considered the socio-economic effects that protected areas are having on forest-dependent communities – and how this results in struggles over resource access and land tenure (Holmes, 2014). The increasing attractiveness and prominence of conservation PE corresponds with the social importance of ecology itself (Vaccaro et al., 2013).

External forces such as climate change are redesigning biodiversity spaces and thereby changing indigenous people's relationship with the forests. If these spaces affect the availability, access and management of the natural resources of groups and individuals, there will be severe socio-cultural effects for the poor. This consequently affects the adaptation practices of people and the fundamental values (cultural, religious, social) which attach them to nature, natural resource management and ownership (Bayrack et al., 2013). These values are further affected by capitalism and the commodification of nature, thereby providing more space for political values. While the commodification of ecological products is grounded in capitalist ideologies shaped by politics, the capitalisation of nature has biological, cultural and social effects that need to be explored thoroughly (Escobar, 1999) using a PE lens.

Furthermore, the use of PE is justified in the following ways: 1) it explores the origins rather than the indications of social and ecological problems, 2) it examines the circumstances and alteration of social and ecological systems, with unambiguous attention given to relations of power, 3) it examines the unequal distribution of the effects of environmental change among actors and 4) it addresses how environmental systems are influenced by political and economic processes (Bryant and Bailey, 1997; Robbins, 2004, 2012). Based on these views, PE is a suitable approach for analysing climate-natural resource relationships in forest-dependent communities. Additionally, it complements the SLA, since, according to Kates et al. (2001), studies conducted using the SL lens do not provide a comprehensive appreciation of the political-economic constraints within vulnerability and adaptation studies. Despite the usefulness of PE and SLA in understanding the impacts of climate change on natural resources, they have not addressed the concept of perception, which is fundamental in this study. The next section therefore explores this element and its usefulness in comprehending perceptual knowledge and experiences.

3.4 The Concept of Perception

The previous sections of this chapter have explained the sustainable livelihood approach and political ecology, each useful in enhancing our understanding on issues surrounding livelihoods, natural resources and power relations. They do not, however, address perception, which is the focus of this study. This section describes perception and examines the related theories of naïve realism, Berkeley's idealism and sense-datum, and their relevance to this study.

3.4.1 Defining Perception and Related Concepts

The word 'perception' has been defined differently by many writers. According to Kumar (2009), it refers to the meaning a person ascribes to or subtracts from the knowledge he obtains via the sensory organs. Inbound stimuli relate to stored knowledge to produce a perception. Perception also refers to an interaction between humans and the environment, having first-hand knowledge of something (Hamlyn, 2017). Furthermore, it relates to individuals understanding and interpreting what is perceived, based on personal experiences (Kumar, 2009).

Perceptual knowledge is a person's understanding of something after perceiving it, implying perceiving something and remembering it, and it is either grounded on conclusions arrived at based on evidence and reasoning or information that is not proven and deficient of claims (Ginet, 1975). Furthermore, perceptual knowledge consists of understanding the environment through the recording of information, using our senses (sight, sound, taste, smell and feel) (Ginet, 1975; Kumar, 2009). For perception to happen, the perceiver has to be attentive in order to produce the stimulus for sensation (Kumar, 2009). Perceptual knowledge is not always representational, since decisions arrived at by the perceiver are at times different from the perceptual knowledge itself. Perceptual experiences are vital, due to the uniqueness of the perceiver's experience (Allen, 2019b).

3.4.2 Conceptualising Perception

Perception has mostly been used by psychologists and in behavioural studies. The perceptual process involves stimuli and responses (Garner et al., 1956), and it is driven both externally and internally (Pautz, 2010; Beck, 2019). Perceptual research aims at establishing something regarding the features of the perceptual system (Garner et al., 1956). Perception is exclusive to each person, and different people and societies may have their views about an object or happenings around them based on these perceptions (Kumar, 2009). From the explanations, it would be erroneous to think that perception is a physiological state, a mental process or a kind of behaviour, as these labels do not fully explain the concept. I propose a brief account of three analogies with related perception theories, in order to enhance understanding of the concept thereof: physical contact (naïve realism), subjective experience (Berkeleyan idealism) and imagination (sense-datum theory). Exploring these theories involves appraising them and determining their relevance to the study, but it also means in this instance expressing the extent to which they illuminate our understanding of how perception relates to climate change and livelihoods.

The first analogy is physical contact, grounded in the theory of naïve realism. Naïve realists believe that the real notion of perception has naturalistic leanings (Butchvarov, 1970) and embodies a relationship between objects and subjects (Allen, 2019a). In respect to this study, understanding ourselves as humans and the environment in which we live entails that perception be viewed as humans not separated from the physical environment and having a close relationship and contact with the physical environment. This means that indigenous people who live around forests and parks have an intimate and direct relationship with the natural environment; thus, a perceptual experience cannot take place if an individual does not interact with elements within the environment (Allen, 2019a). Naïve realism strongly maintains that perceptions are externally dependent, relational in nature and have outer objects as components (Pautz, 2010; Beck, 2019; Moran, 2019). These external objects shape our experiences and the ways we understand and interpret mind-independent objects in the environment (Putnam, 1994; Campbell, 2002; Allen, 2019a; Moran, 2019). Some naïve realists also believe that what a person perceives actually directs his consciousness, thoughts and experiences (Brewer, 2011;

French, 2014), thereby providing us with unique information that can surmount fears of reliability (McDowell, 2008). Other theorists suggest that a 'perceptions phenomenology' is shaped by the object, properties, standpoints, relations and characteristics (Campbell, 2009; Allen, 2019a). The relationship between the object and subject explain why some people see things attentively, critically and blurrily (Campbell, 2009; Fish, 2009; French, 2014). Proponents of selectionism in naïve realism explain a standpoint as the choice of perceived objects (Beck, 2019).

The second analogy concerns subjective experience and is based on Berkeley's idealism theory. Berkeley contends that the idea of an unperceived functional object is unreasonable and illogical, and the existence of objects involves being able to perceive them (Butchvarov, 1970). Relating to this study, Berkeley's argument is somewhat convincing. For example, an individual cannot envision the existence of an animal in the MCNP, except when he also envisions that he perceives it. Moreover, imagining the presence of a *Prunus africana* tree on farmland, according to Berkeley, would mean one is able to see it and touch it; thus, a person is able to imagine the *Prunus africana* tree as he would picture it from a particular standpoint, and therefore natural resources, indigenous livelihoods and perceptions are indivisible. Following Berkeley's reasoning, an individual cannot talk about a particular NTFP without agency of its existence and characteristics. From the aforementioned, the analogy using subjective experience has the same objective as that of physical contact.

The third analogy is based on imagination drawn from the sense-datum theory and expresses that "*perceptual knowledge comprises direct awareness of sense-data*" (Allen, 2019b:3). Moreover, according to the sense-datum theory, what is conceptualised should not always exist; it entails having a visual image of something else, but not necessarily identical to the item imagined. Therefore, the existence of the image is vital to the imagination – and not the object imagined (Butchvarov, 1970). Imagination does not mean what is imagined truly exists, though, i.e. people do not only imagine things embedded in their environment, because at times they imagine objects which do not physically exist, even though their imagination might be real. Drawing from my field experience in the MCNP region, elderly people believed in the existence of tigers in the past, although this belief was manifested through witchcraft, and in reality, in the MCNP region, tigers have never existed. This mental image of tigers had been transferred from one generation to another, and though it may not have been true, the visual and imaginary image of tigers still shaped their perception. Thus, equating perception to imagination provides us with knowledge on how indigenous people relate with objects in their environment. This view counters those of theorists supporting naïve realism, who state that "*if I am perceiving, then necessarily what I am perceiving exists*" (Allen, 2019b:4).

From the above, it is evident that the theorists of naïve realism, idealism and sense-datum have all contributed to our understanding of perception, but some are closer to this study than others. The research goal is based on indigenous people's accounts of changes in natural resources and livelihoods, and adaptation strategies linked to climate change. This means collecting information from people who interact with the environment and are live witnesses to changes therein. The research demands more than having a visual image of something as expressed by the sense-datum theory, and it entails acquiring detailed and reliable narratives from indigenous people who should have physical contact with and viewpoints on their environment – as we see in naïve theory and idealism theory – by being able to express what resources exist, as well as their uses and occurrences. Also, they should be able to explain how climate change and extreme events have affected natural resources and their livelihoods, thus endorsing the notion that there is an association between our perceptual knowledge and its qualitative nature and the world we perceive (Campbell, 2010) – validating the existence principle theorised by naïve realists but rejected by the sense-datum theorists (Moran, 2019).

Furthermore, the sense-datum refuses to accept the existence principle, articulating that it is impossible to perceive an object that does not exist (Moran, 2019). From my point of view, I cannot research the impacts of climate change on natural resources and livelihoods or document natural resources which do not exist. It is true that some natural resources might have become extinct, but this does not cancel the fact that they once existed in the past. If this is factual, then perceptual knowledge utilised in this study should be in reference to things which have existed and currently exist. This refers to the fauna and flora on which the local population depend for their livelihoods, but it also describes events and happenings which individuals and communities have witnessed within their environment. The different ways in which indigenous people use natural resources and interact with the environment reflect the qualities of the resources and are "*the phenomenal character of one's of experience*" (Moran, 2019:207). It is the phenomenal nature of perceptual knowledge which is vital in addressing the research goal and objectives. Thus, this perceptual study on the exposure of humans and natural resources to climate change, and the climate adaptation actions undertaken to protect the ecosystem and improve livelihoods, is based on the notion that:

> *"[...] to have an experience is to have a viewpoint on something: experiences intrinsically possess some subject-matter which is presented to that viewpoint. To understand such experience and what it is like, one has to understand the viewpoint on that subject-matter, and hence also to attend to the subject-matter as presented to the viewpoint. On this view, difference in presented elements between two experiences will be sufficient for difference in their phenomenal properties*"
>
> (Martins, 1998: 173-175).

3.4.3 Conclusion

This section has discussed the concept of perception by exploring different theories. Perception is understood to mean perceiving and imagining an object, but it also entailed the use of sensory organs in perceiving something and in relation to our personal experiences. Perceptual knowledge is seen as inferential, non-inferential, relational and varying between individuals, and perception itself is conceptualised using three theories: naïve realism, Berkeley's idealism theory and sense-datum. First, naïve realists suggest that for perceptual knowledge to be conceived, there must be an interaction between the perceiver and the object. Second, Berkeley's idealism theory expresses that all functional objects have to be perceived – and from a particular viewpoint. Third, the sense-datum theory connotes that the way objects are perceived is at times independent of how they are in the environment. These theories describe how people differ in the ways they perceive objects in the environment, and the different processes involved in perception. This section has helped streamline the convoluted concept of perception, thus enhancing its use in the study and its application during the empirical phase; however, it does not explain the subject of local perception, which is the true motivation of this research. The next section thus centres on the theoretical and conceptual frameworks of local perceptions and related concepts, and their relationship with climate change and natural resources. That is, it explores local perceptions and their effectiveness in improving our understanding of changes in natural resources, livelihood vulnerability and adaptation initiatives as a consequence of climate change.

3.5 Devolving Local Perceptions

The previous sections explored and critically examined existing information on the sustainable livelihood approach, political ecology and perception, and they specified their relevance to this research. While Section 3.4 shaped our understanding of the complex concept of perception, this section focuses on local perceptions.

Climate change is at the core of environmental concerns, and the growing interest in environmental change and the increasing awareness that science cannot provide all of the answers to environmental issues (Chambers, 1983) has prompted the need for local perception studies in the Global South. This is also true for the MC region. This study contributes to knowledge by using the concept of local perceptions and knowledge and related terms to explore how communities dependent on the MCNP for their livelihoods perceive climate variability and change. The PCVCBLA framework (Figure 3.2) is used to show the interconnectedness between local perceptions, biodiversity and indigenous livelihoods. The literature in this section addresses research objective two, which focuses on local perceptions and experiences of climate change, and objectives one and four, which address natural resource utilisation and access, respectively. The literature in this section will enhance understanding of local perception and knowledge, explore the connectivity between local perceptions and climate change, and lastly the rationale for looking at local perception in the study is outlined.

3.5.1 Defining Local Perceptions and Related Concepts

Much of the scholarly concern surrounding local perceptions and practices is explained by the following terms: ‘local knowledge’, ‘indigenous knowledge’, ‘indigenous knowledge systems’, ‘indigenous traditional knowledge’, ‘indigenous technical knowledge’, ‘traditional environmental knowledge’, ‘rural knowledge’ and ‘traditional ecological knowledge’ (Chambers, 1979; Brokensha et al., 1980; Neumann, 2005), or a mixture of these terms (Huntington et al., 2004). These concepts surfaced in the 1970s and 1980s as a means to bring forth alternative development strategies (Chambers, 1983; Richards, 1985). Local perceptions of environmental change should be understood as slices of bigger knowledge systems inbuilt locally, through continuous interaction with the environment (Berkes, 2009). They are inspired and shaped by local economic and religious experiences, by cultural and colloquial notions of their surroundings and by personal values and hybrid knowledge (Pepper, 1986; Blennow and Sallnäs, 2002; Descola, 2005; Rudiak-Gould, 2014). Individuals and communities have different ways of recognising, understanding, observing and reacting to their environments (Vignola et al., 2010). The differences in interests, perceptions and values affect the way environment and scientific evidence is perceived (Harris, 2004), and they impede efforts to arrive at global policies and agreements to protect the environment (Harris, 2004; Adger et al., 2007).

The indigenous knowledge system (IKS) refers to the complexity, distinctiveness and rationality of rural people's knowledge, while indigenous technical knowledge (ITK) has a health perspective and stresses the practical manner of rural knowledge (Chambers, 1983). Some authors use the term 'traditional ecological knowledge' (TEK) and see a common thread with traditional indigenous knowledge (TIK), because both are dynamic, grounded on people's close observations of an area and experience with the ecosystem through direct and indirect observations and are the basis upon which people's livelihoods depend (Huntington, 2000; Green and Raygorodetsky, 2010). Berkes (2009) notes that TEK and TIK are mostly used in global ecological change contexts. In this study, I shall use some of these terms, including others (local and indigenous knowledge), where appropriate, but I consider rural ecological knowledge (REK) as the most inclusive term, due to the fact that many of the world's remaining riches (landscape, linguistic, ecosystem and cultural) are found in remote rural areas (Green and Raygorodetsky, 2010). 'Rural' here includes all actors (individuals, indigenes, non-indigenes, groups, farmers, NGOs) living on the 'periphery' away from 'central' and 'urban' settings. The 'ecology' element of the term highlights the natural environment on which they depend for their livelihoods, and 'knowledge' emphasises the "*whole system of knowledge, and the process whereby it is acquired, augmented, stored and transmitted*" (Chambers, 1983:83).

Local knowledge refers to "*knowledge that is clearly spatially bounded within an identified locality; or it may be grounded in a culture or ethnicity*" (Forsyth, 2003:182). It is acquired through a broader observation and interaction with the environment (fauna and flora) (Huntington, 2000), and it can also be made known via learning from the rural people themselves (Chambers, 1983). In addition, it is knowledge that is specific to a group of people, a community, a culture or civilisation, individuals or places, and it is not open to outsiders but merges with belief systems (Warren, 1991; Ajibade, 2003; Forsyth, 2003; Berkes, 2008). Moreover, it is informal knowledge (Horsthemke, 2004) that has existed for an extended period of time (Mapara, 2009) and been used to maintain the local household economy (Poe et al., 2014). As people's beliefs and needs change, alongside the resources available to them, indigenous knowledge is amended and adapted to new ecosystems (Briggs et al., 2007). The social character of indigenous knowledge reinforces its culturally in-built notion, with various climatic and social elements considered interrelated (Orlove et al., 2010).

To some scholars, local knowledge represents a struggle against domineering universal philosophies on the environment, or the idea that local/indigenous knowledge is more nuanced and precise than the general views of outsiders (Forsyth, 2003). It is believed to be the foundation for local decision-making in environmental management, health and agriculture, as well as for policymakers and scientists seeking to enhance living conditions in rural areas (Warren, 1991; Kropp and Scholze, 2009). Much of the credibility of rural people's knowledge rests on the fact that it is inventive, investigational, vigorous and always integrating internal and external inspirations to manage new situations. It is perceived locally and verified in a livelihood framework, making it not merely 'yes' or 'no' in an impassive manner, as scientific knowledge may suppose; it provides solutions to current problems and is thereby significant in dealing with lives and livelihoods (Chambers, 1983; Kallard, 2000).

'Indigenous' means emanating from, and genuinely fashioned in, an area (Chambers, 1983). It embodies customs, non-Western beliefs, local practices and traditions (Horsthemke, 2004), but it also signifies what people know, do, have known and done, practices that have progressed by means of trial and error and are able to cope with change. Indigenous is related to verbal knowledge (songs art, stories, laws) handed down from one person to another over generations (Moller et al., 2009b; Poe et al., 2014) and grounded on people's interpretations, views and practices over the years (Ingty and Bawa, 2012). Labelling an area as 'indigenous' or 'local' designates it as powerless, marginalised and oppressed (Agrawal, 1995) by reiterating power relations (Chambers, 1997). Subaltern – or less represented – people include the poor, women and ethnic minorities (Forsyth, 2003). These groups are represented by development workers and researchers, with the objective of advancing environmental policies and justice relevant to local needs (Chambers, 1997).

3.5.2 Development of Indigenous Knowledge

The entire issue surrounding indigenous knowledge (IK) has been the subject of debates in human history. Before colonisation and the introduction of Western education, indigenous education was based on symbols, restrictions, respect for ancestral spirits and values. These indigenous beliefs, respected by people, were themselves laws and guardians of ecological control and ensured the conservation of natural resources from extinction and damage (Eyong et al., 2004). People protected nature, as they saw it as part of their tradition. With the coming of missionary and Western education during the colonial era, indigenous beliefs and knowledge systems were relegated to the background, discarded and negatively coded (Bryant and Bailey, 1997; Devlin and Zettel, 1999; Herbert, 2000; Nyati, 2001). Indigenous people were made to understand that indigenous knowledge systems were bad, low-grade and unconventional (Nyati, 2001), so that the colonisers could manage economically important ecological resources (Bryant and Bailey, 1997). This way of thinking still exists in policy arenas, albeit perhaps with diminishing importance nowadays, due to the growing acknowledgement that local knowledge is neither backward nor unproductive (Murdoch and Clark, 1994).

Avoiding environmental ruin and protecting natural resources in local communities was achieved through various local institutional regimes (Ostrom, 1990; Sanginga et al., 2010), but these were later marginalised by governments' territorialisation of natural resources (Ostrom, 1990). The '*Tragedy of the Commons*' suggested that collectively-owned resources should be under state protection or privatised (Hardin, 1968). This was followed by the debate that natural resources should be conserved as common-pool resources and protected areas as a means of protecting endangered species (Haller and Galvin, 2008). The capability of local communities in defining rules and playing a key role in achieving conservation goals (Borrini-Feyerabend et al., 2004) was later acknowledged in public discourses on protected area management, alongside indigenous and local groups claiming their rights as agents in resource management (Haller and Galvin, 2008). This awareness led researchers to explore the historical circumstances under which protected areas were created and the manner in which stakeholders effect forest management policies and approaches, with the objective to promote people-centred conservation (Adams, 2009). The participation of local people in the debate on global natural resource management indicates the willingness to collaborate with grassroot movements, reinforced by international conventions (Agenda 21, Convention on Biological Diversity (CBD)), international organisations (UNDP) and NGOs (WWF and IUCN) (Haller and Galvin, 2008). This collaboration should run alongside adaptive co-management and learning systems, if stakeholders are to cope with new challenges such as climate change (Moller et al., 2009a).

3.5.3 Indigenous Knowledge and Natural Resource Management

Indigenous knowledge and practices have always served as the foundation for effective environmental management systems, permitting concurrent exploitation and conservation (Bryant and Bailey, 1997), particularly in areas where scientific data are missing (Wong, 2016). IK and perceptions guide resource availability monitoring and lead to the successful design and the sustainable management of natural resources by local communities (Maule and Hodgkinson, 2002; Oldekop et al., 2012). Additionally, they provide information on the reasons and actions that can be taken to protect endangered species, thereby scientifically enriching the IUCN Red List criteria (IUCN, 2014). IK holders may be a unique source of biological and socio-ecological information for some plant and animal species not detectable through natural sciences (Wong, 2016), and hence, drawing from the notion of "popular epidemiology" (Brown, 1992), IK on the environment should not be considered less valid than scientific knowledge (cited in Martinez-Alier et al., 2016).

Protected area regimes that do not recognise knowledge diversity often provide a one-sided approach to species conservation and consequently fail to ensure good conservation outcomes (Berkes, 2012). Working closely with rural societies enhances understanding on how indigenous people are resilient to their environment (Berkes, 2012; Alessa et al., 2015). The CBD acknowledges the significance of perceptual knowledge for protection, sustainable management and biodiversity conservation, and it recognises the link between local and indigenous communities and the environment. Article 8 (j) of the Convention has the objective to encourage, respect and preserve such indigenous knowledge. Forest management plans and operations should include the rights and knowledge of local and indigenous societies, which can be done through the active participation and mainstreaming of indigenous people and local actors in the governance and decision-making process, based on consultations and information-sharing on projects and changes that may affect their lives. For example, REDD may be beneficial to indigenous communities, but this would depend on whether people have secure land tenure, provided space to participate in decision-making, are involved on an equal basis and there is free, informed and prior consensus on the use of their resources and land (SCBD, 2001).

Development practitioners who are educated in the "Global North" pay less attention to IK and manage resources in a rational and technocratic manner (Blaikie, 2000), because they are carriers of a system deeply embedded in them and they believe that unschooled and untrained rural people are uninformed and inexperienced (Chambers, 1983). This belittles the significance of indigenous information, even though it is continuously shaping people's lives in the Global South. Some development practitioners acknowledge that local decision-making guided by local agency is suitable, and it is the rationale for the management of resources (land, labour and capital) vital for the achievement of economic progress and development. For example, traditionally commons production is grounded on local consumption and minimising risks, rather than maximising surplus, meaning that pressure on natural resources is less than when excesses are sought. Resource exploitation is done whilst conscious of local environmental and social implications, with communities seeking to diminish the negative impacts of economic activities on the environment (Bryne et al., 2015).

3.5.4 Reactions to Indigenous Knowledge

Despite the increasing recognition of IK in environmental management and local development, it has not been without criticism. The claim that it should be the foundation of “bottom-up” development, according to Agrawal (1995), relied on a properly narrow construction of information. IK is built as a self-reliant form of understanding unconnected to modern scientific knowledge – a separation challenging to uphold for historical and validity reasons. Moreover, IK enthusiastically focuses on a deep understanding of people’s environmental conditions. By positioning it as the foundation for bottom-up development, Neumann (2005) expresses that some scholars ignore other knowledge systems (market conditions, outside institutional constraints and price variability) that indigenous people may not have but which may be vital for improving local livelihoods. Blaikie (1996) denounced advocates of IK and the local for merely substituting one dominant paradigm, namely progress, with neo-populism, and development critics who exchanged Western ideas with the local, thereby favouring local viewpoints without expounding the role of governments, international organisations and Western science. Furthermore, he condemned social scientists’ claim to revive IK and ridiculed their amazement about and passion for local people’s ecological knowledge.

Political ecologists consider IK a challenge to the excessively universal assertions on environmental decadence and as the basis for a development pattern which substitutes unsuccessful and unsuitable scientific arrangements built on modernisation theory (Neumann, 2005). For example, Hecht (1990) explained the potential for traditional soil management techniques to operate as the basis for durable agricultural prototypes for small agriculturalists in the Amazon (cited in Neumann, 2005). In the same manner, Richard (1983) discussed that Western thoughts on ecologically damaging traditional land use methods were centred on evolutionary prototypes of development that rejected indigenous land practices as mechanically and socially retrograded (cited in Neumann, 2005).

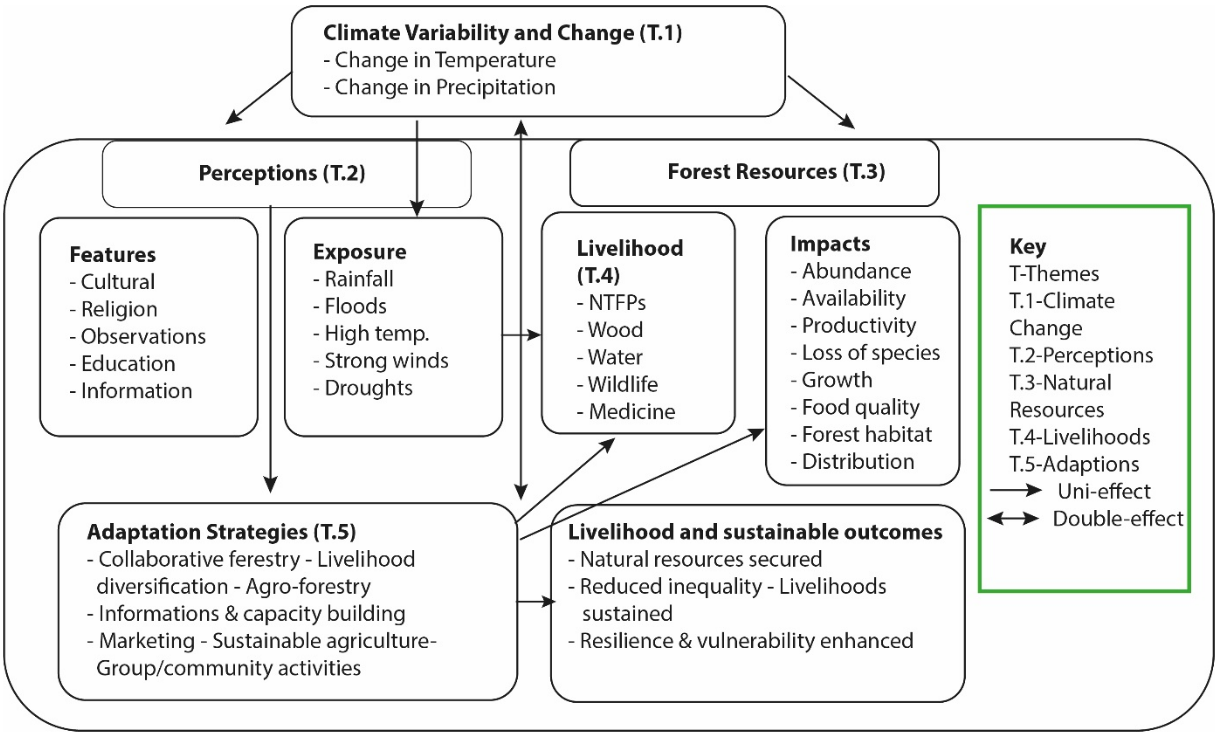
Alongside these contestations, the slow integration of IK into climate research and natural resources management is due to the fact that some development experts consider it an obstacle to economic growth (Riseth, 2007), whilst others see it as being rooted in cultures, outdated, timeless, unable to rapidly adapt to global ecological change and in opposition to the constantly progressive nature of society (Chambers, 2008; Moller et al., 2009b). Societies and cultures dependent on local knowledge are confined and operate outside the sphere of modernity (Chambers, 2008), and as a consequence, indigenous populations should be taken out of traditional isolation and placed into a modern system (Moyo, 2009). Furthermore, IK is tempting for its simplicity, a fault reflected in its interpretation as knowledge pertaining to a local environment, instead of the knowledge of people as a function of beliefs, a system of concepts and ways of learning (Chambers, 1983). Also, it is embedded with unclear ideas and follows holism by way of building collective psychological simulations, linking a huge quantity of qualitative variables and divergent to Western knowledge relying on lesser quantifiable variables (Berkes and Kislalioglu Berkes, 2008).

3.5.5 Local Perceptions and Climate Change

Climate variability and change are not isolated phenomena, since people and the environment are interlinked. Climate change and related effects are important issues to communities (Weber and Schmidt, 2016). The framework for analysing perceptions, climate variability and change, biodiversity, livelihood and adaptation (PCVCBLA) (Figure 3.2), as developed in this study, contends that people's perceptions are characterised by culture, religion, education, information and observations. These features determine how people understand and interpret changes in temperature and rainfall, as well as their attitudes to natural resources and adaptation strategies. Thus, understanding socio-cultural and environmental features is vital for the effective execution of adaptation plans suitable for local conditions (Patt and Webber, 2014), since they govern their attitudes to adaptation and mitigation actions (Engels et al., 2013). Knowledge on local perceptions can enhance our appreciation of environmental change in terms of its appearance and effects on communities. Marin (2010) explains that divergences between weather records and local perceptions of climate change illustrate the probable support that these can create in learning new ideas about environmental change.

The National Trust for Nature Conservation (2012) expresses that in the Himalayas there is a general lack of micro-climate data, and thus researchers rely on people's perceptions to understand ecological changes. As a consequence, local perceptions are vital to policies and programmes aimed at sustainably managing and protecting resources and promoting climate change adaptation and mitigation (Pyhälä et al., 2016). Though people's perceptions are important in climate analysis, stakeholders should acknowledge that experiences and meaning ascribed to environmental risks depend on the context and vary between individuals and societies, so it is unrealistic for scholars to label environmental risks as uniform, global or shared threats (Forsyth, 2003). If the international community does not recognise differences in views and experiences, it might enhance inequality, sideline the most vulnerable (Weber and Schmidt, 2016) and influence efforts at reaching international compromise in climate change policies (Adger et al., 2007). Close collaboration is thus required among actors on all scales and within various socio-cultural and knowledge regimes (Weber and Schmidt, 2016).

Figure 3.2: Multi-dimensional framework for analysing Perceptions, Climate Variability and Change, Biodiversity, Livelihoods and Adaptation (PCVCBLA) strategies in forest- dependent communities.



Source: Vivian NTOKO, 2018

3.5.6 Rational for Local Perceptions in the Study

For decades, indigenous people have vigorously provided meanings to natural ecosystems unknown to outsiders. Individuals and groups understand nature depending on their social standing and are influenced by historical periods, and so experience is therefore a function of one's degree of interaction with the environment and social relations (Escobar, 1999). Forestry programmes are void of context-specific, indigenous-based experiences and practices (Belsky and Siebert, 2016), but nevertheless, individuals, groups and household phenomena that trigger local environmental processes occur in local communities (Wilbanks and Kates, 1999). Perception studies explore "*worlds and knowledge that the sciences have effaced or only gleaned obliquely*" (Escobar, 2011:139).

In a world that is rapidly changing, researching and documenting local principles, and understanding local practices across generations and communities, is becoming more vital than ever before (Moller et al., 2009a). This notion is based on evidence (IPCC, 2013) that weather-related events affect local communities, and the poorest are often unrecognised by standard climate observations in low-income countries. Results generated by global climate models are inefficient when used in local assessments (Kropp and Scholze, 2009), as they fail to include localised variations between regions at lower and higher altitudes, or precise climate situations in valleys. Moreover, in a baseline and sustainable development assessment study in Bolivia, Cameroon, Costa Rica and Sri Lanka, Westhom et al. (2009) found out that these countries, in relation to REDD, lack reliable data on forest areas and climate trends, due to remote and inaccessible forest areas. Jodha et al. (2010) concur that accurate information on weather is not usually available at the micro-village level. To reduce this feasibility and information gap, weather information joined with local perceptions on seasonal variability and impacts would enhance assessments of climate change impacts on natural resources (Jodha et al., 2010; Masinde and Bagula, 2011). This means that more social and anthropological knowledge on local perceptions of climate change is needed in areas such as the MC region, if "*we are to fully understand, and therefore effectively manage, the natural resources of Mount Cameroon*" (Lambi and Ndenecho, 2010:123).

Furthermore, Green and Raygorodetsky (2010) studied "*Indigenous knowledge of a changing climate*" in Australia and saw the need to merge scientific and indigenous knowledge. They expressed that the world's remaining biodiversity is found where indigenous people live, as they hold site-specific knowledge and play a vital role in preserving locally resilience and environmental systems. In addition, Vogel and O'Brien (2003) found that seasonal forecasts by farmers are effective in increasing food productivity and ensuring food security among communities reliant on agriculture and vulnerable to climate variability. Thus, indigenous forecasts of seasonal variations can fill gaps in climate data, therefore valorising their role in predicting seasonal changes. Nevertheless, perceptual climate knowledge remains a largely unexploited area (Gearheard et al., 2010), and attempts to incorporate it in development are currently coming up short (Shiferaw et al., 2013). This study adds to knowledge by exploring indigenous perceptions of climate change in villages around MC, the importance of which is that knowledge originating from local communities has the benefit of being locally specific and comprehensive, and it varies from adaptation strategies and local vulnerabilities, to specific weather parameters (Kropp and Scholze, 2009). Although this section has examined local perceptions, a vital feature of this study, it does not provide information on climate change, which is another cornerstone of the research. The next section thus examines existing knowledge on climate and environmental change and its linkages to indigenous livelihoods and biodiversity.

3.6 Devolving Climate and Environmental Change

The preceding section explored the significance of local perceptions and knowledge in understanding environmental changes and the vulnerability of indigenous livelihoods to climate change. This section explores climate and environmental change, since the study involves an exploration of climate change impacts on natural resources and vulnerability of livelihoods. It uses the PCVCBLA framework (Figure 3.2), as well theoretical and empirical knowledge, to explore the interconnectedness between climate variability and change, livelihoods, ecosystems and forest resources. Writings on environmental change (soil degradation, biodiversity loss, climate change) are of great importance in understanding climate variability, human and climate co-habitation and the relationship between climate change and people's livelihoods in forest-dependent communities. The literature in this section will enhance understanding and historical accounts of climate change, explore international reactions to climate change and examine the interconnectedness between climate change, biodiversity and livelihoods.

3.6.1 Understanding Climate Change

Climate change refers to significant variations in temperature, wind patterns and rainfall for an extended time period (Kaggwa et al., 2009; United States Environmental Protection Agency (USEPA), 2009). It is a change in the statistical distribution and average weather conditions in the climate system, and it is related to human activities that change the configuration of the global atmosphere tallying with natural variability, including wind, temperature and precipitation (Kaggwa et al., 2009). The natural control regime performed by atmospheric gases maintains the Earth's temperature in an equitable state which sustains life and economic activities. These gases (carbon dioxide, nitrous oxide, ozone and methane) confine the radiation which penetrates the Earth's surface and sends it back to Earth, therefore heating it. They act like a greenhouse, and hence they are called ‘greenhouse gases’. Human activities (livestock rearing, transportation, deforestation, burning of fossil fuels, agriculture) send greenhouse gases into the atmosphere, consequently heating the Earth’s surface and bringing about global warming (Kaggawa et al., 2009). The core of the discussion about climate change comes from evidence and signals from scientists and scholars that more than 90% of current global warming stems from anthropogenic activities (IPCC, 2007a; Stern, 2007; Yanda et al., 2010; Lal et al., 2011) significantly triggering the greenhouse effect through the rise in the atmospheric concentrations of CO_2 (Jensen, 2009; USEPA, 2009; Harris et al., 2015), therefore placing this gas at the centre of environmental policies, discussions, desires and targets (Swyngedouw, 2010).

3.6.2 Historical Accounts of Climate Change

Climate change is not new (Mendelsohn, 2009), since the Earth’s warming began around the late 1800s (USEPA, 2009). Researchers indicate that climate change is without boundaries, wrecking our planet and affecting all Earth systems (oceans, atmosphere, forests) with important consequences (Gore, 1992; Clark et al., 2008). Although there have been differences in opinion on whether the climate is indeed changing, scientific communities all approve the notion that the temperature is increasing, along with environmental and human impacts (Jensen, 2009; Yanda et al., 2010). The general approval of the authenticity of climate change is shown in a statement by the United States Global Change Research Program (USGCRP), Third National Climate Assessment (2014):

> “*Evidence for the climate abounds, from the top of the atmosphere to the depth of the oceans. Scientists and engineers from around the world have meticulously collected evidence, using satellites and networks of weather balloons, observing and measuring changes in location and behaviours of species and functioning of ecosystems. Taken together, this evidence tells an unambiguous story: the planet is warming [...].*”
>
> (Cited in Harris et al., 2015:3)

The USGCRP made this statement after the IPCC (2001) report which expressed difficulties and uncertainties in climate predictions and the incompleteness of technical knowledge (Lal et al., 2011). Later reports by the IPCC expressed with certainty that since the 1950s, unprecedented changes have occurred (Harris et al., 2015), with warming mostly attributed to anthropogenic factors (USEPA, 2009). Climate change is undisputable, proven by sea level rise, increased warming of the atmosphere and oceans, growing concentrations of greenhouse gases and a reduction in the quantity of snow and ice. The warmest periods over 139 years, according to the National Oceanic and Atmospheric Administration (NOAA), were from 2014 to 2018 (Borunda, 2019).

The IPCC projected in the 20th century a rise of 1.2 to 1.4°F, and in the 21st century it quoted 3 to 7°F (IPCC, 2001). Climate change at this rate is accelerating faster than over the past 10,000 years (USEPA, 2009). Average temperatures are on the rise daily (USEPA, 2009), with an envisioning of a temperature variation by 2100 of between 1.5°C (2.7F) and 4.8°C (8.6F) (Harris et al., 2015). Experts predict temperature increases and catastrophic sea level rise by 2100 (Horton et al., 2014; Jackson and Jevrejeva, 2016). The IPCC report projects that in the 21st century, warming in Africa will increase faster than the universal average (Niang et al., 2014), and even though the continent is the lowest emitter of greenhouse gases contributing to global warming, it will suffer most (Nilsson, 2008; Lynn et al., 2011), due to low capacity to adapt, high dependence on climate-sensitive natural resources, high poverty, low per capita GDP, an unadaptable financial sector and institutions and a lack of safety nets (Thornton et al., 2006; Nilsson, 2008). The faster it warms, the greater the negative risks of climate change and higher adaptation costs, especially for poor people and sensitive ecosystems which may find difficulties in adapting even to minor changes. The objective of global action is thus to moderate the risk and chances of greater and more rapid warming (USEPA, 2009).

3.6.3 International Reactions to Climate Change

Climate change debates and scholarly works are grounded in the invocation of danger, uncertainty and socio-ecological distress for future generations. Scholars and activists express that climate change has huge dimensions (Swyngedouw, 2010) rapidly occurring at a record pace (NTNC, 2012), and if ignored, it might fundamentally disturb the Earth's system, with grave consequences and the premature end of human civilisation (Gore, 1992; Stern, 2007; Swyngedouw, 2010; Lal et al., 2011). Gore's evangelical film *An Inconvenient Truth* is one of the most revealing demonstrations of climate change threats (cited in Swyngedouw, 2010). The Stern Review (2007) warned that if immediate action is not taken, climate change will drastically reduce human development and threaten economic growth. Stern forecasts huge levels of damage and estimates that effective policies could slow – but not stop – climate change. Thus, stakeholders should mobilise energy now, to escape from an imminent environmental catastrophe and to moderate costs. Furthermore, instant changes in regulations would incite swift technical improvements that would lead to increasing declines in emissions at nearly no additional cost.

In response to the Stern Review, Mendelsohn (2007, 2009) expressed that economists always give too pessimistic a view of climate change, and hastily designed policies will not be efficient or cost-effective. The effects of climate change and variability on humanity and ecosystems are over-estimated, and extreme conclusions have been reached. Stern under-estimated that present investment costs of 1% of GDP can solve the problem, whereas the United Nations estimated not less than 5% of GDP (Monckton, 2006). His reasoning in this regard was grounded on a wrong supposition that the discount ratio is almost zero, an assumption highly challenged (Dasgupta, 2008). Stern highlighted the significance of adaptation but provided little credibility to adaptation studies and over-estimated the probable outcomes of impacts (Mendelsohn, 2009). His assumption that climate change will lead to an increase in extreme events was misleading and based on a misinterpretation of statistics on damage from severe occurrences caused by societal factors (Pielke and Downtown, 2000). The greatest challenge of climate change to economic growth is the acceptance of a costly and unproductive mitigation policy that heavily pulls down the world's economy (Mendelsohn, 2009). Furthermore, Davidson et al. (2003) expressed that development can be fashioned in such a manner as to attain its objectives and diminish exposure to climate change, thus enabling durable development that achieves local, regional and national goals. To achieve these goals, the North and South should promote an integrated approach to development and put in place international mechanisms to support them. It will be dangerous for countries in the South to have their development affected by climate change policies.

3.6.4 Linking Climate Change, Biodiversity and Livelihoods

Climate change, biodiversity loss and livelihoods are key human concerns, but the connection between them is not fully recognised. These features affect and are affected by each other (Yanda et al., 2010). Due to the complex interlinkage occurring between the natural and human regimes, effects on one regime will affect the other, and the exposure of one regime will possibly lead to the vulnerability of the other (Sonwa et al., 2012). Focusing efforts on addressing one without the others can undermine natural and social resilience (Yanda et al., 2010). Climate change is affecting the living conditions of humans and ecosystems

(Swyngedouw, 2010; Morzillo and Alig, 2011) in terms of human well-being, the vitality of natural ecosystems, water supplies, precipitation, the extinction of fauna and flora (IPCC, 2007b; Sonwa et al., 2012) and a rise in extreme events (Stern, 2007) with millions of people exposed to flooding (Dasgupta et al., 2009). The PCVCBLA framework (Figure 3.2) presents the linkages between climate variability and change, and biodiversity and livelihoods. Variability in temperature and precipitation at all-time levels (days, seasons, inter-annual variations) affect physical and biological regimes, with the ideal signals of climate change in the form of seasonal changes and mean temperatures. Scholars focus research on changes in temperature and precipitation, because physical and biological reactions to temperature and precipitation are more comprehensible and anthropogenic indications easily perceived (Niang et al., 2014).

Climate variability and change also influence sustainable development (Boko et al., 2007; Kaggawa et al., 2009), in addition to the challenges of migration, inequalities, socio-cultural barriers, land tenure and health (UNDP, 2016a). It is a challenge to realising development objectives, such as health, equity, poverty, food and water provision, and eradicating poverty and hunger (Boko et al., 2007; Kaggawa et al., 2009) by slowing down actions to achieving Agenda 2030 and the SDGs (Marley, 2017; OECD, 2017). Moreover, it is an obstacle to the survival of the marginalised and poor despite them contributing less to the problem (UNDP, 2016b). In the past centuries, human development has made substantial progress, but millions still remain in the poverty trap, and in every community, some people suffer more than others. Focusing on climate change and development is a complex undertaking, but it is imperative for poor people and vital for achieving the 2030 Agenda and SDGs (UNDP, 2016a).

Climate change also affects other sectors, namely biodiversity conservation, tourism and energy production (Food and Agriculture Organisation (FAO), 2015). The effects occur as a result of pollution, deforestation, forest degradation, climate change and fragmentation (FAO, 2016), while increases in tropical cyclones are accompanied by high windspeeds and rainfall, due to continuous warming (Dasgupta et al., 2009). In response, forest regulations and programmes such as REDD should ensure that effective tenure and entitlement rights are put in place alongside collaborative management regimes involving all stakeholders, if people's livelihoods and ecosystems are to be secured and the poverty and environment gap reduced (UNDP, 2016b).

Global South countries are exposed to climate variability, with impacts heavily felt by Africa's already less resilient population (Barua et al., 2013; OECD, 2017). These countries have faced socio-economic and environmental problems, now worsened by the current climate change (Barua et al., 2013), with subsequent effects on economic growth (Mirza, 2003). The impacts of climate change in the Global South are also worsened by the disproportionate sharing of development benefits, especially in Africa, where inequality is greatest. This inequality stems from human capabilities, gender inequality, geographical location and economic opportunities. About 7.6 million people in 2014, and 23.5 million people in 2015, were affected by natural disasters in Africa (OECD, 2017) – a significant increase that could be reduced by enhancing holistic development, which integrates resilience to shocks and climate change (Davidson et al., 2003; Adger et al., 2004), and building resilience through inclusive growth, conflict prevention, peace promotion and disaster risk reduction, as part of Agenda 2030 and SDGs (OECD, 2017).

3.6.4.1 Climate change and biodiversity

Climate is a vital feature which determines the spread and availability of ecosystems suitable for different species (Parmesan and Yohe, 2003; Thomas et al., 2004; Audubon Society, 2010; Yanda et al., 2010). Climate change will affect the quantity, distribution, communities and assemblages of species (Hansen et al., 2001). Much of Africa's biodiversity is found in protected areas threatened by climate change and variability (Boko et al., 2007), and any decrease or loss in biodiversity is difficult and impossible to repair (Julius et al., 2013). The first signals of climate change are noticeable in mountain areas, since mountain species are more sensitive to ecological change (Lambi and Ndenecho, 2010) in terms of range and endangered species (Leemans and Eickhout, 2004; National Tribal Air Association (NTAA), 2009). In addition, according to the Millennium Ecosystem Assessment (MEA), biodiversity (fauna and flora) loss is due to increasing habitat dilapidation and heightened by the impacts of climate change (MEA, 2005) disturbing cycles that regulate biodiversity, such as biological processes that determine population growth as well as plant and animal ranges (Julius et al., 2013).

Ecosystems are predominantly exposed to climate change (Stern, 2007), and forest changes are closely connected to species; therefore, forest and range communities can be disturbed because of climate change (Dale et al., 2000). There is a high degree of certainty that climate change and variability are leading to species loss and extinction, and they restrain climate envelopes and spaces populated by plants and animals. Changes in ecosystems have been found in Southern Africa at a speed faster than expected as a result of climate change (IPCC, 2007). For example, with a temperature increase of 2°C, about 15-40% of species risk extinction (Stern, 2007; IPCC, 2007a). Climate change will affect forests through changes in distribution and categories, increases in wildfires, pests and diseases and negative impacts on biodiversity (Lal et al., 2011). Ecosystem vulnerability is worsened by turbulence (drought, wildfire, floods) and general change drivers (the unsustainable exploitation of resources, land use alterations). This will be accompanied by negative changes in species interactions, geographical location, the availability of food and water (Niang et al., 2014) and seasons traditionally suitable for reproduction or growth. Any activities (reproduction, growth) outside their suitable conditions and settings may lead to inapt conditions (Lal et al., 2011). Changes in seasonal and ecological conditions are used as measuring standards to examine whether or not physical and morphological changes are adequate (Visser and Both, 2005).

Temperature increases and changes in rainfall patterns are having intense effects on forest systems (Hare, 2006) by extending the range of certain harmful insects (Callaway et al., 2010), changing animal and plant group configurations and increasing pest outbreaks and wildlife disturbances (Morzillo and Alig, 2011). For less than a 1°C increase, the consequences are usually minimal, but in some situations it is not irrelevant, especially for very fragile ecosystems. Over a 1°C increase, the dangers are important, particularly for vulnerable environments and species. Above 2°C, the effects are extremely high, comprising huge amounts of losses and ecosystem breakdown, hunger epidemics or water crises, with socio-economic challenges particularly for African countries (Hare, 2006). The increasing levels of CO_2 will have immediate effects on ecosystems and biodiversity, especially tropical forests (Körner, 2004). The drying of the Amazon, as projected by climate simulations, would cause dieback of the forested area with the greatest biodiversity on the globe (Stern, 2007).

Climate change modifies vegetation types and density, extends dry land (Lal et al., 2011) and shifts the community of major flora types (Gonzalez, 2011). Increases in temperatures are changing the life-cycle events of flowering plants ((Visser and Both, 2005; Gonzalez, 2011), such as blooming, and insect appearance is moving from spring to autumn (IPCC, 2007). By the 2080s, the proportion of arid and semi-arid land in Africa will increase by 5-8% (Yanda et al., 2010). In response to climate change, plant species and groups are moving to the poles, ascending in altitude and flowering earlier than previously, with consequent effects on wildlife dependent on them (Morzillo and Alig, 2011).

Environmental alterations caused by temperature change affect fauna species differently, grounded on their personal characteristics and capacity to cope with changing habitats (Morzillo and Alig, 2011). Natural climate alterations have induced huge topographical modifications in species range, variations in the configuration of biological groups and species loss. Many genera are unable to occupy new spaces because former ones have become inappropriate. The coaction between climate change and habitat damage is endangering an increasing number of species (Peters, 1990). Habitat loss, damage and fragmentation are hindering species from stretching to different climatically suitable spaces. Their ability to resist in suitable climate areas is hampered by new, intrusive and aggressive species. Biodiversity hotspots are experiencing a loss of thousands of species (Malcolm et al., 2006). There is a projected change of humid tropical forest from 1990 to 2050 accompanied by 6.3% species extinction (Thomas et al., 2004). Some researchers express that unless a substantial amount of greenhouse gas is reduced from deforestation and transportation, warming might overtake the capacity of numerous species to adapt (Gonzalez, 2011).

Furthermore, animals are facing difficulties in adapting, because tree dispersion and growth are slower than climate warming, and therefore the future availability of fauna and flora might face a net decrease (Peters, 1990). By 2050, climate-prompted changes in habitat will drive 15-37% of species to extinction (Maclean and Wilson, 2010). The variety and dispersal of species will change, and those that cannot adapt will become extinct (USEPA, 2009). Alterations in the habitats and behaviours of species do not occur in isolation but are linked through relations with other species on the same or similar levels. Thus, changes to lower levels may instigate bottom-up effects through environmental systems and prompt feedback reactions (Walther, 2010). Hotter temperatures and precipitation variations are negatively disturbing the habitats and migratory configurations of several wildlife species (USEPA, 2009). The movement of species to upper altitudes and latitudes may be affected if not accompanied by associates such as crossbreeds (Hansen et al., 2001). Scientists express a northward shift in climate range for several species. Climate range refers to the area which has the ideal climate conditions for a particular species to thrive, and assemblages of species might change (Hansen et al., 2001; Audubon Society, 2010). Climate change is leading to the spread of epidemic diseases, resulting in the extinction of about 1% of amphibian species from tropical forests (Pounds et al., 2006).

Most amphibians are tightening their ranges for survival (Loyola et al., 2013). By 2050, ranges suitable for amphibians will reduce (Alisson, 2014). Biodiversity loss can be reduced by averting species extinction, which requires urgent and clear conservation policies and programmes being put in place (Ricketts et al., 2005).

Animal movement is vital for a healthy ecosystem (Moore, 2011). Alterations in ecosystems by climate change interrupt the timing and movement of migratory species (Parmesan et al., 1999) through fragmentation, habitat disturbance and changes in resources availability (Moore, 2011). The progression of spring coming to life by 2.3 days each decade (Parmesan and Yohe, 2003), and an increase in fire incidence and severity, changes species composition and movements and leads to habitat modifications for specific animal species (Morzillo and Alig, 2011). Reacting to climate change is slow for sedentary wildlife species. For instance, out of 35 non-migratory European butterflies, 63% will shift northward and 3% southward (Parmesan et al., 1999). Climate change is also affecting the timing of egg-laying and migration. If spawning and migration are done together, then the impact on the ecosystem is trivial, but if changes are not done jointly, then reproductive realisations for most species are drastically affected (Nye, 2010). In response to higher temperatures, some species are moving to upper altitudes and latitudes (Julius et al., 2013). Parmesan and Yohe (2003) predict an important range shift of 6.1 km per decade in the direction towards the poles and higher altitudes. Most species might not catch up with climate change, due to restrictions in seed distribution, thus resulting in a loss of plants and animals, leading to huge variations in species phenotypes and generating new groups (Lal et al., 2011; Julius et al., 2013).

3.6.4.2 Climate change and livelihoods

Climate change is affecting people's lives and livelihoods (Stern, 2009; Yanda et al., 2010; Lal et al., 2011). This vulnerability is worsened by unequal access to capital, inequality, globalisation, poor governance and water crises (Boko et al., 2007; NTNC, 2012). With increases in temperature and emissions, the IPCC envisages more adverse than positive effects to human well-being (Yanda et al., 2010; Harris et al., 2015). Climate change is affecting livelihoods in the following areas: tourism, water, forest, human well-being, coastal resources, household assets, reduction in agricultural output, high occurrence of hurricanes and extreme weather events, loss of forest area and extinction of species and energy (Pearce et al., 1996; Mendelsohn, 2009; Harris et al., 2015). Climate change is affecting these sectors, because they are climate-sensitive (Mendelsohn et al., 2006). According to Boko et al. (2007) about 25% to

40% of animal species vital to tourism are endangered. Consequently, changes will unwaveringly disturb human well-being, cultures and development (Jensen, 2009), in addition to a loss of employment and household income (Mäler, 2008; Lal et al., 2011).

Many rural communities in the Global South are exposed to the impacts of climate change due to their high dependence on forestry and agriculture, aligned with their geographical location in vulnerable environments (Duchesne and Wetzel, 2002; Mendelsohn et al., 2006). They often live in politically and economically peripheral areas of fragile ecosystems and are tied to natural resources, considered traditional lands for hunting, trapping, farming, spirituality, culture and gathering (Mendelsohn, 2009; MINFOF, 2014). Price changes due to warming are being seen in forestry and agriculture, with the trickle-down effect being felt by consumers, especially forest-dependent communities (Mendelsohn et al., 2006). Rural communities will be affected by ecosystem changes, since they rely on NTFPs for their survival, health and food security.

Climate variability and effects on livelihoods are due to uncertainties surrounding forest products, changes in productivity, decreases in availability and consequently increases in food costs (Lal et al., 2011; Lynn et al., 2011). Invasive plants will extend their range, and non-timber forest products will be significantly affected by pests, therefore reducing their availability to forest-dependent communities (NTAA, 2009). Furthermore, the threat to subsistence and culturally significant natural resources could lead to a sense of loss of place and culture (Lynn et al., 2011). For example, hotter temperatures affect the Porcupine caribou herd, an important resource vital to the welfare of Old Crow, Yukon people. Temperature changes have reduced the birth rate of this animal by 20% and caused a decline of 4% per year (Eamer et al., 1997).

3.6.5 Conclusion

This section has elaborated on the meaning of climate change and provided a historical account thereof. Climate change was defined by statistical distribution and average weather conditions over a long period of time, and climate variability was explained by referring to the day-to-day changes observed in weather conditions. The section also explored the evolution of climate change debates from a scientific perspective, revealing that it is attributed to anthropogenic factors, proven by increases in sea level, greenhouse gas concentrations, a decrease in snow and ice and an increase in atmospheric warming. Climate change is a threat to humanity, especially those in Africa, who are dependent on climate-sensitive ecosystems.

Despite the series of reports on climate change and its gravity, international views and approaches on how to tackle the issue are still divided. Presently, temperatures are on the rise and are expected to continue to increase. Also, the section reveals that climate change and biodiversity and livelihoods are interrelated and affecting each other. The PCVCBLA framework (Figure 3.2), expounded for this study (elaborated in Section 3.5.4), highlighted the interconnectedness between climate variability and change, biodiversity and livelihoods, thus enhancing the analysis of the research goal and objectives. The framework shows how climate variability and change are impacting natural resources, and consequently livelihoods, thus constructing a broad analysis of the subject under study.

Furthermore, the section showed how climate variability and change are affecting the achievement of development goals and the 2030 Agenda. The main argument is that climate change is affecting the marginalised and the poor, who are mostly dependent on climate-sensitive natural ecosystems. Also, climate change is affecting flora species in the following ways: changes in the timing of flowering plants, alterations in vegetation types and density and changes in the productivity and availability of NTFPs. This section also contributed to exploring the link between climate change and fauna, thus enhancing understanding of climate impacts on biodiversity and livelihoods. Climate change is affecting wildlife habitats and food, leading to movements to suitable locations. In this regard, some animal species are surviving, while others risk extinction. Finally, the section focused on the relationship between climate change and livelihoods, expressing that the livelihoods of native people in the Global South are mostly affected due to their significant dependence on NTFPs and agriculture. Climate change has reduced the availability of forest products and influenced food costs. However, this section has not explored adaption strategies vital to understanding how individuals, groups and communities cope with climate variability and change. The ensuing section centres on adaptation initiatives taken to tackle the impacts of climate change.

3.7 Adaptation to Climate Change

In an era of increasing deforestation, capitalisation of nature, biodiversity loss and growing poverty, adaptation to climate change presents a new challenge to forest stakeholders involved in the utilisation and management of forest resources (Gerardo et al., 2010). This study focuses on adaptation to environmental changes rather than mitigation, though they can be dealt with simultaneously (Forsyth, 2003). It explores how individuals and communities reduce the impacts of ecological changes affecting their livelihoods by exploring climate adaptation strategies, since it is vital for natural resources and forest-dependent communities (Gerardo et al., 2010). The PCVCBLA framework (Figure 3.2) is used to show the link between adaptation initiatives and outcomes. The literature in this section explains the etymology of adaptation, defines adaptation and related concepts and examines international responses to adaptation and reactions from stakeholders. Furthermore, the section addresses adaptation approaches and ends with the rationale for adaptation in this study.

3.7.1 Etymology of Adaptation

The word 'adaptation' comes from the Medieval Latin word *apare ad* (Corring, 1980), used in English in the 16th century to refer to the act of adapting, meaning to adjust (Corring, 1980; Simonet, 2010). Adaptation was incorporated in alterations in the 19th century, due to the development of biology (Simonet, 2010; Yan and Galloway, 2017). Adaptation denotes a duality of outcomes and the artefact of a process (Ghiselin, 1997; Simonet, 2010). Adaptation is a historical concept (Ghiselin, 1997) with theoretical roots of duality traced back from the Theory of Evolution (Simonet, 2010).

3.7.2 Prelude to Adaptation

Adaptation to ecological change and climate variability is not a new issue. Historically, people have adapted to climatic changes, using different approaches and environmental knowledge accrued through past experiences. For example, communities in the Sahel region have always coped and responded to droughts linked to unpredictable precipitation and famine conditions by diversifying livelihoods and introducing new crop species (OECD, 2009). Africa is more vulnerable concerning climate change than wealthier countries in the Global North, because it faces numerous stresses and low adaptive capacity, due to frequent disasters and dependency on natural resources (Niang et al., 2014). When it concerns adaptation, most nations in the Global South and North rarely integrate the wellbeing of the coming generations and the poor in society (Pelling, 2011). Though countries like Cameroon have been coping and adapting to climate change, with increases in stresses, existing strategies are probably unable to deal with the current climate threat, given the challenges of corruption, health, lack of data and information and poor institutional regimes (Niang et al., 2014).

The adaptive aptitude of a community designates its capacity to change attitudes and ways of doing, in order to handle external changes effectively. Adaptation to climate change entails two stages: 1) people initially perceive that the climate is changing and 2) they recognise and decide on different adaptation options and execute them (Maddison, 2006). The greater a society's adaptive aptitude, the lesser its vulnerability to climate variability and change. Adaptive features include: justice, wealth, institutions, knowledge and expertise. Rich nations have greater capabilities, thereby holding greater adaptive ability for climate change (Lal et al., 2011). Though the initial effects of climate change can be resolved through adaptation, alternatives for effective adaptation reduce, and related costs increase, in line with growing climate variability. Currently, there is no definitive boundary to adaptation and costs, because operative strategies greatly depend on the region, scale of risks, financial, political and institutional constraints (Niang et al., 2014).

3.7.3 Defining Adaptation and Related Concepts

3.7.3.1 Adaptation and mitigation

The IPCC, since its First Assessment Report (1990), has provided two approaches to deal with climate change: mitigation (decreasing the emission of greenhouse gases in the atmosphere) and adaptation (decreasing the vulnerability of humans and ecosystems) (Houghton et al., 1990; Gerardo et al., 2010). The IPCC (2007b, WGII) defines adaptation as any adjustments in natural or human systems in reaction to immediate or anticipated climatic stimuli and impacts (Wenger et al., 2004; Yan and Galloway, 2017). Adaptation permits individuals, groups or communities to survive better a threatening situation (Yan and Galloway, 2017), reduce vulnerability and exploit profitable opportunities that the climate may offer (IISD, 2003; Tompkins and Adger, 2003; Wenger et al., 2004). Adaptation comprises regulations, political and economic strategies and agencies geared towards diminishing reliance on natural resources affected by ecological alterations, moderating exposure to extreme climatic events, reinforcing adaptive aptitudes, offering safety nets and sustaining societies most impacted by climate change (Forsyth, 2003; IISD, 2003). Adaptation used in geography brings to mind the natural environment, meaning interlinkages between the physical and the social, and the natural and the cultural (Simonet, 2010). The different definitions of adaptation show that there is no mutual consensus on the term (Kropp and Scholze, 2009).

Adaptation can be anticipatory or reactive. Anticipatory adaptation occurs when societies adjust before the start of the impact, whilst the reactive element happens when measures taking the form of rebuilding are introduced in reaction to the start of the impact (IISD, 2003; Yan and Galloway, 2017). Adaptation actions are usually interwoven and may create a continuum

(Adger et al., 2007), and their measurement depends on the following: timing, scope, purposefulness and adapting agent (OECD, 2009; Yan and Galloway, 2017). Adaptation can be classified in various ways: scale (local to national), sector (biodiversity, agriculture), type of action (monitoring, market), actors (communities, individuals, NGOs, states) and climatic zone (mountains, coastal zones), or a mixture of these and other types (Adger et al., 2007). Related strategies for communities include technical (sea defences), attitudinal (modifications in food and leisure selection), managerial (changes in farming methods) and policy (regulations). Obstacles to adaptation are ecological, socio-economic, informational, attitudinal and behavioural (IPCC, 2007; OECD, 2009). Decisions on adaptation are entrenched in social processes that reveal the liaison between groups, governments, aptitudes and systems (Adger, 2001).

The concept of adaptation, used in environmental adaptation in the context of land tenure, management practices and approaches, denotes socio-economic survival despite ecological changes and population increases (Batterbury and Forsyth, 1999). Some scholars question the attribution of adaptation to solely natural selection, and they see a link with ecological adaptation (Rosslenbroich, 2014), which refers to ecological management approaches and livelihood strategies that permit the conservation of natural resources, regardless of the presence of poverty, insufficiency or population increase. However, ecological adaptation not only occurs on the local scale, but it also consists of international and national approaches, policies and capabilities in terms of environmental change (Forsyth, 2003). Adaptation is a contentious issue, because it is viewed by some opponents as a means to adapt to changes instead of preventing environmental degradation, thereby overlooking the fact that if we continue to doubt destiny, changes in the climate regime might occur speedily, with efficient adaptation being unable – and costly – to solve the problem (Gore, 1992). Approaches to adaptation sideline ways in which ecological changes can be controlled and regularised when they are not grounded in local traditional knowledge and beliefs (Forsyth, 2003). Besides adaptation, mitigation is important to dealing with the effects of climate change. The etymological origin of mitigation stems from the Latin word *mitigare*, meaning to "make mild or gentle" (Martinovski, 2006). It refers to dealing with climate change effects by reducing their severity (Füssel and Klein, 2006) and can be achieved through innovative policies, changes in behaviour and production techniques. These measures are vital in reducing greenhouse gases, but doing so at the lowest possible cost (OECD, 2018).

3.7.3.2 Resilience

Fundamental to comprehending adaptation is the concept of resilience, which has its origin in engineering (Yan and Galloway, 2017). Resilience differs between individuals, households and localities (IISD, 2003) and denotes their capacity to endure the effects of the challenges posed by climate change while sustaining livelihoods (Folke et al., 2002). It is shaped by assets owned by people and external services, and for the majority of people in the Global South, access to external services is tremendously reduced, and thus resilience to them is largely mirrored in local asset availability (IISD, 2003). In addition, resilience is geared towards maintaining existing institutions and power relations, and it is a subcategory of adaptation, with adaptation divided into three groups: resilience (sustaining the present system), transition (incremental change) and transformation (major change). Transitional adaptation is preferable but also has flaws, in that it does not question the current regime. Transformation could be an alternative, since it entails restructuring and questioning the social, political, economic and cultural regimes linked to development, safety and hazards (Pelling, 2011).

3.7.3.3 Vulnerability

The word ‘vulnerability’ originates from the Latin *Vulnus*, denoting “a wound,” and *vulnerare*, which means “to wound.” Precisely, the word stems from *vulnerabilis*, used by the Romans to explain wounded soldiers, thus referring to early damage and not imminent stress. Generally, vulnerability refers to the character, extent and inconsistency in the level of climate change to which socio-ecological systems are susceptible in terms of events that consist of shocks and disturbances (IPCC, 2007; Reed et al., 2013). Vulnerability in a community is explained by poverty, marginalisation, inequality and institutional adaptation (Kelly and Adger, 2000). For local communities, vulnerability refers to an inability to circumvent, manage or deal with the negative effects of events that alter their livelihoods and lie outside their direct control (IISD, 2003).

Vulnerability to climate change can be worsened by the manifestation of non-climatic stresses which decrease resilience and adaptive aptitude. For example, effects on biodiversity include changes in the availability of non-timber forest products and medicinal plants that are important for the survival of local communities, unequal access to resources, poverty and economic globalisation. The vulnerability of communities to climate variability and change is also a function of development trajectories followed on different scales (Niang et al., 2014); for example, there may be huge variations in a nation’s approach to biodiversity conservation.

While on the local scale natural resources such as *Prunus Africana*, found on MC, are for subsistence use, the GoC has authorised commercial exploitation by Plantecam (French company) and the International Transactions Trade Company in Douala (Page 2003; Lambi and Ndenecho, 2010). These differences under alternative scenarios are determining features in the degree of people's vulnerability to climate change (IPCC, 2007). This is especially so in situations where it may affect the availability and quality of natural resources on which people rely for their survival. The major goal of adaptation is therefore to ensure security and sustainability for both humans and the natural environment (IISD, 2003). To achieve this goal, this study will explore how people more vulnerable to climate change sustain their livelihoods, the vitality of natural resources in people's livelihoods and different adaptive measures engaged to reduce vulnerability and increase the resilience of humans and biodiversity. This is not as easy as it appears, for climate variability is not the only factor influencing people's lives (IISD, 2003). This research thus acknowledges this view and adopts varied research methods and techniques (see Chapter 4: methodology) to explore people's perceptions on the dynamics of livelihoods and natural resources to vulnerabilities brought about by climate variability and change.

3.7.4 International Actions to Climate Change Adaptation

In retrospect, it is astonishing that the IPCC for several years deliberately emphasised more on mitigation to climate change and overlooked adaptation. The IPCC focused on decreasing greenhouse gas emissions and promoting new technologies to cope with climate change effects (Yan and Galloway, 2017). The IPCC First Assessment Report expressed that though climate impacts may increase, scientific evidence was not convincing, while the Second Assessment Report explained that understanding of climate change occurrence is inadequate (Houghton et al., 1990). The IPCC (2007) Fourth Assessment Report (AR) provided incontestable proof that climate change is anthropogenic. From the first IPCC publication in 1990, scholarly understanding and awareness and policy reactions have been on the rise on international, national, regional and local scales (Locatelli et al., 2008). There has been growing awareness that the temperature is rising at an increasing rate (Gerardo et al., 2010), alongside increasing incidents of storms and floods globally, consciousness about the necessity for adaptation as vital and discussions in this regard on all levels (Gerardo et al., 2010; Yan and Galloway, 2017). The IPCC (AR5) expressed that climate change is an interlinked issue, among others, and its features are grounded in a blend of complex and dynamic problems, which explains why adaptation has been watered down in climate change deliberations for years (Yan and Galloway, 2017).

Adaptation is thus a new issue within the framework of international climate change negotiations. The United Nations Conference on the Human Environment (Stockholm Declaration, 1972) provided an open door on how to tackle the challenge of protecting and enhancing the environment. Although it did not focus on adaptation, it set the scene for future environmental policies, conferences and declarations (Handl, 2012). The most renowned international response to adaptation is the UNFCCC (1992) and the Kyoto Protocol, 1997 (Locatelli et al., 2008), which marked "a loss of innocence" (Indonesia's Minster of Population and Environment) and the start of a "new international ecological order" (Sand, 1993). Looking keenly at articles of the UNFCCC, Article 3.3 makes no mention of adaptation but explains that interest groups should adopt protective measures to avert, anticipate and reduce the reasons for climate change and its impacts (UN, 1992). Article 4.1 (b) mentioned adaptation in its expression that all parties should frame, execute, make public and continuously appraise national and regional projects comprising actions to mitigate and simplify adaptation to climate change. Furthermore, adaptation became more visible in Article 4.1 (e), clearly explaining that all stakeholders should work together to draw up and expand suitable and inclusive plans for coastal area management, water resources, droughts, floods and desertification, especially in Africa (UN, 1992). Both the UNFCCC and the Kyoto Protocol have been slated for their lethargic interference and inability to realise a significant breakthrough in global climate policy (Böhringer, 2003; Pettengell, 2010).

The first international response to climate change adaptation began in the COP to the Framework Convention (COP-1 Berlin, 1995). During this meeting, stakeholders took the decision (Decision 11/CP.1) to deal with adaptation in three stages: 1) inclusive planning with research on the effects of climate change, detect specific exposed societies, policy alternatives for adaptation and suitable capacity development; 2) actions comprising capacity-building, appropriate to organise for adaptation and 3) processes to enhance efficient adaptation, as well as insurance and new adaptation measures (IISD, 2003). Much attention was placed on adaptation in the Marrakech Conference of the Parties, 2001 (COP-7 Marrakech, 2001), with specific funds (Least Developed Countries Fund) allocated to develop national climate change mechanisms, capacity-building and the reporting and identification of adaptation necessities. In this regard, many meetings have attempted to develop inclusive approaches to handling adaptation; for example, the Nairobi Work Programme (2005-10 programme) emphasised the themes impacts, vulnerability and adaptation to climate change. The programme aimed at helping countries enhance their appreciation of climate change and make knowledgeable judgements on realistic adaptation choices (OECD, 2009).

At Montreal (COP-11 Montreal, 2005), a Five-Year Work Program on Adaptation for Least Developed Countries was approved, with a focus on the scientific, technological and social aspects of impacts, vulnerability and adaptation to climate change. At Nairobi (COP-12 Nairobi, 2006), a Subsidiary Body for Scientific and Technological Advice was delegated to address vulnerability, impacts and adaptation to climate change as stipulated in the "Nairobi Work Program." Alongside this initiative, deliberations were held on the "Adaptation Fund," intended to collect a 2% share of proceedings from the Clean Development Mechanism (CDM). The Bali, Indonesia, conference (COP-13 Bali, 2007) concluded with the approval of the Bali Action Plan (a two-year plan) for discussing a new climate agreement. Adaptation was one of the four pillars of the negotiations, and the aim was to provide resolutions and to agree on the overall management of adaptation and shape an imminent global framework to back up adaptation actions in the Global South (UNFCCC, 2007; Locatelli et al., 2008). This possibly resulted in a meeting organised by the Environmental Change Institute Oxford in 2007, to deliberate on how local communities perceive, react to and are affected by climate change. They also discussed people's capabilities and actions in reaction to climate variability (Salick and Ross, 2009).

The discussions at Poznan (COP-14 Poznan, 2008) finalised the Adaptation Fund under the Kyoto Protocol. The Adaptation Fund Board was given the legal authority to deal directly with developing countries. The Copenhagen (COP-15 Copenhagen, 2009) conference agreed on general terms for verification, reporting, improving actions and international cooperation on adaptation. It also stressed the necessity for a stable attribution of the sum of US$ 30 billion for mitigation and adaptation (UNFCCC, 2009; Khan, 2016). The Copenhagen Accord was criticised as a return to realism[6] (Khan, 2016), with adaptation in the Global South not considered an issue for countries in the Global North, since they do not reap any direct benefits (Barrett, 2008). At Cancun (COP-16 Cancun, 2010), the parties created the Cancun Adaptation Framework, aimed at strengthening institutions and establishing adaptation offices and international stakeholder networks (UNFCCC, 2010). Furthermore, the Durban conference (COP-17 Durban, 2011) made some advances in the establishment of a Green Climate Fund

[6] Realism theory refers to a situation whereby states maximise profits grounded on power politics and use available power to change situations in their favour (Khan, 2016). Thus for a realist, the impact of climate change on some countries without a trickle-down effect is not an issue, implying that adaptation in the poor nations is not a problem for rich nations since poor nations do not get direct benefits (Barrett, 2008; Vanderheiden, 2008)

aimed at providing US$ 100 billion yearly to help poor nations adapt to climate impacts. The Doha conference (COP-18 Doha, 2012) provided technical procedures to enable countries to develop national adaptation plans (NAPs) and encourage consistency throughout various adaptation channels (Morgan, 2012). The international community's financial support on climate change adaptation, provided to vulnerable countries of the Global South, operates through the UNFCCC, and adaptation planning is expedited through the National Adaptation Programmes of Action (NAPAs). Countries with NAPAs identify primary programmes to be executed in the near future to address pressing climate adaptation needs (Gerardo et al., 2010).

At Warsaw (COP-19 Warsaw, 2013), progress was made on discussions on the Green Climate Fund started in Durban and the Warsaw Framework for REDD+. The Lima conference (COP-20 Lima, 2014) emphasised that adaptation and resilience measures should be mentioned in nations' policies, with a special focus on vulnerable populations. In Paris (COP-21 Paris, 2015), parties agreed that the adaptation committee, least developed countries and expert groups should together develop guidelines to recognise the adaptation activities of least developed countries and strengthen regional collaboration on adaptation (UNFCCC, 2015). The first collective and legitimate text was the Paris Agreement, created during COP21 (UNFCCC, 2016a). The Marrakech conference (COP-22 Marrakech, 2016) aimed at reinforcing processes and protocols for the Paris Agreement (Klynveld Peat Marwick Goerdeler (KPMG) International, 2016), but it was met with reluctance by some parties (International Emissions Trading Association (IETA), 2016). In terms of adaptation, parties agreed that adaptation benefits should be substantial, through the quantification of needs, an increase in resource allocation and the intensification of capacity-building (Union Interparlementaire (IPU), 2016). Finally, at Bonn (COP-23 Bonn, 2017), parties emphasised enhancing dialogue among stakeholders and ensuring that capabilities to adapt to adverse impacts of climate change are strengthened and resilience encouraged (IPU, 2017).

3.7.4.1 Reactions to global adaptation policies

From the aforementioned, the international community has developed strategies and policies to enhance adaptation, but its actions have been considered by scholars as trivial, insufficient, a game of interest and top-down in nature. These conferences make no connections between global adaptation objectives, actions and those on the local scale (Buclet and Lazarevic, 2014). Moreover, in the IPCC 2nd Assessment (Vol. 2), adaptation features sparingly, and in 728 pages only 32 pages are dedicated to the subject (Wilbanks and Kates, 1999). From these numbers, one can deduce that despite international efforts, little attention is been placed on adaptation on the global stage, where decisions are made. Furthermore, information on adaptation is occupied by activities of the CBD comprising COPs. For example, at COP 4, indigenous participants arrived at the consensus to apply article 8j of the CBD, which emphasised respect for and the preservation of indigenous knowledge regimes (Escobar, 1998).

Following these conferences, Global South countries have had to pursue adaptation plans for which models have been instituted (WRI, 1995). These models and blueprints are conventionally designed and reflect the establishments of knowledge and power (Ferguson, 1990), which determine the agenda (Khan, 2016), with reactions from Global South criticising their "brothers" in the North for failing to discuss and negotiate financial and technological adaptation issues (Escobar, 1998). These establishments uphold neo-liberal philosophies and preserve the current status quo (Bulkeley and Newell, 2010). The motive behind adaptation funding is self-interest (Khan, 2016) geared towards inducing fragile states to stay as feasible companions in business, implying adaptation is a way to force poor nations to implement mitigation (Buob, 2009). As a consequence, financial aid is provided faster, ends faster and is not sustained over a long period. Adaptation aid alone will not help developing countries escape the climate trap, and financial assistance can only mirror climate-associated problems (Collier, 2007). It is therefore impossible to achieve climate adaptation on all levels as well as balance people's and environmental needs within current structures and institutions (Escobar, 1998).

3.7.5 Cameroon's Climate Change Adaptation Initiatives: Global and National Actions

Having discussed international actions and criticisms of climate change adaptation in the previous segment, this section examines adaptation actions carried out by the GoC. The objective is to comprehend GoCs' climate adaptation efforts to protect biodiversity and enhance livelihoods.

3.7.5.1 Cameroon's climate change adaptation initiatives at global and regional scales

At the global level, Cameroon signed the Biological Diversity Convention on June 14, 1992 and the UNFCCC in 1994 (Bele et al., 2009) and participates in all associated processes (ALM Cameroon, 2009). In collaboration with the UNDP, Cameroon elaborated climate adaptation policies in its National Communication to the UNFCCC (Bele et al., 2011; Taylor, 2015). Furthermore, the government developed procedures and steps to reduce greenhouse gas emissions in line with the 1996 Law on Environment and the Kyoto Protocol in 2002 (Bele et al., 2009; Brown et al., 2010). In 2008, Cameroon was accepted by the World Bank, among 30 Global South countries, to the Forest Carbon Partnership Facility (Brown et al., 2010).

In Africa, adaptation actions in relation to climate change comprise the Climate Change and Development – Adaptation by Reducing Vulnerability (CCDARE) programme, executed by the United Nations Environment Programme (UNEP) and UNDP in sub-Saharan Africa, including small island nations, the Southern African Development Community (SADC) policy paper and the Southern African Regional Climate Change Programme (RCCP). Also, Cameroon is part of the ClimDev-Africa programme introduced in 2006 and developed by the United National Economic Commission, African Development Bank and the African Union Commission (UNEP/UNDP, 2011; IPCC, 2014).

Regionally, Cameroon is a member of the Central Africa Forests Commission (COMIFAC), and it is charged with joint sustainable forest management in the Congo Basin. In October, 2009, the GoC jointly decided with Chad to protect the endangered Lake Chad, and in February, 2014, it approved the "Convergence Plan for the sustainable management of forests in the Congo Basin," (RCCU, 2015). Furthermore, West African countries have been involved in environmental protection and the fight against climate change through regional and national bodies. To achieve this objective, the African Union created a Meeting of Ministers of Environment and reinforced discussions at the sub-regional level to design suitable institutional guidelines (AGRHYMET Regional Centre, 2010). The coming together of stakeholders from different countries enhances information and good practice-sharing on adaptation, thus providing a platform for more diverse understanding and methodologies to come forth (Miller and McGregor, 2019). Cameroon also participates in the programme "Supporting integrated and comprehensive approaches to climate change adaptation in Africa," initiated in 2008 by the Japan International Cooperation Agency (UNDP, 2009). Both global and regional initiatives could have substantial influences on the biophysical and political facets of climate change, thereby suggesting that climate adaptation actions are being rescaled and regions are vital spaces for climate adaptation initiatives and governance (Miller and McGregor, 2019). Although a discussion of global climate change policies is beyond the scope of this study, the information provided in this section prepares the stage for discussions in Section 3.7.5.2 on Cameroon's adaptation initiatives and how they enhance biodiversity and livelihoods. Actions by the GoC to protect the environment and improve the livelihoods of forest-dependent communities have also been discussed in the contextual analysis (Chapter 2).

3.7.5.2 Cameroon's climate change adaptation initiatives national level

The discussions in the previous section have shown the GoC's involvement in environmental protection and climate adaptation initiatives at international and regional levels. The objective of this section is to comprehend further government actions on the national scale to protect the environment and government adaptation initiatives, and to understand how they enhance livelihoods and biodiversity.

Cameroon has a long history of poor environmental governance and policies, explained by the lack of detail and clarity on environmental issues after independence in its constitution and the delay in creating a ministry in charge of forestry (Taylor, 2015). Since independence, the GoC, in following the colonial footprints of preserving biodiversity, reframed its territory for commercial and political purposes, by restricting local use and increasing park creation to reinforce its grip over the territories (Neumann, 1998; Mbuagbo and Tanga, 2001). In the 1970s, the state eradicated indigenous tenure rights and introduced a regime of land registration, which was not popular with the rural population (Ngwasiri, 2001). Until the 1980s, local participation in biodiversity management was not of state interest (Galvin and Haller, 2008), as depicted in the Law of 27th November 1981, No. 81/13, which placed all natural forests under state control (Taylor, 2015). After the 1980s, there was a paradigm shift from state control to community awareness and participation, based on the realisation that top-down strategies such as policing, reserves and parks had failed to meet intended objectives (Galvin and Haller, 2008; Tumnde, 2001; Ingram, 2014).

To protect forests and wildlife, the GoC created the Ministry of Environment and Forest (MINEF) following decree No. 92/069 of 9 April 1992 (Foaham, 1996; 2001; Lambi et al., 2012) and promulgated the Forestry and Wildlife Law No. 94/01 of January 20, 1994 (Foaham, 1996; 2001; Taylor, 2015). The 1994 Cameroon forestry law created room for decentralisation, by involving communities in forest management and protection and thereby devolving authority from the state to the local level (Tumnde, 2001; Asanga, 2002; Anong, 2006). It enabled organisations such as the GTZ, WWF and the Wildlife Conservation Society (WCS) to work in collaboration with local communities in the creation of community forests, and to jointly manage natural resources. Community forestry is aimed at sustainably managing Cameroon's forests, eradicating poverty and enhancing local livelihoods (MINEF, 1995, 1998; Crook and Manor, 1998; Foaham, 2001; Tumnde, 2001; Zoa, 2009). The GoC, in the March 12, 1996, decree No. 96/050, created the Institute of Agricultural Research for Development, with focus on forestry and environmental research (Foaham, 1996; 2001), thereby merging forestry and agricultural research institutions. In the August 5, 1996, Law No. 96/12, a national environmental management plan (NEMP) was approved, serving as a guideline for biodiversity management and impact evaluations (Lambi et al., 2012; Taylor, 2015).

In 2004, the GoC created MINFOF, and in 2012 the Ministry of Environment, Nature Protection and Sustainable Development (MINEPDED) (MCNP, 2014), the aim of which was to direct government actions effectively. The conservation of national parks in Cameroon is entrusted into the hands of MINFOF (Mount Cameroon inclusive). MINEPDED is charged with the implementation of the REDD+ project on MC (Awung and Marchant, 2016) and the promotion of pillar three of the CBD based on access to, and the fair and equitable sharing of, generic resources (MINEPDED, 2016; GEF, 2018).

The evolution of Cameroon's forestry policies, and the adaptation to climate change, is in line with international conventions and perspectives on the protection and sustainable use of natural resources (Escobar, 1998) – as depicted in the re-enforcement of nature reserve laws in Cameroon, induced by the concern for sustainable development, an artefact of the Brundtland Report (1987) and the Rio Earth Summit (1992) (Lambi et al., 2012; Ayonghe, 2017). Nationally, the GoC has taken several measures to fight against climate change, and it has been part of international negotiations on REDD+ since 2005 (Maschler, 2011). The first REDD+ experimental scheme began in 2007 (Carodenuto, 2010). Funding for REDD+ is driven by the international community, with national stakeholders' involvement limited to technical issues (Dkamela, 2010). Furthermore, climate adaptation initiatives comprise the National Plan for Environmental Management (NPEM) and the First National Communication (NC1) to the UNFCCC. Apart from the NC1, policy documents scarcely mention climate change; for example, forest policies provide generalised notions on sustainable forest management but fall short of particularly integrating climate specific policies to address adaptation (Bele et al., 2011).

The National Adaptation Action Plan (NAAP) consists of climate adaptation and mitigation, and it is geared towards reducing greenhouse gas emissions (Bele et al., 2011). In 2008, the government implemented the "Green Sahel" programme, and since 2009, MINFOF and the National Agency for Forestry Development (ANAFOR) have planted about three million trees to regenerate forests. In 2009, 12,000 fruit and forest trees were planted by the Parliamentary Network for the Sustainable Management of Forest Ecosystems in Central Africa (REPAR) to fight desertification in the north of Cameroon. The National Observatory on Climate Change (ONACC) was created on December 10th, 2009, via a presidential decree designed specifically to fight against climate change (RCCU, 2015). Furthermore, the GoC 2009 Vision 2035 and Growth and Employment Strategy Paper 2010-2020 emphasised the need to involve climate change in all development policies and enhance actions to manage forest ecosystems sustainably (Nachmany et al., 2015). The aim of Vision 2035 is to educate stakeholders on the consequences of climate change on the economy and livelihoods, and to inform actors on different approaches and know-how to boost resilience, facilitate access to funding and technical assistance to deal with climate change. Setbacks to the realisation of this vision include: poor information-sharing, lack of motivation by politicians, poor governance, funding reliant on external aid, limited capacity-building and adaptation experience, as well as the involvement of local actors in adaptation planning and programming (Ministry of Economic Planning and Regional Development (MINEPAT) and UNDP, 2009). In addition, non-governmental and international organisations, notably the IUCN and WWF, have integrated climate change in their strategic plans and work closely with COMIFAC to encourage sustainable forest management (Brown et al., 2015).

3.7.5.3 Criticisms to government actions on environmental protection and adaptation to climate change

Looking at the numerous measures enacted by the GoC, one may be tempted to conclude that government actions to environmental protection have been significant. However, they are not without contention, and according to Balgah (2001) their application leaves much to be questioned. The Cameroon forestry policy is highly politicised and has colonial leanings reproducing European concepts and ideas of the past (Ngwasiri, 2001). Following British law, 'empty' lands belong to local communities, while according to French colonial law, 'empty' lands are owned by the state. In 1972, the reunification of Cameroon watered down and retained little of the British notion of communal land (Ngwasiri, 2001; Tumnde, 2001; Ingram, 2014), thus hailing the French idea of the government as the only 'proprietor' responsible for forest management and defining forestry policies, regulations and granting logging permits (Foaham, 2001). Also, the 1994 Forestry Law is criticised for been inefficient by undermining the goals it sought to obtain (Assembe, 2009b). In sections 8 and 4 of Decree 95/466, communities were only given usurp rights to resources in community forests (Ingram, 2014). Furthermore, community access to resources is not a clear set of laws, changing in line with tenure and affected by history and emerging formal and informal institutions (Ingram, 2014). In a world faced with environmental challenges, this involves understanding access dynamics caused by climate change (Assembe, 2009a).

Despite the actions undertaken by the GoC to fight against climate change and to promote adaptation initiatives, some scholars are of the opinion that actions are still premature (Brown et al., 2010), i.e. less priority is placed on adaptation to climate change and more emphasis goes toward reducing unemployment and poverty (Norrington-Davis, 2011). This nonchalant attitude and mediocre success is explained by the following: 1) climate change is not a major concern to politicians, especially parliamentarians with a limited term of office (Brown et al., 2010); 2) state departments and personnel at national and local levels lack the capacity to integrate climate change into programmes; 3) climate change adaptation is reliant on foreign aid; 4) Cameroon's focus on mitigation rather than adaptation is often linked to other societal concerns (Bele et al., 2011), proven by its involvement in fighting against climate change through the implementation of the Reducing Emissions from Deforestation and Degradation (REDD+) programme (Kehbila et al., 2014); 5) the creation of 35 reserves to preserve biodiversity and reduce carbon emissions, in order to fight against climate change, being labelled as 'ecological-social colonialism' and 'eco-imperialism' (Dietz, 1999; Nguiffo, 1999); and 6) some NGOs consider existing activities in forest-dependent communities as geared towards climate change, whilst others integrate climate change into programmes due to the availability of funds offered by donors (Brown et al., 2015). Furthermore, despite the threats posed by climate change in Cameroon, MINFOF, albeit responsible for forest governance, still plays a small role in planning and designing the foundation to fight against climate change, due to shared responsibilities with the Ministry of Environment and Nature Protection. Consequently, MINFOF does not formally participate in deliberations on climate change at the global level (Bokwe, 2013).

3.7.6 Climate Change Adaptation Approaches

Despite the fact that adaptation to climate change officially arrived on the international scene during the UNFCCC in 1992, communities, individuals and NGOs were already implementing measures to cope with environmental changes. At the national level, measures to deal with environmental change were on climate-sensitive sectors such as agriculture and forestry. These sectors are directly concerned with people's livelihoods, especially the most vulnerable in society, and are found on the molecular scale. It is on the local scale that adaptation interventions are most needed and benefits welcomed. Adaptation is closely connected to development, as activities carried out by individuals, households and governments to adapt to climate change are top of the MDGs and Agenda 2030. The PCVCBLA framework presents adaptation measures and initiatives taken by governments, communities, individuals and conservation and development projects to cope with the challenges presented by climate variability and change, and to achieve environmental and livelihood outcomes. The strategies include: collaborative forest management, marketing, capacity-building, group and community activities, livelihood diversification, migration, agroforestry and sustainable agriculture.

To achieve conservation and development outcomes, adaptation measures are matched with efforts to tackle associated biodiversity threats (Innes et al., 2009) and enhance livelihoods, and they are carried out jointly and separately. Adaptation strategies are reliant on people's perceptions, understanding and interpretation of environmental changes (Yu et al., 2014; Apgar et al., 2015), but they are also dependent on the degree of vulnerability and are carried out by people themselves and reinforced by outside agencies (IISD, 2003). Despite recognition of the importance of local perception, climate change and variability adaptation initiatives are worsened by power struggles and customs which divert the focus on local differences. Such focus is interpreted as very expensive, complicated, challenging and not feasible (Innes, 2016). Climate adaptation initiatives mitigate rural livelihood vulnerabilities and in the long run could stabilise flows of livelihood benefits, especially in mountainous regions (Agrawal and Perrin, 2008).

Stakeholders usually adopt comprehensive approaches aimed at enhancing sustainable development through mainstreaming climate change in development programme designs, strategies and policies (Agder et al., 2007; IPCC, 2007; Agrawal, 2008). At international and national levels, the REDD+ scheme of the UNFCCC has delivered prospects for sustainable management in tropical forests intended for timber production and reducing emissions (Sasaki et al., 2016). In the MCNP region, the PSMNR-SWR in charge of REDD+ is involved in the promotion of alternative income-generating activities. The provision of alternative livelihoods to forest communities is aimed at reducing dependence on forest resources and enhancing biodiversity conservation, but it is also geared towards adapting and mitigating climate change impacts. Socio-economic activities carried out by individuals, groups and communities around the MCNP region have been discussed in the contextual analysis (Chapter 2). Some of the livelihood activities are promoted by local NGOs with the aim of improving rural lives and ensuring biodiversity sustainability. Sustainable agriculture as an alternative to the 'slash-and-burn' method of farming is also encouraged through promoting agro-ecological farming. Both income-generating activities and agro-ecological farming are adaptation as well as mitigation approaches aimed at reducing forest dependence and improving local livelihoods.

Adaptive approaches are rarely carried out in reaction to climate change only but incorporated in other strategies and approaches such as community forestry, community-based natural resource management, participatory forest management, co-management, sustainable forest management, adaptive management and water management (Leach et al., 1999; Gilmour, 2016). These approaches, strategies, organisations and practices are aimed at enhancing the livelihoods of rural communities and involving them in the management and protection of biodiversity (Gilmour, 2016). In addition, they represent local voices and enhance participatory co-management (Tyler and Fajbar, 2009) by providing indigenous people with the opportunity to exhibit their knowledge of fauna and flora preferences and landscapes in the forest environment (Singh, 2008). These approaches to sustainable forest management are vital and should be considered as goals in climate change adaptation (Glück et al., 2009). 'Keys' to achieving these goals include safeguard tenure, good governance, equitable and regulatory policies, access to markets and information and recognition of indigenous cultures and knowledge (Gilmour, 2016). Their effectiveness depends on the establishment of a multi-criteria and joint decision-making structure to back up strategic sustainable biodiversity management decisions geared towards addressing the managerial (economic value of forest resources) and ecological sustainability (carbon sequestration, water management) of the forest (Alvarez-Miranda et al., 2018).

Adaptation actions are promoted by development and conservation projects through capacity-building and privileging local interventions in climate risk assessments (Yanda et al., 2010). Grounded on the notion of sustainability, they reflect an important link between climate change, adaptation actions and biodiversity in their fight against resource degradation and atmospheric carbon dioxide emissions for present and future generations (Singh, 2008; Eriksen, 2009). Some scholars propose co-management between stakeholders to address the impacts of climate change. Co-management refers to collective actions between resource stakeholders and governmental institutions to carry out resource management (Brown et al., 2002). Collective action is the combination of endeavours by more than one person, geared towards attaining shared objectives when individual action may be insufficient to obtain anticipated goals (Wade, 1987). In theory, co-management provides an alternative solution to natural resource management by creating and consolidating spaces (work, engagement, negotiation) through which actors may build people's resilience and aptitude to deal with the effects of climate change (Tompkins and Adger, 2003). Despite the hailing of co-management as a means of involving indigenous people in forest management, current decentralisation has been established in a manner whereby failure is unavoidable, with marginal and degraded land placed at the disposal of forest-dependent communities (Innes, 2016).

3.7.7 Rational of Climate Change Adaptation in the Study

Adaptation is a vital global response to climate change. The poor and marginalised face unique challenges and play an important role in planning, implementing, monitoring and evaluating local concerns (CARE International, 2010). Enhancing livelihood options for forest-dependent communities entails researching and broadening knowledge on climate-related changes, their manifestations and how they influence ecological systems and processes (Julius et al., 2013). Climate change will create new challenges, usually external to historical understandings, which are not enough to direct adaptation to climate-related impacts (OECD, 2009). Moreover, in spite of protracted knowledge on dealing with climate variability and change, there is significant proof that communities and climate-sensitive sectors remain poorly adapted (IPCC, 2007). Therefore, it is necessary to enhance adaptation and understand changes which may fall within and outside historical events (OECD, 2009).

For several years, the international community has concentrated on climate change adaptation on the global scale, with emphasis on the international political and economic regimes (IISD, 2003). Moreover, attention on vulnerability in terms of social and ecological systems has been examined on the regional scale, but with little focus on local impacts (Wenger et al., 2004). Managing climate risks has always been the duty of indigenous societies (Heltberg et al., 2009), and so adaptation should build from people's perceptions and strategies, particularly marginalised people, who are the most vulnerable (IISD, 2003). Context-specific knowledge and evidence is a prelude for any adaptation approach (Meyer-Ohlendorf, 2009). Some scholars have expressed the need to study local adaptation to enhance policies, inform resource management and add to scientific data (Robbins, 2012). Nevertheless, the difficulty with existing literature of climate change adaptation is in determining what drivers and impacts communities are adapting to, since local stresses and vulnerability come from various sources, climate change being just one of them (Pyhälä et al., 2016). This study fills this gap by using both qualitative and quantitative approaches and triangulation to understand adaptation strategies employed by communities on the ecosystem boundaries of MCNP, and impacts on livelihoods and natural resources. So far, the different concepts and theoretical frameworks useful in understanding the research have been discussed separately, but the next section links these different concepts elaborated in the previous sections of this chapter.

3.8 Linking the Concepts

Brainstorming how one might approach indigenous perceptions of the link between climate change and natural resources and adaptation initiatives aimed at promoting livelihoods and protect ecosystems in the MC region, the idea that "*a multifaceted cocktail could give a rounded perspective*" (Ingram, 2014: 44) through bricolage, manifold perspectives and diversity (Scoones, 2009; Ingram, 2014), to me at least, is the most appropriate way forward. Employing theoretical approaches of SLs and PE alone would not provide a comprehensive view, since no one could entirely come to grips with the research. The literature therefore has to draw further theoretical and empirical inspiration from multidisciplinary research themes and concepts of perceptions, adaptation, local perception and knowledge, livelihoods and biodiversity and environmental change. The significance of each concept and theme is emphasised to different degrees (Chapter 3: literature review). Theorising in a comprehensive manner these themes and concepts in the literature is necessary in understanding issues relating to the study generally – and specifically in the MCNP.

The question is, how do I present a 'multidimensional buffet' from these multidisciplinary concepts that will be suitable for this research? The SLA offers a fundamental framework (Figure 3.1) useful in exploring the livelihoods, institutions and survival strategies of people faced with the challenges posed by environmental change. The PE enables the assessment of politics and stakeholders embedded in accessing natural resources and determining benefit sharing, thereby to be integrated into the SLA and evaluated. The processes embedded in an

SLA and a PE are connected to a set of socio-environmental associations (Ferrari, 2015) implicit in the climate and natural resources nexus. Livelihood adaptation, though inherent in an SLA, is further developed to explore climate adaptation approaches to natural resources. Theorising on climate adaption recognises the initiatives taken at global, regional, national and local levels to fight against climate change and improve people's lives, but it also uses the PCVCBLA framework to elaborate on adaptation approaches taken by different stakeholders to achieve livelihood, conservation and climate change outcomes.

The SLA entails six forms of capital, measured using conventional economic and monetary values. The approach does not explain non-monetary assets such as the perceptions central in this research in understanding the natural resources and climate nexus. Thus, a perception research agenda, which is the focus of this research, recognises the importance of bottom-up approaches and the role of local communities in providing site-specific information vital to understanding environmental dynamics. The linkage between local perceptions, climate variability and change and natural resources was highlighted in the PCVCBLA framework. Theorising and conceptualising perception was also vital in comprehending perceptual knowledge and experience processes, in order to facilitate data collection and analysis. Chapter 3 also theorised on climate and environmental change by providing the ecological, climate and livelihood relations implied in forest environments. This interconnectedness is emphasised in the PCVCBLA framework. Biodiversity, climate change and livelihoods affect each other, but climate variability and change also influence development efforts and slow initiatives set up to achieve development goals. The use and elaboration of different theories, concepts, frameworks and themes in this research is an indication that multiple 'lenses' are required to comprehend and get to grips with the vulnerability of indigenous livelihoods and natural resources to climate change impacts. The discussions in Chapter 3 also enhance our understanding of the research goal and objectives and prepare the groundwork for the data collection and analysis. The next chapter expands on the methods vital to addressing the research objectives and questions.

CHAPTER 4: METHODOLOGY

4.1 Introduction

Chapter 2 provided a contextual analysis of the study, while Chapter 3 discussed and examined the state of the art on themes and concepts of SLA, PE, perceptions and local perceptions, climate and environmental change and adaptation to climate change. Furthermore, it analysed their suitability for the study. This chapter focuses on the research methodology and explores techniques suitable to examining local perceptions of climate change and natural resources, and climate adaptation actions carried out to protect the ecosystem and enhance livelihoods in the MCNP region. According to Corbin and Strauss (2008:8), "*Events are the result of multiple factors coming together and interacting in complex and often unanticipated ways. Therefore any methodology that attempts to understand and explain situations will have to be complex*." To paint a comprehensive picture of the research problem, it is necessary to employ mixed methods to examine different perspectives. The use of qualitative and quantitative methods is deemed appropriate herein, as I wish to present a detailed appreciation of climate change impacts on natural resources valuable to people's survival, as well as outcomes of the study which could contribute to policy design. The methodology is determined by the nature of the study area, i.e. the notion that people are confronted with environmental changes and a world in which food crises, biodiversity abundance and availability reflect variations enforced by climate variability and change (Corbin and Strauss, 2008).

This chapter presents the research design and protocol, the research approach and sampling techniques. Furthermore, it explains qualitative and quantitative methods used in the empirical research and provides different sources of secondary data. The chapter also elaborates on the procedure used for collecting both quantitative and qualitative data in this study. Moreover, it explains the challenges faced during the study and how I sought to overcome them, in order to enhance validity, reliability and representativeness. Finally, it ends with a conclusion highlighting important aspects of the methodology.

4.2 Research Design

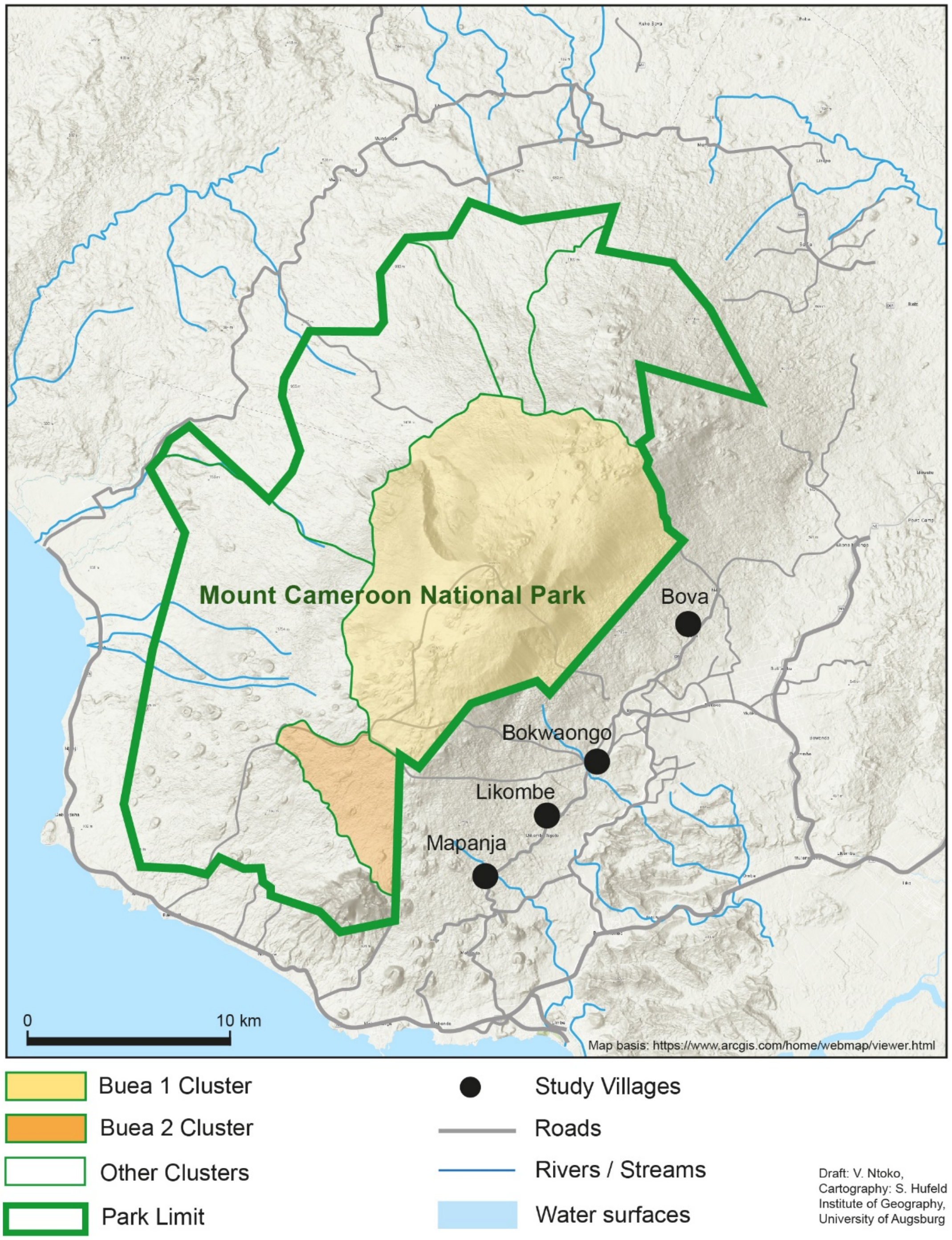
4.2.1 Study Area Selection

The study was carried out in Cameroon, specifically the south-west region, which is English-speaking. At the time of conceiving this research, Cameroon was considered relatively peaceful compared to other West and Central African countries despite insecurity in the north of the country caused by Boko Haram attacks. Around the end of 2016, instability began in the two Anglophone regions (north-west and south-west) of Cameroon until 2018 during the field research. Following Unwin's (2006) view on doing development research in politically insecure environments, and tied to financial constraints, it is necessary to work within a familiar setting. This also meant working with the English, French and Pidgin languages to facilitate and comprehend complexities during interviews and text analysis. Furthermore, Cameroon has a rich and diverse ecosystem, but despite efforts to protect its rich biodiversity, the nation still faces challenges of forest encroachment, population growth, high rural dependence on forest resources, increasing poverty, climate change and natural resource degradation. These features made Cameroon suitable for the proposed research to achieve the study objectives. Moreover, growing up in Cameroon, and having done a Masters' research in the Lobéké National Park, was a major advantage for the research, as I was already familiar with the situation in the country.

This research was carried out in selected villages in the MC area. This case study style is customary in qualitative research and is vital in studies aimed at examining concrete situations in historical and local terms, by observing people's activities in their local settings (Flick, 2002). Though the case study approach has often been disapproved of for its ability to deliver detailed knowledge on specific contexts, and the absence of generalised results, the significance of this study does not rely on the expansion of a theory or a climate model but in acknowledgement of the positioning of climate change in relation to natural resources and people's livelihoods. The MCNP is made up of 41 villages divided into six cluster conservation zones and villages. This research is classified based on the cluster division. Out of the six clusters, only three (Buea 1 & 2 and West Coast) were accessible and relatively secure during the research. Though West Coast was calm, leaving Buea to travel to this region was not safe, due to spontaneous attacks and killings in towns and villages between Buea and Limbe. The research was thus carried out in selected villages of the Buea 1 & 2 clusters (Figure 4.1). The selection of villages from two clusters was not aimed at doing a comparative study but was done in order to gain a detailed, broad and multi-level understanding (Tellis, 1997; Agrawal, 2007) of the themes under study.

According to Yin (2009), focusing on one area does not often provide the finest facts; instead, diverse and dissimilar cases are more illuminating, which explains why villages were chosen from two clusters with similarities and differences in socio-economic and biophysical features. This enabled the researcher to have a wider comprehension of natural resource use, local understandings of environmental change and an appreciation of climate variability's impacts on livelihoods, thereby providing information necessary to enhance and construct validity.

Figure 4.1: Map presenting Buea 1 & 2 clusters and study villages



4.2.1.1 Buea 1 cluster

Buea 1 cluster is made up of eight villages. Table 4.1 presents the villages and the biological and physical features on which the choice of village was based. All the villages are dependent on the mountain for livelihoods, have very similar climatic and ecological conditions and major economic activities and are dominated by the indigenous population (Bakweries). On the ground there is no clear demarcation between Bova 1 and Bova 2, but the division is for government administrative purposes (Mbella, 2013). In this study, these two villages will be considered as one (hence Bova). Buea 1 cluster villages differ in terms of population, altitude and proximity to the mountain and the degree of involvement in conservation activities, depicted by type of group and conservation benefits. Woteva's conservation benefit is explained by the fact that it has a community forest. Thus, its degree of dependence on the park might be less than that of other villages. Woteva and Bonakanda were insecure, due to the presence of Anglophone secessionist's fighters, and thus were not considered for selection. Buea village is heterogeneous and could not be considered due to the fact that village selection is not guided by population size and a necessity for representation but determined mainly by relevance to the study (Seale et al., 2007). Furthermore, the populations of Bokwaongo (5790) and Bova (2246) were suitable candidates to produce a non-probability sample unit for household interviews, so the Buea 1 cluster villages selected for this study include Bokwaongo and Bova.

Table 4.1: Matrix for Buea 1 cluster, biological and physical features

Names of Villages	Features							Pop.	Sources
	Altitude/ pro-ximity/Distance from park	Vegetation, relief	Climate	Community ethnic composition	Pre-dominant ethnic group	Economic activities	Involvement in forest management activities		
Bokwaongo	- High altitude - Main route to the mountain (2days/1night) – About 6hrs trekking to park boundary – two footpaths to the mountain	Tropical rainforest vegetation, trees, medicinal plants, steep topography, volcanic soils,	Low temperature, rainy season (moist, foggy, cold)	Heterogeneous	Bakwerie	-Timber exploitation - Hunting - Farming (75%) - Fuel wood collection - Horti-culture -Bee-keeping (5%) - Trading - Workers	Prunus harvesters union (MOCAP), VFMC, Hunters union, CDA (2015) - CB/187 000 (2014) –CC/1 539 000 (2014/2015)	-5790	MCNP/CDA, 2015e; Mapanja, 2015; MINFOF, 2014; Mbella et al., 2012a; Ndam et al., 2000

Bova 1	-10km from MCNP	Tropical rainforest – Secondary mountainous forests (Patches)	Low temperature, rainy season (moist, foggy, cold)	Heterogeneous	Bakwerie	-Farming (70%) – Hunting - - honey - fuel-wood - palm wine - livestock (chicken)	VFMC, Basque Bova Animal Farm CIG (Bee, Animal & Cane rats), United Bee Farmer CIG (Agric/Bee-keeping) –n CDA (2014) - CB/187000 (2014) –CC/41 000 , -CDA (2014)	-981	Degrande et al., 2017 ; Mapanja, 2015; MINFOF, 2014; MCNP/CDA, 2014a; Njimin et al., 2012b.
Bova 2	-10km from MCNP	Tropical rainforest - Secondary mountainous forests (Patches)	Low temperature, rainy season (moist, foggy, cold)	Heterogeneous	Bakwerie	-Farming - honey, - hunting - fuel-wood - palm wine - livestock (chicken)	VFMC, WEWULEY Consultancy (Management of NR), NDUTU Farmer (Agric/Bee-keeping), Matangu Group (Prunus and crop production) -CB/200 000 (2014) -CC/10 000 (2014/2015)- Eru training Limbe – Tree nursery demonstration plot -CMA/PMA benefits: 80 000 (2011) & 1746617 (2017) - PSMNR Village training: 28 (2011) &23 (2017); -CDA (2014)	1265	Degrande et al., 2017 ; Meng et al., 2017 ; Mapanja, 2015 ; MCNP/CDA, 2014b ; MINFOF, 2014; Njimin et al., 2012c.
Lykoko Membea	-6-7 kms to the park	Tropical rainforest, Trees, Animals	-Cold climate -High rainfall -Two seasons (rainy and dry)	Heterogeneous	Bakwerie	-Wild honey – NTFPs – Farming (60%)	VFMC, CDA (2015) -CB/200 000 (2014) -CC/76 000 (2014/2015)	-5449	Mapanja, 2015 ; MCNP)CDA, 2015i; MINFOF, 2014; Njimin et al., 2012e.
Ewonda	-10kms, 3 hours trekking to park	-Timber - NTFPs – Wildlife	-Cold climate Low temperature, rainy season (moist, foggy, cold)	Heterogeneous	Bakwerie	-NTFPs – Farming and livestock rearing (75%) - honey harvesting – hunting - petit trading - traditional healing - tourist guiding - tapping.	VFMC, CDA (2015) -CB/200 000 (2014) –CC/51 000 (2014/2015)	-195	MCNP/CDA, 2015h; Mapanja, 2015 ; MINFOF, 2014; Njimin et al., 2012d
Bonakanda	Near to the mountain	Tropical rainforest vegetation, trees, wildlife	-Cold climate Low temperature, rainy season (moist, foggy, cold)	Heterogeneous	Bakwerie	-Farming (70%) -Honey harvesting -Hunting – Petty trade -Tourist guide – Livestock rearing	-VFMC -BOBEEFAG CIG beefarming,- CDA (2015) - CB/200 000 (2014) – CC/175 000 (2014/2015)	-1345	MCNP/CDA, 2015f; Mapanja, 2015 ; MINFOF, 2014; Njimin et al., 2012a.

Woteva	800m altitude above sea level, park access through community forest,	Secondary and high forest, trees, wildlife	Low temperature, rainy season (moist, foggy, cold)	Homogenous	Bakwerie	-Farming (80%), timber exploitation, petty trading, traditional healing, tourist porters, tourist guards, animal rearing	Woteva Community Forest (Wod CIG-Farming/Community Forest), VFMC, CDA (2013), -CB/200 000 (2014) – CC/10 000 (2014/2015) - CMA/PMA benefits: 50 000 (2011) & 1394615 (2017), *Prunus* revenue: 5 672 000	-85	Meng et al., 2017 ; Tchouto & Besong, 2016; Mapanja, 2015; MIFOF, 2014; MCNP/CDA, 2013a; Njimin et al., 2012a.
Buea village	Main route to the mountain (2days/1night), 7kms from park; 2-3 hours trekking to park boundary	Tropical rainforest vegetation, trees, wildlife	Rainy season (moist, cold and foggy	Heterogeneous	Bakwerie	-Farming (40%) -Livestock rearing – hunting – petty trading- ecotourism	VFMC, -CB/187 000 (2014) – CC/140 000 (2014/2015)	-7159	Mapanja, 2015; MINFOF, 2014; Mbella et al., 2012b.

Key: * CDA: Conservation Development Agreement . Also e.g. CDA (2013), depicts the year a CDA was signed. *VFMC: Village Forest Management Committee. *CMA: Collaborative management activities. *PMA: Park management activities. *PSMNR-SWR : Programme for the Sustainable Management of Natural Resources in the South West Region of Cameroon. *CB: Conservation Bonus. Also e.g. CB/200000 (2014), depicts the amount and year paid. *CC: Conservation credit. For the period January 2014 to June 2015. The sum for conservation credit includes: in-park patrols, *Prunus* inventory and eco-tourism. * The amounts in FCFA, Cameroon currency. * In the Meng et al., (2017) document CMA/PMA benefits was mentioned Bova. Upon verification by MINFOF/GIZ staff, I was made to understand that it is for Bova 2.* MOCAP: Mount Cameroon *Prunus* Common Initiative Group

-Tree species/medicinal plants: Mahogany, Iroko,White afara, Eucalyptus, Camwood, Poga, *Prunus africana*
-Wildife: Elephants, Monkeys, Chimpanzees, Porcupines, Buffalos, Antelopes, Grass Cutter, Birds, Reptiles, Blue Duikers
-NTFPs: wild honey, njangsang (*Rhicinodendron heudeolotti*), bitter kola (*Garcinia kola*), eru (*Gnetum africana*), bush onion (*Afrostyrax lepidophyllus*), bush pepper (*Piper guineense*), kaso nut (*Tetracarpidium conophorum*), monkey cola (*Cola lepidota*) and "Ngongo" leaf (*Thaumatococcus daniellii*).

4.2.1.2 Buea 2 cluster

Buea 2 cluster is made up of five villages. Table 4.2 presents the villages and the ecological and physical features on which the selection is based. All the villages are predominantly indigenous (Bakweries), they are dependent on the mountain for livelihoods and have similar climatic and ecological conditions and economic activities. In terms of population, Bwassa (930) and Likombe (515) are the most prevalent. Bwassa, in 2014/2015, had no conservation credits (Mapanja, 2015), an important determinant for village participation in collaborative and participatory management activities aimed at conserving natural resources. Mapanja has a population of 287 and had more conservation credits/bonus than the other villages in this cluster. The choice of study villages for Buea 2 cluster rested on Likombe and Mapanja, justified by their contribution to conservation activities and village groups relevant to the study.

Table 4.2: Matrix for Buea 2 cluster, biological and physical features

Names of Villages	Features							Pop.	Sources
	Altitude/proximity/Distance from park	Vegetation, relief	Climate	Community ethnic composition	Predominant ethnic group	Economic activities	Involvement in forest management activities		
Bwassa	-500 km from MCNP –High altitude	-Tropical rainforest vegetation (trees, medicinal plants)	Low temperature	Homogenous	Bakwerie	-Farming (80%) -Forest exploitation - fuel wood - palm wine - tapping - Traditional doctors – hunting – small scale livestock, - petit trading and wages	-Very High -VFMC - Mary Ann Beekeeping group –CDA (2014) -CB/200 000 (2014) – CC/0 (2014/2015)	-930	Mapanja, 2015 ; MCNP/CDA, 2014c ; MINFOF, 2014 ; Mbella et al., 2012c ; Ambrose-Oji et al., 2002
Mapanja	-5km from MCNP	Tropical rainforest, tall economic value trees, NTFPs (pygeum)		Homogenous	Bakwerie	-Agriculture (70-90%) – Petty trade – Timber expliotation (artisanal) – Hunting – Livestock rearing	Prunus harvesters union, VFMC, Snail rearing, Bee-farming, CDA (2014) -CB/200 000 (2014) –CC/380 000 (2014/2015)	-287	Mapanja, 2015 ; MCNP/CDA, 2014d; MINFOF, 2014; Ndam et al., 2000; Mbella et al., 2012f;
Upper Boando			Rainfall (8 months intensive) –Dry season (4 months)	Heterogenous	Bakwerie	-Farming (80-90%) -NTFPs marketing (popular "ngongo" leaf)	VFMC, Water management committee, CDA (2017) - CB/200 000 (2014) –CC/30 000	-44	MCNP, 2017; Mapanja, 2015; CDA/MCNP, 2014; MINFOF, 2014; Mbella et al., 2012g;
Likombe	-High altitude -16 km from park. -3.5 hours trekking to park boundary	Tropical rainforest, Trees Medicinal plants, wildlife		Homogenous	Bakwerie	-Farming (90%) - Livestock rearing - NTFP – Workers (civil servants, carpenters, builders) – Beekeeping (3%) - Hunting	VFMC, CDA (2013) -CB/200 000 (2014) –CC/10 000 (2014/2015)	-515	Mapanja 2015 ; MINFOF, 2014; CDA/ MCNP, 2013; Mbella et al., 2012[e].
Ekonjo		Rich ever green forest, trees, medicinal plants, wildlife	High temperature and abundant rainfall	Heterogenous	Bakwerie	-Farming (80%) –NTFP marketing (ngongo leaf) –hunting – timber exploitation – livestock rearing	VFMC, CDA (2013) – CB/187 000 (2014) -CC/10 000 (2014/2015)	-58	MINFOF, 2014; MCNP/CDA, 2013b; Mbella et al., 2012d.

Key: * CDA: Conservation Development Agreement . Also e.g. CDA (2013), depicts the year a CDA was signed. *VFMC: Village Forest Management Committee. *CMA: Collaborative management activities. *PMA: Park management activities. *PSMNR-SWR : Programme for the Sustainable Management of Natural Resources in the South West Region of Cameroon. *CB: Conservation Bonus. Also e.g. CB/200000 (2014), depicts the amount and year paid. *CC: Conservation credit. For the period January 2014 to June 2015. The sum for conservation credit includes: in-park patrols, prunus inventory and eco-tourism. * The amounts in FCFA, Cameroon currency.

-Tree species: Pygeum, Mahogany, Iroko, White afara, Eucalyptus, Camwood, Poga
-Wildife: Elephants, Monkeys, Chimpanzees, Porcupines, Buffalos, Antelopes, Grass Cutter, Birds, Reptiles, Blue Duikers

-NTFPs: wild honey, njangsang (*Rhicinodendron heudeolotti*), bitter kola (*Garcinia kola*), eru (*Gnetum africana*), bush onion (*Afrostyrax lepidophyllus*), bush pepper (*Piper guineense*), kaso nut (*Tetracarpidium conophorum*), monkey cola (*Cola lepidota*) and "Ngongo" leaf (*Thaumatococcus daniellii*). -Medicinal plants: *Prunus Africana*

4.2.2 Description of Research Villages

The villages selected for this research, as depicted in Figure 4.1, consist of Bova and Bokwoango (Buea 1 cluster) and Mapanja and Likombe (Buea 2 cluster). These villages are found in the Buea sub-division, in the south-west region of Cameroon. Their biological and socio-physical features are detailed in Tables 4.1 & 4.2. Bokwaongo and Bova villages are close to Buea town and have workers commuting to Buea for work (Ayukeba Forestry, 2017). From the literature, Bokwaongo is heterogeneous but has an indigenous population that is actively involved in conservation activities, explained by its conservation benefits, distance to the forest, *Prunus africana* and former hunter groups. Though the hunters' union of Bokwaongo no longer exists, local knowledge still remains. Bova is mainly inhabited by the indigenous Bakweries, who receive conservation benefits, and its residents are actively involved in ecotourism and agroforestry activities. Furthermore, the populations of Bokwaongo (5790) and Bova (2246) are suitable for producing a non-probability sample unit for household interviews. Likombe and Mapanja are further from Buea and are smaller villages compared to Bova and Bokwoango, and whilst Mapanja, Likombe and Bova have a linear settlement pattern, Bokwaongo has a scattered pattern.

4.3 Researching with MCNP

The empirical research was carried out for four months, between April and August, 2018. A research permit was obtained from MINFOF, Yaounde (see Appendix 1). The MCNP conservator provided letters addressed to the chiefs (see Appendix 2) and VFMC presidents (see Appendix 3) in the study villages, authorising me to conduct research in the MCNP region. These letters were important at a time when the region was politically insecure and communities were being given instructions by the state not to work with outsiders without authorisation.

4.4 Research Approach

This section explains the techniques employed to transform the research goal, objectives and questions into a practical enquiry. Various data collection techniques and sources were applied to acquire the qualitative and quantitative information elucidated in Table 4.3.

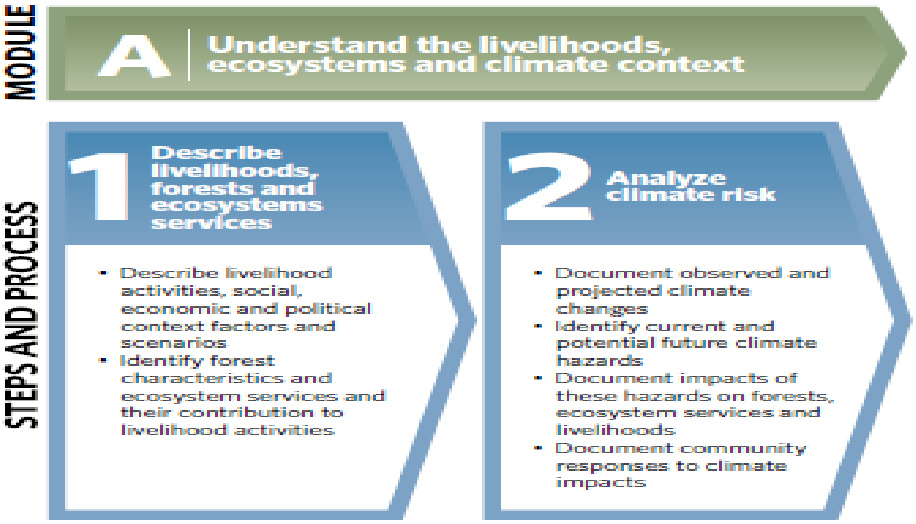
4.4.1 CVCA and CRiSTAL Tools

In order to blend the qualitative methods used in data collection, inspiration was drawn from the 'community-based risk screening tool – adaptation and livelihoods' (CRiSTAL) (IISD, 2012) and 'climate variability and capacity analysis' (CVCA) (Dazé et al., 2009) frameworks, which provide several tools based on the fact that "*there is always more than one explanation to things*" (Corbin and Strauss, 2008:40) and one framework cannot fit the entire research. These frameworks, designed for examining people's perceptions of climate change and adaptation actions to enhance livelihoods and ecosystem protection, consist of both top-down and bottom-up techniques.

The CRiSTAL framework was launched in 2007 by the International Institute for Sustainable Development (IISD), and it has been used in more than 20 countries in Asia, Africa and the Americas. Furthermore, it is divided into two parts. The first segment (Figure 4.2) was deemed appropriate, due to its focus on understanding climate change, ecosystems and livelihoods. It describes, explores and analyses forest and ecosystem services and their contribution to livelihoods, as well as current and future climate hazards, impacts on ecosystems and livelihoods and adaptation initiatives engaged in by communities. The second segment does not apply to this study, since it is based on project design, execution and assessment.

CRiSTAL uses primary data collection techniques such as discussions with national, local and community experts and group discussions (IISD, 2012). The appropriateness of the framework in this study is explained by the following factors: 1) it provides understanding and analysis of the connection between livelihoods, adaptation, climate risks, ecosystems and vulnerabilities, 2) it does not consider climate risk as an exclusively environmental issue but relates it to people's lives through a focus on environmental goods and services and livelihoods, 3) it relies on grassroots agency and privileges participatory methods to collect data and 4) CRiSTAL can be used on all levels and for varied purposes. The purpose herein is to examine perceptual knowledge on climate change impacts, livelihood vulnerabilities and adaptation strategies (IISD, 2012).

Figure 4.2: The CRiSTAL forests framework.



Source: IISD, 2012.

The CVCA framework is built on CARE's community-based adaptation (CBA) framework which joins local knowledge and innovative actions to tackle exposure to climate change. The CVCA methodology focuses on communities, climate variability and change, livelihoods and hazards. It pulls together local and scientific knowledge to offer an in-depth conception of the effects of climate change on the livelihoods of vulnerable people, and it is also useful for analysing natural resources used by indigenous people, the vulnerability of livelihoods and the adaptation actions of stakeholders. It additionally provides useful principles on how to collect data from local communities, using the following methods: seasonal calendar, historical timeline, vulnerability matrix, climate context and livelihood-climate linkages (Dazé et al., 2009). Both CVCA and CRiSTAL therefore provide useful tools (Table 4.3) and understanding on how indigenous people conduct and sustain livelihoods, the effects of climate change on livelihoods and the environment and the adaptation initiatives employed by stakeholders.

4.4.2 Mixed Methods in Data Collection

The empirical study made use of mixed data collection methods, and consequently data analysis. This blend of data provides a good appreciation of the research objectives and questions. Mixed methods, according to Creswell (2014), came to prominence in the 1980s and early 1990s from the education, sociology and health disciplines. They merge quantitative and qualitative research techniques and diminish the flaws found in both methods. As in this study, exploring local perceptions of climate change and impacts on biodiversity has as its objective to provide profound perspectives and, as a consequence, use mixed methods. This point notwithstanding, the research questions on natural resource utilisation, power relations and adaptation strategies were addressed rigorously, using qualitative methods, thereby giving the research a more qualitative than quantitative focus. Thus, the rationale for mixed methods in this study is due to the fact that the research questions could not be addressed by one approach alone. Both methods could be applied at the same time during fieldwork, and the choice was based on the objectives and jointly analysing some parts of the data.

Table 4.3: Techniques used in data collection

Objective	Information	Specific tools	Generic tools
Analyse local perceptions and experiences of climate change	Information regarding people's perceptions and understanding of climate change. Also, historical occurrences and major events of climate change	-Local environmental knowledge -Records of extreme events	**PRA Tools (Qualitative)** -Stories, oral history. -Historical time lines -Seasonal calendar -Individual and expert interviews -Semi-structured interviews -Focus group discussions -Transect walks -Participant observations -Vulnerability matrix -Triangulation **Scientific (Quantitative)** -Structured questionnaire -Records of extreme events
Explore biodiversity availability and utilisation	Examining natural resources exploited, use and purpose. Furthermore, explore information on the impacts of changes in natural resource utilisation and availability on livelihoods	-Livelihood and vulnerability analysis -CARE International climate vulnerability and capacity analysis framework -CRiSTAL (community-based risk screening tool-adaptation and livelihoods)	
Explore local perceptions of climate change impacts on biodiversity and livelihoods	Information on perceived changes in natural resources caused by climate change and effects on livelihoods	-Climate risk analysis -Livelihood and vulnerability analysis -Local environmental knowledge	
Analyse power relations concerning biodiversity	Explore climate change effects on natural resource access for groups and individuals, and analyse social struggles reflected in climate-induced natural resource changes	-Livelihood analysis	
Study adaptive measures and practices taken to maintain biodiversity	Examine short-term and long-term adaptation measures and practices undertaken by groups, individuals and communities. Explore information on how adaptation strategies enhance people's livelihoods and biodiversity	-Adaptation and livelihood analysis -CARE International climate vulnerability and capacity analysis framework -CRiSTAL (community-based risk screening tool-adaptation and livelihoods)	
Source: Chambers (1991); Dazé et al., (2009); Care International (2010) ; IISD (2012)			

4.4.3 Entering the Study Villages

Very important to the outcome of any research is first contact with communities and the organisation of work. During the research, "village entry" varied from one village to another. The first visit to the communities was aimed at presenting the study objectives to the chiefs and getting a first view of the villages. The chiefs decided on suitable dates for the general sensitisation, planning and information meetings. While in Bokwaongo, Bova and Mapanja the entire village was convened in a meeting at the chief's house, in Likombe only traditional council members and some village elders were present. In Mapanja and Likombe, I expressed the need to stay in the village for some time, which was generally agreed by the community. During village meetings, a detailed work programme was drawn on when to meet the relevant groups. Attendance was documented for meetings held in all villages (see Appendix 4, attendance sheet village meeting). Through these meetings, people understood the benefits of the research, thus reducing the risk of their weariness and lack of participation (Gaillard and Mercer, 2013).

The village meetings permitted me to identify key informants and groups relevant to the study. They brought me closer to the population, widened the sample size, enhanced validity, built trust and confidence and ensured the participation of different actors in the research. According to Rahnema (2010), when people participate in planning activities, more work is accomplished with fewer resources, even in pure monetary terms. For example, I wished to talk with hunters in the villages. Since hunting is prohibited by the state and now carried out illegally, people were scared of being identified, but during the sensitisation and information meetings, I explained that by doing hunting in the past, hunters knew the forest well and were better placed to inform the study on changes in wildlife and climate-related factors. They were also assured of the confidentiality of information. This strategy worked out well, especially in Bokwaongo, where many hunters attended the focus group discussion.

4.5 Data Collection

4.5.1 Primary Data

Research on local perceptions of climate change would not be complete and valid without empirical fieldwork. Primary data-gathering was employed to collect accurate and reliable information that could provide a realistic representation of the subject under study. It started with an introduction to the MCNP region by the park conservator, discussions with MCNP unit heads and a PowerPoint presentation by the researcher to stakeholders and park staff (see Appendix 5, attendance list). The meetings and presentation enabled stakeholders to understand the study and provide input to the research. They also enhanced the identification of reports necessary for the study and facilitated a snowballing approach vital to identifying experts at the regional and local levels.

4.5.2 Sampling Techniques

Information-gathering in the study area is based on village surveys. As such, a non-probability sampling technique was employed for the selection of survey respondents, including snowballing and convenience sampling. ‘Snowballing’ refers to one respondent proposing another respondent, in order to comprehend some features of the study (Carvalho and White, 1997). Convenience sampling refers to a person interviewed based on his availability at the time of the interview. In all of the four villages selected for the study, questionnaires were processed using non-probability sampling. In addition, purposive sampling was employed based on people's experiences, agency and applicability to the study, in order to offer positive findings (Flick, 2009). It enabled the triangulation of information from varied sources, to yield a configuration of perspectives (Carvalho and White, 1997), and was used for the selection of MCNP authorities, bee farmers, VFMCs, women's groups, traditional authorities, hunters and ecotourism groups.

4.5.3 Sample Size

A total number of 200 questionnaires were administered in the four villages (Table 4.4). The equal distribution of 100 questionnaires per cluster was aimed at reducing bias and enhancing representativeness in the selection process and study.

Table 4.4: Population distribution of questionnaires in the study villages

Name of Cluster	Name of Village	Village Population	Number of Questionnaires
Buea 1	Bova	2246	28
	Bokwaongo	5790	72
	Total	8036	100
Buea 2	Likombe	515	64
	Mapanja	287	36
	Total	802	100
Buea 1 & 2	General Total	8838	200

Source: Field Work, 2018

The total number of questionnaires for each village was obtained by summing the population per cluster and percentages calculated. Thus, in Buea 1 cluster, 28 questionnaires were administered in Bova and 72 in Bokwaongo. In Buea 2 cluster, 64 questionnaires were administered in Likombe and 36 in Mapanja.

4.5.4 Selection of Questionnaire Respondents and Groups

The respondents for the questionnaires were individuals living in the study communities and present at the time of the interview. Individual respondents included hunters, farmers, petty traders, women, men, youths and other village dwellers. This target group diversification broadened the scope of indigenous knowledge necessary in the research, empowered the voiceless and powerless, such as women, and reduced the bridge between the researcher and data validity (Rahnema, 2010; Cornwall, 2011). Groups (Table 4.5) consisted of ecotourism guides and porters, *Prunus africana* associations and hunters, and forest management institutions such as traditional village councils and VFMCs. These groups of people were considered vital, because they possessed specific information on the management, utilisation and dynamics of natural resources in the study area.

Table 4.5: Village distribution of stakeholders for the focus group discussions

Type of group	Name of Village & Group Frequency			
	Bova	Bokwaongo	Likombe	Mapanja
Village forest management committee	1	1	1	1
Traditional village council	2	1	1	1
Hunters	1	1	1	-
Ecotourism	1	1	-	-
Women’s groups	1	2	-	1
Prunus	-	1	-	1
Local NGO	1	-	-	-
Total	**7**	**7**	**3**	**4**

Source: Field Work, 2018

Table 4.5 indicates the number of focus group discussions per village, as follows: Bova (7), Bokwaongo (7), Likombe (3) and Mapanja (4). Except for hunters, the other groups were existing at the time of the research. The *Prunus* groups are MOCAP for Bokwoango and Mapanja and the Community-Based Forest and Management Consultancy (WEWULEY) in Bova. The women’s groups: Hands on the Ground (Mapanja), IFOSE and Emmaculate Ladies (Bokwaongo) and Solidarity Women (Bova). These focus group discussions enabled me to gather information on natural resource management, utilisation, availability, conflicts, laws, interpretation and comprehension of climate change, adaptation, access and benefit-sharing for different groups.

4.5.5 Questionnaire Administration

In the four selected villages, structured questionnaires (see Appendix 6, sample questionnaire) were randomly administered by hand and by me. They were administered in English and Pidgin, the principal languages spoken in the area. The exercise was executed from morning till evening in people’s homes and public places, and over weekends. Through the use of random sampling, the administering of individual questionnaires was carried out based on the availability of persons during the field research period. As a result, all community members were given an equal chance to be part of the sample (Carvalho and White, 1997; Mertz et al., 2009).

4.6 Qualitative Methods

The collection of data was further enhanced by the use of PRA tools (Table 4.3), including oral history, historical timeline, livelihood and vulnerability analysis, individual and expert interviews, semi-structured interviews, focus group discussions, transect walks and triangulation.

4.6.1 Stakeholder and Expert Interviews

'Stakeholder' refers to individuals, groups and organisations having an interest in the use and management of the natural resources of MCNP. These include NGOs, CIGs, village forest management institutions, government representatives and traditional councils. Some experts (NGOs, government staff) were interviewed in their offices, and interview guides were prepared based on the research objectives and questions, and they were guided by secondary data. As vital information gatekeepers, the interviewees were asked open-ended questions based on their background, field experiences and functions. The objective was to acquire diverse information, enhance representativeness and verify and triangulate information. Working with knowledgeable stakeholders provided information, enhanced insight into the research themes under investigation and helped enrich quantitative data from the household surveys.

4.6.2 Focus Group Discussions

'Focus group' refers to interviews with a cluster of individuals on a specific theme (Flick, 2009). Groups were chosen following research questions and objectives, their relevance and insight into the study, in connection to theoretical knowledge and not representativeness (Flick, 2009). Focus group discussions were held in all study villages (Table 4.5), and they took place during the day, over the weekend and in the evening (see Appendix 7, schedule for group discussions). This flexibility in focus groups and household interviews was based on people's availability and helped circumvent the researcher's activities clashing with those of the villagers. Group discussions with women's and traditional councils were held on their normal meeting days. An attendance sheet prepared by the researcher was filled out during each group discussion, with the exception of hunters for confidentiality. I held 21 group discussions (Table 4.5), solely facilitated and with the use of context- and subject-specific interview guides (see Appendix 8, sample interview guide). They were intended to generate and triangulate information from individuals and expert interviews (Mertz et al., 2009) and deepen knowledge on issues of climatic occurrences related to natural resources. Group discussions further permitted me to gather information on issues about which people where uncomfortable to talk during the household surveys, such as wildlife hunting and the illegal use of natural resources by communities. In a group setting, the participants provided information based on the notion that it is “delivered by all.”

4.6.3 Oral History and Historical Time Line

Oral history and historical timelines are vital in a study where information is needed on people’s past agency of events and happenings around their environment and subsequent effects on livelihoods. Used for both expert and focused group discussions, it permitted the study participants to provide their perceived experiences, observations and knowledge of major climatic events and associated consequences. Oral history was also useful during discussions on changes in wildlife availability and extinction over the past 20 years. For example, informants were able to give personal and intimate accounts on the non-existence of certain animals like tigers, which some respondents claimed existed in the past. Elderly persons more than 60 years old said the tigers people saw where totems belonging to families and manifested as witchcraft.

4.6.4 Livelihood and Vulnerability Analysis

A central premise of the study is the impact of climate change on natural resources vital to the livelihoods of forest-dependent communities. This entailed an analysis of the vulnerability of local livelihoods, due to seasonal variations and medium-term changes. The vulnerability analysis enabled study participants to identify the natural resources that are available in their environment, changes identified and the reasons for doing so. Specifically, participants were able to provide their experiences and perspectives on the dynamics of food, medicinal plants and wildlife imposed by climate variability and change.

4.6.5 Transect and Observation Walk

To verify and triangulate information provided during the interview surveys, focus groups and expert interviews, especially on medicinal plants new to me and presented in the local dialect, a random transect and observation walk was organised in Bokwaongo village. The objective was to provide clarification on issues not understood, thus avoiding repetition and enhancing validity. Some respondents provided names in their local dialect, with particular NTFPs species called using different names. For example, about five varieties of *Agaricus* sp. (mushroom) (locally called *wetoloh*, *ngohteh*, *etuketuke*, *mwiehmeh* and *ewondeh*), all belonging to the same family, were identified and used interchangeably. This exercise facilitated the data collection and analytical process.

Three persons took part in the transect and observational walk. This included me and two village resource persons, one each from Likombe and Bokwaongo. The selection was based on their knowledge of the forest environment and natural resources. Before embarking, the team had a discussion based on the list of NTFPs stemming from empirical data. With the guidance of the resource person from Bokwaongo, a starting point was decided, and together the team identified and authenticated traditional names with scientific terms. During the walk, issues of usage, management and availability of natural resources were discussed, which enabled the researcher to comprehend and explore concerns and issues relating to people's livelihoods and natural resources in the area. In addition, I could compare, verify and give meaning to empirical data. The transect results will be incorporated in Chapters 5 and 6 (data analysis and discussion).

4.7 Quantitative Methods

4.7.1 Questionnaire Design and Survey

The structured questionnaire focused on the research objectives and questions (see Chapter 1.3) and was inspired by the conceptual frameworks for analysis (see Figures 3.1 & 3.2). It is divided into six sections (see Appendix 6) addressing the cornerstones of the study and laying the analytical foundation and structure. It provides quantitative information vital to the study and incorporates biographical data and issues about livelihoods, the environment, socio-economic frame conditions, conservation and policy. Furthermore, it entails a quantitative illustration of people's perspectives of climate variability and change, natural resource utilisation, management and livelihoods and eventual changes to natural resources over the past 20 years.

Section A of the questionnaire addresses bio-data, to provide data on the interviewees' background. Section B examines issues on natural resources utilisation, abundance and availability. This provides relevant information on the areas where people collect natural resources, changes in availability, abundance and utilisation, and changes caused by climate change. It also explores natural resources that have been or become extinct in the past 20 years. Section C focuses on issues of climate variability, change and perceptions, and it explores people's perceptions and understanding of climate change, and local indicators and parameters thereof. Furthermore, it provides an opportunity for respondents to identify climatic events that have occurred in their community and the consequences on livelihoods and natural resources.

Section D expands knowledge on climate variability and change effects on natural resources, and Section E addresses changes in access to natural resources caused by climate change. Finally, Section F examines climate-related adaptation strategies and practices aimed at protecting natural resources. Following the experiences of Thomas et al. (2007) and Mertz et al. (2009) during the design and administering of household questionnaires and interview guides, questions on climate variability and change were addressed after issues of natural resources utilisation and management, in order to avoid biases and not influence responses.

The questionnaire was pre-tested randomly in Bokwaongo village, following which changes were made to create the final version. The questionnaire is made up of closed and open-ended questions, with the former incorporating both descriptive and ordinal rating scales. There were questions with "yes or no" responses and others with ratings from "strongly positive," to "small negative." In this scenario, respondents could choose only one response. Some questions had pre-determined responses clearly explained, and they permitted the interviewee in some situations to choose more than one response. Though the answer options were in an innate order, this did not depict their degree of importance. This is particular for livelihood studies in forest-dependent communities where survival strategies are multidimensional and diversified.

4.8 Triangulation

Triangulation refers to obtaining same information by means of different information sources defined by time, place and person (Denzin, 1989; Corbin and Strauss, 2008). It also means logically covering and using all alternatives for knowledge building (Flick, 2009). In this study information from household surveys was verified during focus group discussions, expert interviews, and transect and observation walk. Inter technique triangulation (Flick, 2009), was also ensured through the use of structured and semi-structured interviews. By focusing on different user groups such as hunters, *Prunus africana* harvesters and forest management institutions, diverse levels of knowledge were uncovered, impossible to get by using only one method. As a consequence, validity and quality of the data was heightened.

4.9 Secondary Sources

Secondary data shaped the research objectives, questions, problem statement and methodology vital for the outcome of this research. Sources consisted of textbooks and articles relating to themes addressed in the study. Information on the climate and ecological regions of Cameroon was taken from publications. The MCNP Management Plan and some publications on *Prunus africana* were accessed online. It was very difficult to access published information on the Mount Cameroon cluster villages, especially the Buea cluster, so to fill this gap, the researcher used the library and documents from the Environmental and Social Sciences Research Centre Buea, Cameroon. This resource house provided information on Cameroon in general and the MC region in particular.

In addition, secondary data were acquired from the south-west regional offices MINFOF and MINEPDED on *Prunus africana* harvesting and commercialisation, as well as natural resources access and benefit-sharing mechanisms and actions by the Government of Cameroon, respectively. Relevant documents from MINFOF, PSMNR-SWR and GIZ included activity reports, yearly reports, a revised *Prunus africana* management plan, an ecotourism development and strategy report, a sustainable financing strategic plan document, PSMNR-SWR technical reports and management plans for the Etinde and Woteva Community Forests, ASEA reports and patrol and surveillance reports. Since the study also addresses wildlife concerns, it was vital to gain knowledge of the wildlife in the MC region. This information was provided by WWF Cameroon, responsible for carrying out wildlife surveys on MC.

4.10 Data Analysis

In this research, both qualitative and quantitative data were collected. Qualitative data are backed up with quantitative and vice versa to offer significance to findings (Corbin and Strauss, 2008). The data are analysed using statistics and qualitative analysis. The use of several methods in data analysis is to ensure triangulation and increase validity.

4.10.1 Quantitative Data Analysis

Survey returns were entered in Excel, taking into consideration the different sections of the questionnaire survey and in line with the study objectives. Each question was entered on Excel and presented using percentages, frequencies, tables and graphs.

4.10.2 Qualitative Data Analysis

Qualitative data analysis denotes exploring and deducing meanings from data to render it meaningful and understandable, and to expand factual knowledge (Corbin and Strauss, 2008). In this study, to make field data comprehensible, responses from open-ended survey questions were entered on Excel, coded and regrouped into topics relevant to the study. Data from focus group discussions and expert and stakeholder interviews were recorded and transcribed (see Appendix 9, sample transcription). Field notes (observations, actions, discussions) were also regularly verified for incorporation into transcripts and analysis. The transcribed interviews were analysed using MAXQDA software, through which data were classified into subsets, themes and categories, taking into consideration the goal and objectives of the study. Using MAXQDA enables the identification of trends and answers to critical issues. For example, subsets were created for all village forest management committee discussions in all the villages, which helped explore similarities and differences in responses from groups and institutions with the same functions from different study areas. The use of MAXQDA enabled the exploration of details from the data that would not have been possible if done manually. Furthermore, data on NTFPs were verified during a transect and observational walk, thereby permitting a further analysis of resources availability, use and dynamics. The qualitative data are presented descriptively, using quotes and narratives from the respondents.

4.11 Limitations of the Study

Collecting information in local communities is not always easy, as information varies from one person to another, and people are not always comfortable to discuss sensitive information. It is difficult for people to recall exact information on environmental occurrences and provide information on issues relating to hunting and natural resource exploitation. To diminish data gaps and weaknesses, a large household survey size and multiple focus groups and stakeholder interviews were used. Also, information was triangulated across different stakeholders.

Many respondents did not want to communicate information on natural resource-related social conflicts, which ultimately hindered the direct and open communication of wildlife conflicts and the collection of more precise information. This difficulty of interviewees being reticent to communicate sensitive information has also been recorded in the West Coast region of MC (Ambrose-Oji, 2003) and Bayang-Mbo Sanctuary (Abugiche, 2008). Information lapses stemming from villagers' inability to provide exact responses to questions on illegal exploitation of natural resources and related conflicts were reduced by completing a detailed review of quarterly and yearly reports on the MCNP.

Quantitative baseline data on the natural resources of the MC region are somewhat sketchy and lack substance. Data essential for projecting potential climate change effects are uncommon, while the state of existing data provides estimates on the availability and abundance of flagship fauna (elephants) and flora (*Prunus africana*) species. This lack of baseline data will hinder an objective exploration of climate change effects on natural resources and livelihoods. The study highlights the necessity to have knowledge about the MCNP resource base and people's livelihoods, which are vital in determining changes in natural resource availability and livelihood vulnerability. Since I could not carry out any inventories, the best alternative was the use of secondary data to complement the empirical research. Literature on ASEA (PSMNR-SWR, 2011; Meng et al., 2017), *Prunus africana* (Ndam et al., 2000; Tchouto and Besong, 2016) and mammal surveys (Eno-Nku and Ekobo, 2007; Eno-Nku, 2013) were used. Where possible, assessments were done by me; for example, field visits and observations were made to see *Prunus africana* trees affected by boring insects. Also, to assess visually NTFPs, field observations and a transect walk were organised around Bokwaongo. General plant identification was complemented by publications on plants (Cable and Cheek, 1998; Howe, (n.d)) and birds and animals (Borrow and Demey, 2004; Serkfem (n.d); Lankester, Costo and Morgan, (n.d)) found on and around MC.

As the research was carried out on local perceptions of climate change impacts on livelihoods and natural resources, this means that people had to provide their views and estimations of these impacts. Researching the socio-cultural and environmental vulnerability of biodiversity to climate change would normally require longer research periods. To fill this gap, flexibility, proper organisation and time management were ensured, to maximise information collection. In addition to village stays, many activities were carried out simultaneously in the villages of Bova and Bokwaongo, and group discussions were arranged ahead of time in all communities. This provided ample space for household questionnaire administration and other activities.

Furthermore, researching far away from my supervisor could be considered another limitation. To reduce the impact, proper preparation was done before departure into the field. Regular feedback on the research advancement was provided to the supervisor through emails. Another challenge was doing research with limited resources. To fill this gap, village stays were organised, to build trust and confidence and to provide more time for data collection. The mastery of Pidgin English, a language understood by all communities, and prior knowledge of the area saved time and enhanced understanding.

Also, the MCNP is made up of six clusters. The research was carried out in two clusters and in four villages. Though the study objective was not to do a comparative analysis, a comprehensive understanding of how climate change influences livelihoods and natural resources would have been necessary in all clusters. The methods used in this research (mixed approaches) were aimed at filling this gap. The outcome of the research, as depicted in the data analysis and interpretation, relies on village and stakeholder selection based on criteria that reduced bias and ensured representativeness (see Tables 4.1 & 4.2).

Finally, the research period coincided with political unrest in the south-west region of Cameroon. Though the study villages were not affected, the ghost towns imposed on Mondays, and general insecurity, hindered movements. To reduce this limitation, the researcher used ghost town days for desktop activities, i.e. to consult secondary data and transcriptions, and to verify empirical data. Also, since the impact of curfews was not felt in villages far away from Buea, such as Mapanja and Likombe, village stays were programmed during these periods in these villages.

4.12 Conclusion

This research employed both qualitative and quantitative methods to investigate the vulnerability and adaptation of forest-dependent communities to climate change from a perceptions standpoint. The empirical fieldwork started with a preliminary and reconnaissance visit to the study villages, to introduce the study to the chiefs and other relevant stakeholders. With the help of local stakeholders, village meetings were organised, during which a programme of work was designed for relevant groups and key informants. These meetings also enabled the identification of subjects valuable to the research and to build trust and confidence with the communities. The quantitative approach used to achieve the research objectives and address the research questions was a questionnaire survey, which was tested in Bokwaongo village to gain an appraisal of its suitability to the study community. The questionnaire was administered by the researcher randomly in the four villages. A percentage system was used to determine the number of questionnaires for each village, in order to reduce bias and enhance representativeness. The questionnaires were administered based on the availability of the respondents.

Furthermore, the study engaged qualitative approaches to explore the vulnerability and adaptation of indigenous people to climate change. The choice of techniques and tools was guided by the CVCA and CRiSTAL frameworks vital for community-based research. The research used the following methods: focus group discussions, key informant interviews, oral history and historical timeline, livelihood analysis, a transect walk and triangulation. These techniques were used to address the research goal and objectives, and they provided information which could not be gleaned using the survey questionnaire. Focus group discussions were held with groups of men and women, and at times mixed groups, depending on the subject. Key informants were mainly people with specific knowledge on issues related to the research. Discussions with key informants and groups were facilitated with the help of subject-specific interview guides, the oral history and timeline provided information on extreme events and their impacts on livelihoods and the environment, and the triangulation of information ensured the authentication of data and enhance validity. To reduced bias and prejudice, and to respect the informants' rights, the researcher used the Pidgin English generally spoken and understood in the research area, lived in the villages and organised meetings in locations chosen by the participants at their convenience. Ethically, the research was explained to the chiefs and during the village meetings, thus helping gain the consent and approval of the study population. Before the start of each discussion, the study objectives were also explained.

The qualitative information collected with the techniques elucidated in this chapter were transcribed, exported to MAXQDA, coded and analysed using themes and categories in line with the research objectives and questions. The quantitative data were entered on Excel and also analysed following the study objective and questions. This research would not be complete without analysing the qualitative and quantitative data collected using the methods and techniques elaborated in Chapter 4. The subsequent chapters thus include data presentation and an analysis of findings (Chapter 5), followed by a discussion and the interpretation of results (Chapter 6).

CHAPTER 5: DATA PRESENTATION AND ANALYSIS: FINDINGS OF THE STUDY

5.1 Introduction

This study explores climate change in the MC region by addressing local perceptions, natural resources and adaptation strategies. Chapter 2 widened understanding of the study area geographically, and Chapter 3 elaborated on the concepts and themes connected to the study, while Chapter 4 outlined the empirical methodology. Chapter 5 now presents empirical data collected from the field, using the methods and techniques elaborated in Chapter 4 and analysed quantitatively and qualitatively following the study objectives and research questions. This chapter is divided into eight major sections, further separated into several subsegments. Following the introduction, Section 5.2 describes the study population by examining the demographic features of the study participants. Section 5.3 presents local perceptual knowledge on climate variability and change, and extreme events. Section 5.4 examines local perceptions of biodiversity changes and availability, and the effects on livelihoods. It also addresses changes in forest products not linked to climate change threats. Furthermore, Section 5.5 explores people's perceptions of the vulnerability of forest products and livelihoods to climate change processes. In addition, Section 5.6 examines climate change impacts on access to forest products, interviewees' attitudes towards regulations and social tensions reflected in biodiversity changes caused by climate change. Section 5.7 addresses adaptation strategies and practices undertaken to improve on local livelihoods and biodiversity. In addition, it explains local approaches to adaptation linked to climate change, and government and NGO roles in supporting local adaptation processes.

In the data analysis, wildlife is not treated under food NTFPs, to enable a proper analysis of the vulnerability of wildlife and livelihoods to the impacts of climate variability and change. Data analysis draws information from PRA tools, including interviews, oral history, group discussions, a transect walk and survey data. To enhance indigenous perceptual knowledge, data analysis involves excerpts and quotes from interviewees, in order to project and reiterate their viewpoints. The data analysis ends with a conclusion (Section 5.8), which provides highlights and important conclusions drawn from the empirical data. The analysis is grounded on the CVCA and CRiSTAL frameworks incorporated in this research and as explained in Chapter 4. In addition, it uses the SL and PCVCBLA frameworks expounded in this research, and examined in Chapter 3, to provide meaning to the data. These frameworks are used jointly and through a selection of some sections of the structures, depending on the subject analysed. To heighten understanding of the subject under study, quotes and narratives from respondents are used.

5.2 Demographic Characteristics of Household Survey Respondents

Gender, education, marital status and age are important features in understanding people's perspectives on changes in their local environment. These data add value to the research by serving as explanatory variables and throwing more light on the research subjects. Analysis is built on facts from household questionnaire surveys in the four study villages.

5.2.1 Features of household survey participants

The demographic characteristics of the respondents are presented in Table 5.1. The survey data express that out of a sample size of 200 respondents, the majority were men (58.5%), the reason being that men are more involved in forest exploitation, as some activities (hunting, palm wine tapping and timber exploitation) require a great deal of strength and can hardly be carried out by women. Also, most of the interviewees were married (73.5%) and fell between the ages of 46-60 years (45%). Finally, the survey data illustrate a high level of primary education (64.5%), and interestingly no respondent achieved more than high school education.

Table 5.1: Demographic characteristics of the household survey participants

Characteristics	Number (N=200)
Gender (%)	
Male	58.5
Female	41.5
Marital status (%)	
Married	73.5
Widow/widower	10.5
Single	10
Divorced	6
Age (%)	
20-35	12
36-45	22
46-60	45
61-above	21
Education (%)	
No formal education	4
Primary	64.5
Secondary	26.5

High school	5
Higher education	0

Source: Survey data, 2018

The data (Table 5.1) signify that the population is within the productive age group. Furthermore, the low literacy rate and no respondent with higher education signify a high level of unskilled labour in the villages and the movement of educated persons to towns in search of white collar jobs. Also, the high level of respondents above 46 years enables the exploitation of perceptual knowledge acquired through the years.

5.3 Indigenous Perception of Climate Change and Seasonal Variations

The previous section enhanced understanding on the social and demographic characteristics of the study population. Based on empirical data from the household surveys, interviews and focus group discussions, this section explores people's thoughts and agency, to address objective two of the study, which is focused on local perceptions and experiences of climate change. Following the PCVCBLA and CRiSTAL frameworks, this section is divided into four subsections. It begins with local knowledge of changes in rainfall and temperature over the past 20 years, and then it is followed by people's interpretations, the causes and local parameters of climate change. It also addresses factors attributed to present climatic conditions and future expectations thereof. The section terminates with historical accounts on climatic and extreme events in the MC region, and the resultant effects on people's livelihoods and the environment. Understanding these aspects provides insights into local environmental knowledge vital in reading indigenous societies and ecological dynamics.

5.3.1 Perception of temperature and rainfall trends over the past 20 years

The interviewees in this study were requested to express their perceptions of temperature and rainfall patterns over the past 20 years. The survey data, focus group discussions and key informant interviews indicate that temperature and rainfall have changed over the years. The survey data illustrate (Figure 5.1) that most respondents (64.5%) had perceived a temperature increase, 34% an alteration in temperature, 1% no change in temperature and 0.5% cooler temperatures.

The focus group discussions and interviews confirmed the trends expressed in the questionnaires. The participants elaborated that they had witnessed changes in temperature in relation to consequences, form and impact on livelihoods. They expressed alterations in terms of changes in the planting season, water quality, sleeping habits, dressing patterns, weather conditions and movements of persons and vehicles. Interviewees mentioned that due to hot temperatures, they put on T-shirts, short-sleeved shirts and short trousers during the rainy season, which was not the situation before. Pipe-borne water was previously cold, but fridges were now being bought, not only for perishable items, but also to enable them have cold drinkable water. Formerly, they slept with blankets and did not use fans, but nowadays they sleep covered in loincloths and use fans for "fresh air."

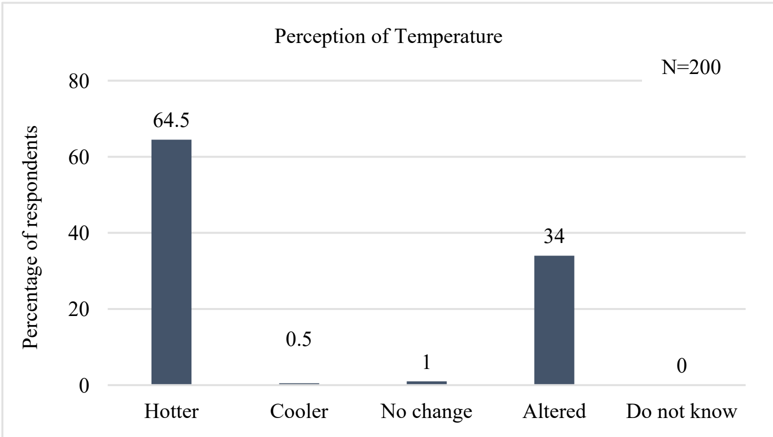


Figure 5.1: Local perceptions of temperature trends over the last 20 years

Also, water dew once soaked their legs when walking around the village in the morning, but now, it is dry in the morning. Local accounts in Bokwaongo expressed that in the past, between the months of March and June, it was foggy with cloud cover everywhere to the extent that they could not see from one end of the village to the other, and from 3 pm they were unable to identify taxis and people on the streets. At home, much of their time was spent sat around fireplaces for warmth unlike now, when they sit in front of their verandas. Also, the interviewees currently have seen some instability in the planting season for maize, most often late planting.

In addition to perceptual knowledge on temperature, participants were also asked for their views on rainfall trends over the past 20 years, as depicted in Figure 5.2. The household survey reveals that most respondents (61.5%) perceived a decrease in rainfall and a 38.5% alteration in rainfall. Results from the questionnaire survey were confirmed by indigenous views during focus group discussions and interviews. Perceptual information from these sources indicates alterations and irregularity in rainfall, an increase in temperature and detrimental effects on planting seasons. Accounts and experiences on precipitation changes are presented in Box 5.1.

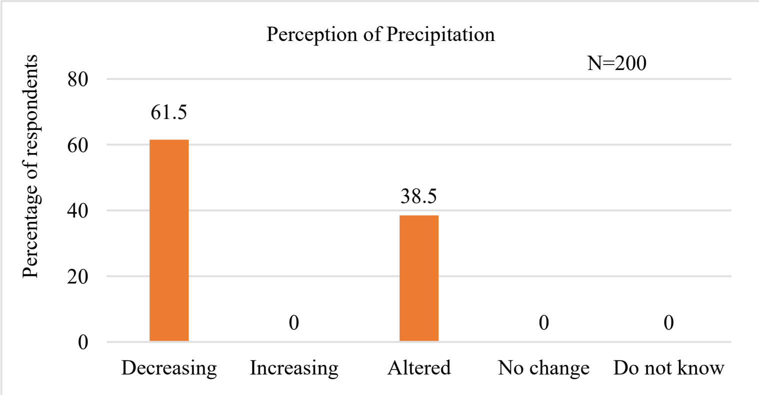


Figure 5.2: Indigenous perceptions of precipitation trends over the last 20 years

Box 5.1: Respondents narratives of precipitation changes

Climate change is right in front of us; it is June 2018, and no rains is something unusual. Formerly in August, the nimbus cloud was thick, and we could not have a day without rainfall. The rainy season normally started in March, but in June and July 2018 the rains have still not started (**Dabuju Evakise, Bokwaongo, 06.06.2018**).

In the past, we did not experience unstable seasons. Now it is difficult to tell the difference between the dry and wet months. For example, in June 2018, there was no rain, thus affecting wotangu [*Prunus africana*], which needs plenty of water to survive (**Ndive Elias, Bokwaongo, 07.06.2018**).

The planting season for maize is usually from March to April, but because of seasonal changes and a prolonged dry season in 2018, I planted maize in June because the rains were not heavy (**Josophine Mbua, Bokwaongo, 18.06.2018**).

We were supposed to have rainfall in June. In June 2018, there was no rain and we did not use umbrellas, which is surprising (**Lyonga Mosoko, Bova, 16.06.2018**).

In the past, we would have heavy breezes in September and October, but in 2018 they came in March and April. After the March and April breeze, we expected the rains to fall continuously, but we had no rain; instead, we had sun (**Molombe Samuel, Bova, 16/06/2018**).

For the first time in June 2018, rain and sun were altering. Before, I used an umbrella, but now there is little or no rain – and the rain is not strong. Thus, I see no need for an umbrella (**Elias Mokake, Mapanja, 15.06.2018**).

In the past, in June and July, we had heavy rainfall and saw no reason to buy water for household use. Now, the containers I put in front of my house waiting for the rain to fall are still empty in June and July, 2018. I still buy water in the rainy season (**Theresse Etanny, Mapanja, 14.06.2018**).

In 2018, rain started in February, but later on the sun continued until July. It is the rainy season, but we still buy water (**Kinge Njie, Mapanja, 08.08.2018**).

In the past, around the month of June, we had thick cloud cover in the village. This has stopped (**Lyonga Mbanda, Likombe, 22.06.2018**).

Formerly, in the month of July, I could not sit on my veranda because of the rains. Now we sit and talk with friends and we can talk with researchers in July on our veranda without rain (**Keka Monoke, Bova, 10.07.2018**).

In the past, in June and July, we had a lot of rainfall and always used umbrellas. The wind usually spoilt our umbrellas. Because of the rains, everywhere was muddy and we used rain boots and other plastic shoes. In June 2018, we still have dust (**Martin Njoh, Bokwaongo, 5.06.2018**).

Source: Field data, 2018

The respondents' views (Box 5.1) show that they recognise alterations in rainfall and late rains. The rains have become very unstable and unpredictable, and people are now unable to differentiate clearly between the rainy and dry seasons. The alterations in rainfall have also had a detrimental effect on the planting season for maize, but the reduced rains have provided more time to stay outdoors. The next subsection examines participants' understanding, reasons for and indicators of climate change.

5.3.2 Indigenous knowledge and interpretation of climate variability and change

To understand further indigenous perceptions on climate variability and change, and seasonal variations, respondents were asked to provide their understanding and interpretation of climate change, which are important to comprehending local agency on environmental changes. First, the respondents expressed their understanding of climate change. They could choose more than one response. The survey data (Figure 5.3) express that a significant percentage of the respondents had noticed an increase in temperature (97%), reduced rains (95%) and long dry periods (91%). Also, the frequency of floods and rainfall intensity had reduced. Thus, perceptual knowledge of climate change is linked to high temperatures and long dry seasons.

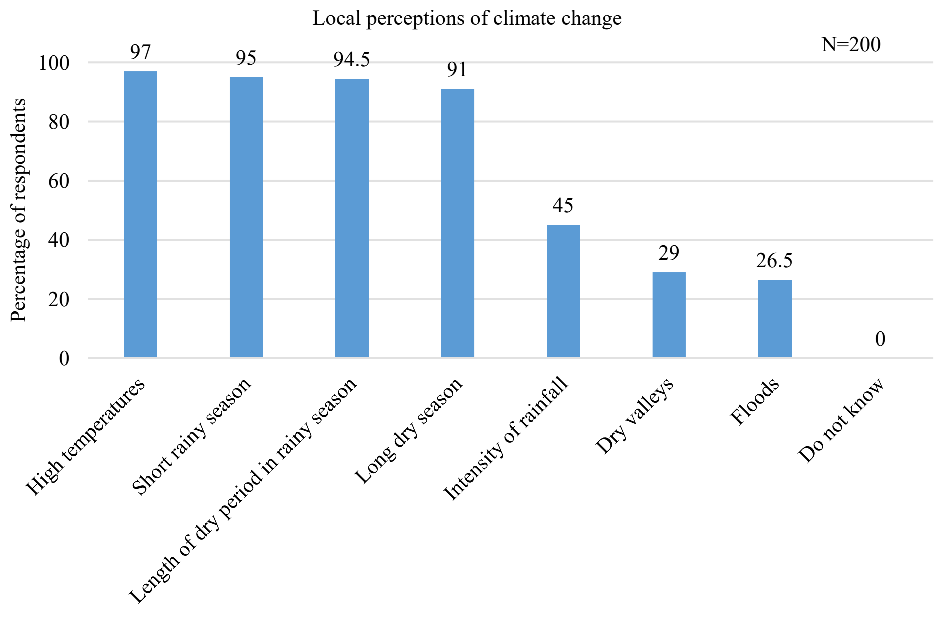


Figure 5.3: Frequency distribution for people's understanding of climate change

Second, the respondents elucidated their perceived reasons for climate change. During the survey, they were again given the option to choose more than one response. As shown in Figure 5.4, they advanced the following reasons: population increase (89%), followed by deforestation (85%), God's doing (70.5%) and modernisation and civilisation (63.5%). Less frequently cited reasons included the economy (44%), rich countries and man's sins (40%), respectively, and lastly politics (33%). In addition, during the focus group discussions and interviews, they said climate variability and change were due to deforestation by farmers, the expansion of plantations, timber exploitation, population growth, volcanic eruptions and an increase in industry in the region.

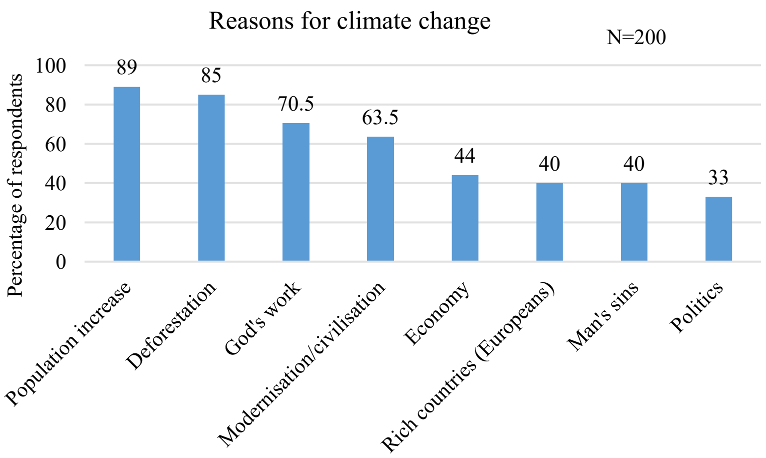


Figure 5.4: Frequency distribution for indigenous perceived reasons for climate change

Lastly, the interviewees expanded on features which influence their understanding of environmental changes. The survey questionnaire provided them with the option to choose more than one response on what they considered as local parameters to climate change. Figure 5.5 reveals that most respondents saw temperature increase (96%) as the first indicator of climate change, followed by fruiting and flowering of trees (95.5%), bird behaviours (77%) and the incidence of insects (56.5%).

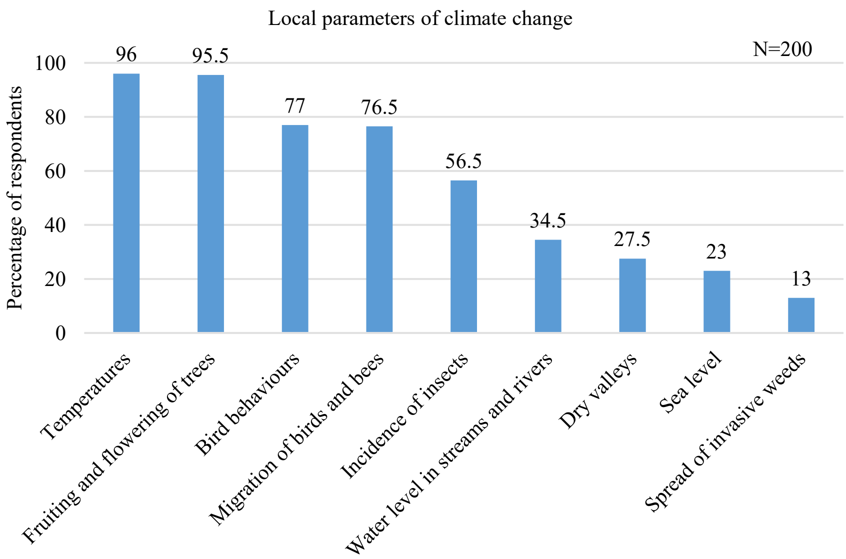


Figure 5.5: Frequency distribution for local parameters of climate change

Furthermore, a few interviewees mentioned dry valleys (27.5%), sea level (23%) and lowest for spread of invasive weeds (13%). The survey data, interviews and focus groups discussions revealed that people's understanding of climate variability and change is shaped by their observations of changes in the occurrence of the fauna, flora and physical features they see and interact with regularly. These parameters shape the perceptions, measurement and appreciation of climate change. Local understanding of changes in seasons is signalled by the movement and behaviour of birds and insects, and flowering of plants. The presence of grasshopper, butterfly (ekolokolo), *Psittacus erithacus* (black and white parrots-kakawombe) and *Spermestes cucullata* (mekunda) birds announces the approach of the dry season and the end of the rainy season.

Also, the flowering of *Pennisetum purpureum* (elephant grass) and the appearance of dragonflies indicates the coming of the dry season. In addition to indigenous knowledge on the perceived causes of climate change and environmental indicators used in understanding climate change, the interviewees also provided prognostic views on climate change, as examined in subsection 5.3.3.

5.3.3 Local perceptions of present and future expectations of climate exposure

Understanding climate trends, perceived reasons for climate change and pointers of change as explained in subsection 5.3.2 are vital in comprehending local agency of a changing environment. Also important are the local perceptions of present, and predictions of future, environmental conditions. The survey data (Figure 5.6) elucidate that most respondents (58.5%) perceive that temperatures have increased (present scenario), and 62.5% of interviewees recognise this rise will continue (future scenario).

Conversely, the respondents noted a decrease in rainfall, from 19% to 17%, for present and future expectations, respectively. Thus, according to indigenous perceptions, they will continue to experience higher temperatures and minimal rainfall, floods and storms. Information from focus group discussions and interviews shows that respondents confirm projections from survey data that temperatures will continue to increase in the future, as depicted the following excerpt:

> *In the future, climate change will continue and we shall be living in an 'oven' with very high temperatures.*
>
> (**Dabuju Evakise, Bokwaongo, 06.06.2018**)

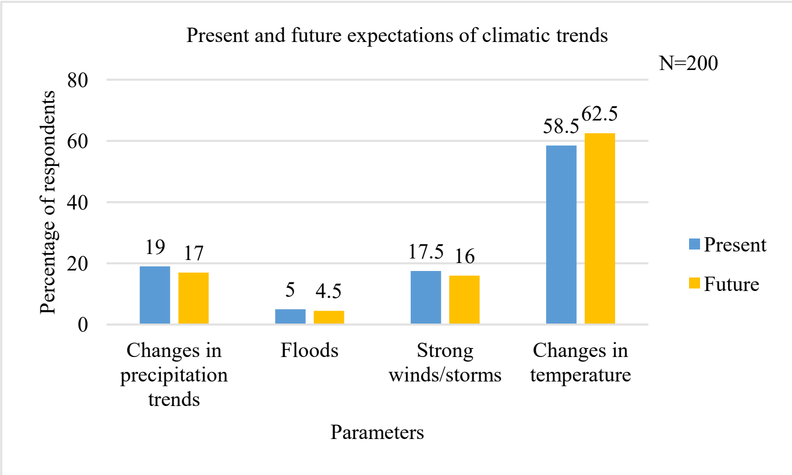


Figure 5.6: Present and future expected climatic trends

Despite this certainty that temperatures will be hotter in the future, respondents also expressed difficulties in making future weather projections, due to unstable and capricious seasons. This notion is indicated in the following statement:

> *It is difficult for us to predict future weather conditions, due to unstable seasons. Today it can rain, tomorrow and the next days it will not rain. The temperature varies from time to time. It's difficult to predict seasons and the gravity of rainfall – only professionals can do that.*
>
> (**Dabuju Evakise, Bokwaongo, 06.06.2018**)

Other respondents said they did not think about weather changes, because it is not their duty to do so. This belief is captured in the following excerpt:

> *It is only a foolish person who will bother to think about changes in rainfall and sun. I think those who worry themselves about this want to take the place of God, who controls everything. At times, we see on television that it will rain, but it does not. People have not understood that God controls all He has created.*
>
> **(Ngomba Moluteh, Bova, 20.07.2018)**

Dabuju and Ngomba's stories indicate that while some people worry about changes in their environment and want to think about what might happen in the future, others consider that it is beyond their ability and should be left for experts to project future climatic trends. Also, another group of persons felt deeply that God the creator controls all that is happening on Earth, and only He alone can understand and explain environmental changes. The subsequent information (Subsection 5.3.4) examines perceptual knowledge on natural hazards and climatic processes which have influenced the local environment and indigenous livelihoods.

5.3.4 Historical occurrences of extreme events and their effects on ecosystems and livelihoods

This section seeks to explore major events that have occurred in the MC region leading to effects on the environment and people's livelihoods. The information stems from individual accounts during interviews, oral and life history and focus group discussions. It uses the PCVCBLA, CRiSTAL, SL and CVCA frameworks to examine the following aspects: 1) climate change and exposure to extreme events consisting of rainfall, floods, high temperatures, strong winds and droughts and 2) the vulnerability of the environment, natural capital and livelihoods to shocks, trends and seasonality, through the use of local knowledge. Many of the data (Table 5.2) are approximations, since people do not keep written records of past happenings around their environment. Validity is ensured by triangulating information during individual, focus group and key informant interviews in the different communities. The recall of events is guided by their gravity, effects and duration of occurrence. Table 5.2 expresses that the effects of the several volcanic eruptions and the April 2018 rainfall were felt in all study villages because of the impacts they had on natural resources, food crops, animals, vegetables and medicinal plants vital for their livelihoods. Also, heavy and acidic rains, storms and floods have destroyed food crops, houses and roads, obstructed movement and endangered lives. Besides, the increase in bush fires has also affected ecosystems and livelihoods.

Table 5.2: Years of extreme events and their effects on ecology and livelihoods

Year (s)	Event	Consequence (s) on livelihoods/natural resources
October 1981 and May 1982	Prolonged dry season	The longest dry seasons; almost all crops died. As a result, there was an increase in bush fires, due to bush burning and deforestation. Farmers were happy, because they could easily burn the forest to ease cultivation.
1987, 14th July 2018	Floods	Mbonjo neighbourhood in Limbe landslides. Houses and property destroyed. Several lives lost.
1982, 1999, 2000	Mount Cameroon eruptions	Eruption in Bakingili in 1999 with changes in forest cover, animals, crops, houses and farms destroyed. Lava flowed into peasant farms and cut off highways. Earthquake destroyed houses in Buea, destroyed crops, trees, soil, killed animals, brought stones. Last eruption in 2000 with houses cracked, animals around savannah killed and heat affecting trees and crops. Animals killed included deer, antelope and monkeys. The 1999 eruption saw the water source "Mosingileh" found in the park dried up because of the earthquake, but water resurfaced after about six months. While it was generally confirmed that the eruptions led to increased temperatures and the drying up of streams, the Bova people said after the 1999 eruption, *Potamochorus porcus* (bush pig) and *Erythrotis preussi* (Preuss's monkey) disappeared from their section of the forest. The volcanic eruption in 2002 affected a lot of trees. *Prunus africana* was affected because of heat from the lava. The heat killed *Prunus africana* especially those found along the lava track. Moreover, streams were

		formerly functional during the rainy season. They provided black sand used for construction, which they collected freely. Currently, the streams no longer flow to the villages. This might be due to the numerous earthquakes and volcanic eruptions. The last stream flow was approximately around 1990. Thus, villagers now buy black sand to build houses. Also, streams flowed down with animals such as antelopes and logs of wood. The antelope was used for meat and the wood for cooking.
2000	Increase in bush fires	Timber exploitation and start of *Prunus africana* sales. Trees and vegetation destroyed and exposure of forest to wildfire. Villagers were restricted from using fire to harvest honey to reduce fire propagation.
2003	Heavy rains and floods	In Mapanja heavy rains and floods destroyed houses. Landslides with many people found dead. Sections of the village were cut off from the others and a blind man was almost carried away, houses were destroyed and bushes and crops washed away.
2005	Heavy rainfall	Heavy rain that endangered *Colocasia esculentus* (igbo cocoa) in the villages; to date, it does not grow well. When it starts growing, the leaves rot and the entire crop dies.
July-August 2006	Heavy and prolonged rainfall	Respondents from Mapanja and Likombe villages indicated that valleys in the village were flooded, which restricted movements within and out of the village.
2011	High temperatures	A hunter set a fire which spread into the forest and killed a lot of *Prunus africana*, more than 50 died. In this area, no *Prunus africana* is found, but there are other plant species.
2012	Heavy rains	The river boundary between Ewonda and Bova 1 brought mud dunes into the village.
2014	Strong winds, violent storms	Destroyed some people's roofs. Pulled off the front roof of a neighbour's house in Bova 1.
2016	Heavy rains	Destroyed *Bidens pilosa* (ndohdokabatweli), *Ageratum conyzoides* (king grass, ewolavako), in that their leaves folded and were yellow in colour instead of green.
April 2018	Heavy and acidic rains	Destroyed food crops and houses. Leaves of crops had a white colour like wood ash. Trees such as *Entandophragma angolense* (mahogany), avocado pear, umbrella trees and *Prunus africana* fell. The rain destroyed and changed the colour of leaves (coco yam leaves, vegetables, medicinal plants, grass) in farmland, compounds and forest into a white and unusable state. It gave people body rashes. The rainwater had a thick whitish colour. People could not use it to drink, cook, wash dishes, do the laundry or bathe.

Source: Field data, 2018

Table 5.2 suggests that the MCNP region has witnessed many extreme events which have affected livelihoods and the forest environment. The long dry seasons have destroyed farmers' crops and led to the drying up of streams. Also, the strong winds, heavy and acidic rains and floods have destroyed food crops and infrastructure, tampered with human lives and affected food and water quality. Finally, volcanic eruptions have destroyed fauna and flora, especially those found along the lava tracks, and affected stream flow and water availability. This and the previous sections of this chapter focused on indigenous perceptual knowledge of climate change and seasonal variations. It also examined extreme events and natural hazards as a result of climate processes, but it did not address local perceptions of forest product availability and utilisation vital to understanding the biodiversity of the MNCP and the dynamics and occurrences of forest products important to indigenous livelihoods. Section 5.4 therefore explores indigenous perceptual agency on the occurrence and availability of forest products and the interconnectedness with sustainable livelihoods.

5.4 Local Perceptions of Biodiversity Occurrence and Availability, and Effects on Livelihoods

The previous section examined indigenous understanding of climate change, and it provided future perceived expectations in this regard. It also explored historical and extreme events and depicted that the sustainability of the forest environment and livelihoods is affected by climate processes and natural hazards. However, an in-depth understanding of the vulnerability of biodiversity and livelihoods involves an exploration of indigenous agency and the experiences of forest product occurrence and availability in the MCNP region. The narrative in the previous section lacked the details necessary to paint a comprehensive picture of biodiversity trends and dynamics. This section examines perceived non-climatic factors that have influenced biodiversity and indigenous livelihoods. Climate-related issues will be addressed in the next section (Section 5.5). In line with the PCVCBLA and SL structures, this section uses perceptual knowledge to describe the livelihoods, forests and ecosystem services enhancing the living conditions of the indigenous population. In addition, it uses these frameworks to examine forest resource occurrences and effects on livelihoods. This section is divided into four subsections. First, it explores forest importance to local livelihoods, followed by local perceptions of changes in biodiversity availability and utilisation, and perceptions of biodiversity trends and extinction rates in the MCNP area. Finally, it examines the perceived consequences of changes in biodiversity occurrence and utilisation on indigenous livelihoods. To address these objectives, it makes use of perceptual facts from survey data, focus group discussions, interviews and a transect walk. To heighten perceptual agency, quotations and narratives from participants are integrated into the analysis.

5.4.1 Forest significance to indigenous livelihoods

Figure 5.7 illustrates that 82% of the population see a strong relationship between the forest and their livelihoods; low importance ranks at 2.5%, and remarkably it is 0% for no importance to livelihoods.

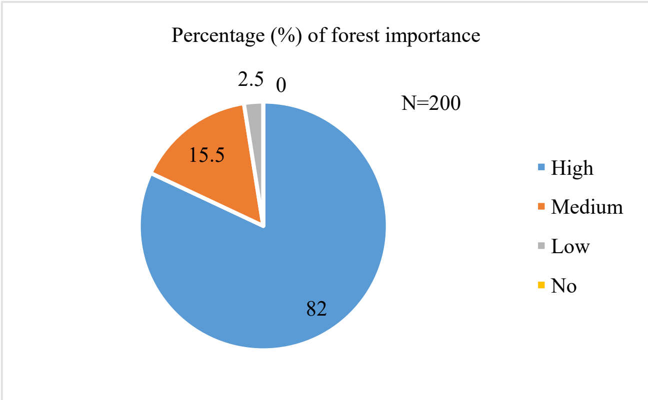


Figure 5.7: Level of forest importance to livelihoods

Furthermore, forest importance is shown in terms of its benefits to indigenous livelihoods. In the household questionnaire, interviewees could choose more than one response. Figure 5.8 indicates the different use categories of forest capital, and forest vitality to native people.

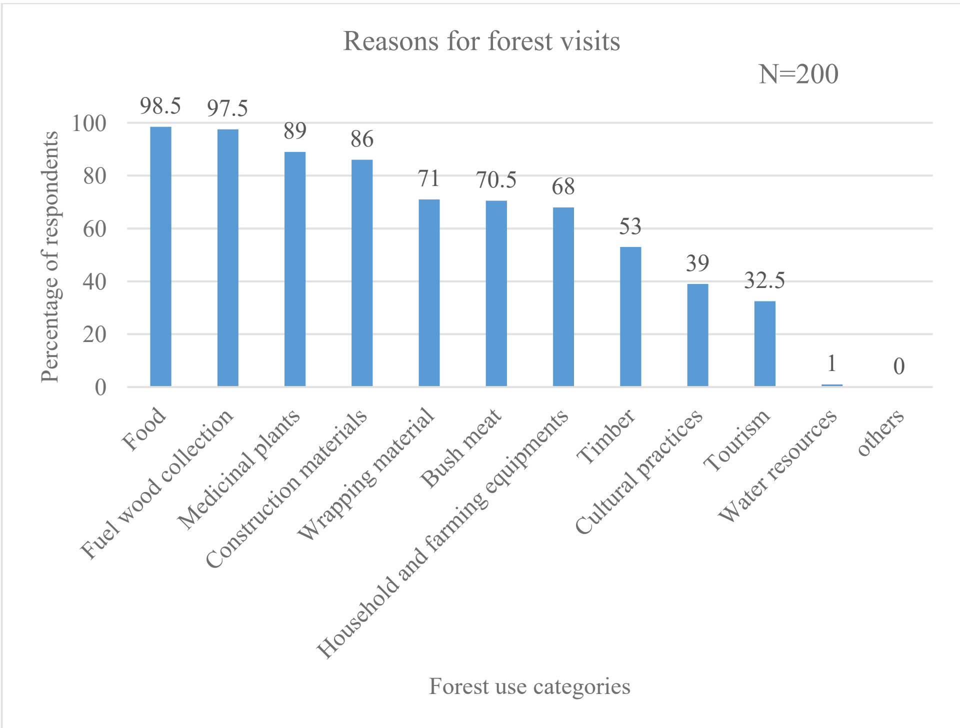


Figure 5.8: Frequency distribution for forest importance to indigenous communities

Figure 5.8 illustrates that most respondents perceive the forest as being important for food (98.5%), followed by fuel wood (97.5%), medicinal plants (89%), construction materials (86%), and timber (53%). Respondents attributed less importance to cultural practices (39%), tourism (32.5%) and water resources (1%). The data imply that the socio-economic lives of the people are dependent on the forest. Also, the non-availability of water resources in the study villages corroborates information that most streams have dried up (see Section 5.3.4). Participants further provided their views on forest resource dynamics over the past 20 years, as elaborated in the next subsection.

5.4.2 Perceived changes in biodiversity occurrence, trends and extinction over the past 20 years

Despite the diverse significance of the forests to the native population, interviewees in the questionnaire survey expressed that most forest products have decreased in their occurrence. Oral history was particularly vital to understanding indigenous perceptions on changes in wildlife trends and extinction. Figure 5.9 presents' local perceptions of natural resource occurrence and provides a clear picture of and trends across the various forest resource categories. It illustrates that most respondents expressed a decline in biodiversity availability as follows: food NTFPs (85%), wildlife (82.5%) and medicinal plants (80.5%). Very few respondents signalled an increase or no change in forest resource availability in any category. Except for food NTFPs, it was only for wildlife (9.5%) and medicinal plants (4%) that the respondents provided no response.

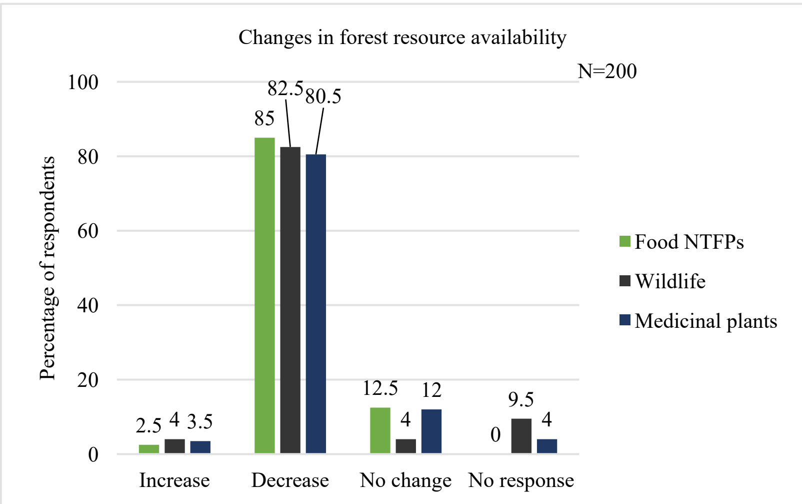


Figure 5.9: Indigenous perceptions of alterations in forest resource availability

Furthermore, to corroborate indigenous views on biodiversity occurrences, it is important to comprehend trends over the past 20 years (Table 5.3). A cross-analysis of the different forest products indicates that more respondents said forest resources are always available, albeit in reduced quantities, depicted by wildlife (98.5%), medicinal plants (98%) and food NTFPs

(96.5%). A few respondents affirmed there were years when natural resources were just not available.

Table 5.3: Indigenous perceptions of forest resource trends over the past 20 years

Availability of resources	Natural resource trends					
	Food NTFPs		Wildlife		Medicinal plants	
	N = 200	%	N = 200	%	N = 200	%
No	5	2.5	3	1.5	4	2
Yes	193	96.5	197	98.5	196	98
Others	2	1	0	0	0	0

Source: Survey data, 2018

Additionally, to triangulate the respondents' views on natural resource occurrence and availability, it was important to understand if some biodiversity species have become extinct over the past 20 years. As shown in Table 5.4, a significant percentage of interviewees perceived that no food NTFPs (99.5%), wildlife (91%) and medicinal plants (100%) species had suffered this fate over the past 20 years. The loss of species was expressed by a few interviewees for wildlife (9%) and food NTFPs (0.5%).

Table 5.4: Local perceptions of forest resource extinction over the past 20 years

Variables	Natural resources extinction					
	Food NTFPs		Wildlife		Medicinal plants	
	N = 200	%	N = 200	%	N = 200	%
Yes	1	0.5	18	9	0	0
No	199	99.5	182	91	200	100
Others	0	0	0	0	0	0

Source: Survey data, 2018

The 0.5% of respondents (Table 5.4) who expressed that some food NTFPs had become extinct were mainly female interviewees from Mapanja and Likombe. They explained that the forest section locally called "wombenjoh" hill, where they collected *Gnetum* spp., was sold in 1984 and had been destroyed. A female respondent in Mapanja said:

> *I collected eru* [*Gnetum* spp.] *from 'wombenjoh' to eat with my family and sell in Limbe market. I only realised that the area has been sold when I went to collect eru and somebody told me that I had no right to collect it. I heard that it is a rich man who bought the land. Eru is a very good vegetable and many people buy it in the market. Now I do not have eru to cook for my family, or money to take care of my children.*
>
> **(Mokie Agnes, Mapanja, 13.06.2018)**

Furthermore, Mokie added that the new landowner destroyed all the *Gnetum* spp. available in this forest area. Mokie's view suggests that the scarcity of forest products is influenced by changes in land tenure, from collective to private ownership by "big men" (rich and powerful). A contrary view was provided by some respondents who signalled its availability in other forest sections, but they kept this information to themselves, since they did not want others to harvest it.

The respondents (9%) (Table 5.4) who said some wild animals had become extinct were mainly elderly men. Their explanations were complex and grounded in traditional and mystical beliefs. There were mixed opinions on whether *Potamochorus porcus*, *Panther tigris* and *Syncerus caffer* actually existed. Some respondents acknowledged not seeing them for over 50 years ago. This view is captured in the following quote: "*My father killed* Syncerus caffer *some 40 years ago*" (**Ngombah Pius, Mapanja, 13.06.18**). Another respondent said, "*I saw a* Syncerus caffer *when my father killed it in 1969*" (**Ngomba Andreas, Bokwaongo, 11.06.2018**). Furthermore, informants expressed that *Panthera tigris* were killed because they ate children, pigs and goats, and *Cephalophus moticola* had not been seen for more than 40 years. *Panther tigris* never existed physically, but their narrative is captured in the following excerpts:

> *These animals did not exist physically [totems]. They belonged to individuals, especially old people, who transformed into tigers [Panthera tigris] mystically to hunt bushbuck [Tragelaphus scriptus*] *and fox [Vulpes vulpes*].
> (**Isume Njoki, Bova, 02.06.18**, **Mese Elkana, Bokwaongo, 06.06.2018**)

> *I saw a tiger when I was young; it belonged to my grandfather. It was killed around 'molie'. It was the personal powers of my grandfather. After his death, there was nobody to control the tiger, and as a result the village decided to kill it, because it was dangerous. Tigers never existed in the past; all the tiger people saw or talked about was witchcraft, and there is nobody presently in the village who has a tiger.*
> (**Ngomba Moluteh, Bova, 20.07.2018**)

Moreover, during focus group discussions and interviews, some participants added that some wildlife species were very scarce and had not been seen for several years. This implies they are endangered and risk extinction. The participants' views are captured in the following accounts in Box 5.2.

Box 5.2: Interviewees' narratives on biodiversity trends

In the past, I saw animals like koti [*Manistricuspus*] and ijah (pangoline) regularly, but now they have become very scarce. For years, I have not seen an ijah in Bova. I can even say for more than 40 years. I do not know why the scarcity in ijah (**Ngomba Nsoa, Bova, 10.07.2018**). Pangoline is extinct, but I do not know why. Maybe it is as a result of farming (**Ngomba Andreas, Bokwaongo, 11.06.2018**). Ihzeu (duicker) has reduced drastically over the past 30 years (**Kalle Litie, Bokwaongo, 07.08.2018**). Ngomba (porcupine) is almost extinct, due to rampant killing and because it gives birth once a year and reproduces only one baby during childbirth (**Mouyongeh Samuel, Likombe, 22.06.2018**).

Source: Field data, 2018

Interviewees' narratives in Box 5.2 indicate that wildlife species such as koti (*Manistricuspus*), ijah (pangoline) and ngomba (porcupine) are perceived to be very scarce and almost extinct. Perceived reasons include rampant killing, an increase in farmlands and low reproductive rates. This subsection has thus enhanced our understanding of indigenous people's perceptual knowledge on forest product dynamics over the past 20 years. It has also expressed that forest products have decreased over time, and provided some perceived reasons for biodiversity occurrence. The next subsection provides details on the perceived causes of alterations in biodiversity occurrence and utilisation.

5.4.3 Perceived reasons for changes in forest product availability and utilisation

Although the former subsection expressed that the biodiversity of the MCNP region has decreased and some wildlife species have become almost extinct, it should be noted that different forest products are affected differently and connected to different processes. The discussion in the previous section falls short of examining this aspect vital for the understanding of the dynamics of biodiversity and connection to rural livelihoods. This section thus fills this gap and uses information from focus group discussions, the transect walk, survey data and interviews to explore reasons for the changes in forest product occurrences and utilisation. First, it addresses food NTFPs, followed by wildlife and lastly medicinal plants.

5.4.3.1 Indigenous perceptions of food NTFPs availability and utilisation

Information from focus group discussions, semi-structured interviews and survey data reveals that the MCNP and its environ are endowed with many food NTFPs. Table 5.5 presents the different food NTFPs important to the livelihoods of the indigenous population, utilisation, collection areas and availability. Food NTFPs consist of vegetables, leaves, fruits, seeds, condiments, animals and insects. They are gathered from the protected area, secondary forest, fallow and farmland. Respondents indicated that except for *Impatiens sakerana* (traditionally called 'mboloma'), *Landolphia* (traditionally called 'viomah') and *Solanum nigrum* (wild huckleberry) collected from all forest sections, the other types are mainly collected in secondary, fallow and farmland areas.

The empirical data also provide respondents' perceived reasons for changes in food NTFP availability and occurrences. They explained that the decrease was because of the use of herbicides such as "glycot" and "gramazone," which destroy all herbs and are harmful to insects. For instance, when an *Apis malifera* (honey bee) visits a plant infected by herbicide, it does not survive, therefore affecting the population of *Apis malifera* and consequently honey productivity. Also, the interviewees expressed that villagers who are indigenes during bush clearing know important natural resources and how to protect them. Non-natives and strangers who rent and buy farms burn everything and even young trees.

Table 5.5: Local knowledge on important food NTFPs, collection areas, utilisation and abundance

Types	Scientific Names	Common Names	Traditional Names	Collection Areas				Parts Used	Purpose/Use	Availability
				PA	SF	FLL	FL			
Vegetables	*Solanum nigrum* L	Wild huckle-berry	Orango	x	x	x	x	Leaves, soft stem	Edible, cash income	Decreased
			Ekomboh			x	x	Leaves	Edible, cash income	Decreased
	Emilia Coccinea		Litolangwah			x	x	Leaves	Edible	Decreased
	Agaricus sp.	Mushroom	Njojoh (wetoloh, ngohteh, etuketuke, mwiehmeh, Ewondeh, Mwime, Egwegweh)			x	x	Tender shoot, resin	Edible, cash income	Decreased
	Gymnanthemum amygdalinum	Wild bitter leaf				x	x	Leaves	Edible	Decreased
	Costus afer		Moudandwaniah		x	x	x		Edible	Decreased
	Gnetum africanum and *buchulzianum*	Eru			x	x	x	Leaves	Edible, stomach ache, cash income, bed wetting	Decreased
			Kalawanjieh			x	x	Leaves, soft stem	Edible	Decreased
	Celosia isertii		Ngoleh, mogweh		x	x	x	Leaves	Edible	Decreased
	Bidens pilosa L.	Black jack	Ndohdohkabatweli		x	x	x	Leaves	edible	Decreased
Leafs	*Thaumatococcus daniellii* or *morantaceace*	Ngogo leaf	Werongo, ewowoh, weteveh, wetomba		x	x	x	Leaves	Cash income, food preparation, tying of	No change

									market products	
Fruits, seeds	*Landolphia lansolphioides* (Hallier f) A. Chev		Ewomah		x	x	x	Fruit, seed	Edible	Decreased
	Dioscorea sp.	Wild yam	Kotoo		x			Fruit	Edible	Decreased
	Impatiens sakerana Hook . F.		Mboloma	x	x			Seed	Edible	Decreased
	Kigalia africana	Sausage tree	Woloulay		x	x		Fruit	Edible	Decreased
	Myrianthus arboreus P. Beauv		Wokekuh			x	x	Fruit	Edible	Decreased
	Aframomum flavul Lock	Alligator pepper	Tondo		x	x	x	Fruit, seed, root, leaves, rhizome	Edible	Decreased
	Dacryodes edulis	Plum				x	x	Seed	Meat supplement, snack	Decreased
	Garcinia kola	Bitter kola	Livelu-lokoh					Seed	Stomach disorder	Decreased
	Impatiens sakerana		Mboloma	x	x			Seed	Edible	Decreased
	Irvingia gabonensis	Sweet bush mango				x	x	Seed	Edible/soup	Decreased
	Irvingia wombulu	Bitter bush mango				x	x	Seed	Edible/soup	Decreased
	Landolphia landolphioides (Hallier f) A. Chev		Viomah	x	x	x	x	Ripe fruit	Edible	No change
Condiments	*Aframomum limbatum*		Manjuelli		x	x	x	Leaves	Spice	No change
	Piper guineense	Bush pepper	Weyowe, veove		x	x	x	Seed, fruit	Spice/Soup	Decreased
Food animal/insect origin	*Apis malifera*	Honey bee	Wooh		x	x	x	Beverage	cough, protein source	Decreased
Food of plant origin	*Elaesis guineensis*	Oil palm, palm wine,	Liya			x	x	Seed, ripe fruit, sap, root, leaves, kernel oil	Cooking oil, kernel oil, palm wine	Decreased
	Raphia hookery	Matutu, raffia palm wine	Lititu		x	x			Housing, alcoholic drink	Decreased
PA = Protected area, SF = Secondary forest, FLL = Fallow land, FL = Farm land. X = Collection sites										

Source: Field data, 2018

Furthermore, tree-felling for fuel, building timber and the collection of NTFPs has also affected the productivity of NTFPs. For example, *Piper guineense* (bush pepper) is a climber plant species, not suitable where there is no forest cover. To harvest it, farmers cut the entire vine, to enable the seeds to drop to the ground for collection. This unsustainable harvesting method, by cutting the whole plant, subsequently destroys it. Also, respondents said that formerly, in order for *Agaricus* sp. (mushroom) to germinate, tree trunks were abandoned to rot. Presently, because of the scarcity of fuel wood, they take the entire trunk home.

Again, respondents advanced that exposure to television, education and training provided by conservation NGOs has raised awareness, influenced attitudes and taught people alternative income-generating activities. Moreover, some interviewees attributed changes in food NTFP availability to politics, as captured in the following excerpt:

> *The government has politically occupied our land by creating the park, which occupies about 70% of our land. The government said we shall have access to the park's resources, but this is not true. The village chiefs no longer have a say like in the past on forestry issues. Formerly, villagers gained permission from the chiefs before using the forest, but now eco-guards are forest police who control the park. Eco-guards harass and arrest villagers who go to the park for NTFP collection.*
>
> (**Mese Elkana, Bokwaongo, 06.06.2018**)

In addition, the interviewees conveyed that in the past many people did not know the uses of *Gnetum* spp. (eru) and *Irvingia* sp. (bush mango). Particularly, *Irvingia* sp. was cut down for fuel wood. With increasing awareness, population increases and exposure, *Gnetum* spp. and *Irvingia* sp. are now widely consumed and have become expensive, and due to their commercial value, collectors prefer to sell rather than consume them. For example, in Mapanaja and Likombe, village harvesters prefer to sell *Gnetum* spp. at Limbe market because of its sale value. Also, there has been an increase in the utilisation of *Piper guineense*, because formerly it was used to prepare soup. Presently, it is also used as medicine for coughs, and is refined and sold in the market. Besides, *Dioscorea* sp. (wild yam) is consumed less because the younger generation does not like to eat it, preferring instead other yam species.

The sale of *Thaumatococcus daniellii* (ngogo leaf) was indicated only in Mapanja and Likombe villages by women. Some male respondents indicated that they were involved in its marketing, because of poverty. It was formerly used by local business people to tie goods, and culturally for food preparation. The situation has changed because of the introduction of plastic bags, the use of plantain and banana leaves for food preparation and the high cost of transportation to the market. Plastic bags, the respondents alleged, were introduced in Cameroon by Nigerian business men and brought about by civilisation and the “white man.” They have therefore lost their traditional way of tying and preparing food.

Furthermore, the interviewees revealed that *Gymnanthemum amygdalinum* (wild bitter leaf) is now consumed less often and has been replaced by other species not difficult to process. This change is due to its bitterness, water scarcity and long processing period required to wash away the bitter taste. Also, *Solanum nigrum* (wild huckleberry) is rarely sold because of difficulties in finding reasonable quantities to sell, aligned with the long distance to collection areas. In addition, respondents expressed that it sprouts naturally after the clearing and opening of new farms. Its availability has been affected by the reduced practice of shifting cultivation, due to land scarcity. The local population now consumes the modern and cultivated species called *Ericaceae* (huckleberry).

Also, the interviewees mentioned that the use of some forest products as condiments had been influenced by changes in local customs. Formerly, the Bakwerie people ate piglets of more than a month old. To render it edible, they prepared it with *Aframomum limbatum* (traditionally named ‘manjuelli’) to provide good flavour. This tradition has changed now, because few people rear pigs and the new generation does not consume piglets at all. In addition, the younger generation does not like the taste and has now replaced it with condiments such as onion and maggi, introduced into their society by civilisation and modernisation.

Notwithstanding the above, a few respondents voiced that some food NTFPs have increased in abundance in the protected area. This view was provided by villagers participating in conservation activities such as park boundary demarcation and clearing and ecotourism. They cited that *Solanum nigrum* (wild huckleberry) and honey have increased in the park because of the favourable climate and general prohibition by the government not to enter the park. They frequent the forest, know where to find NTFPs and even provide for family members. Despite the unstable climatic conditions, these NTFPs are seasonal and available during their right seasons. Finally, some respondents were of the opinion that there has been no change in the availability of food NTFPs. They expressed that these NTFPs are available but the younger generation do not know about them. Also, the older generation, especially women, are too old to walk overly long distances to foraging sites. The interviewees also provided narratives on changes in wildlife availability and utilisation, as discussed in the next subsection.

5.4.3.2 Local perceptions of wildlife occurrence and utilisation

The field data reveal that wild animals in the MC region have both consumptive and non-consumptive uses. First, they are an important source of protein and income for families. Table 5.6 presents the different game species significant to the livelihoods of the indigenous population, as well as their availability, utilisation and collection areas. Discussions with ecotourism groups reveal that ecotourism is boosted in the MCNP region by endemic animal species such as *Francolinus camerunensis* (Mount Cameroon Francoline), *Speirops melanocephalus* (Mount Cameroon Speropes) and *Loxodonta Africana cyclotis* (elephant). Game species consumed by the population are collected from the secondary forest and protected area. Respondents indicated that they do not consume the intestines of most wildlife because they have a bitter taste and are difficult to process for food.

Table 5.6: Indigenous knowledge on important wildlife species, collection areas, utilisation and abundance

Common name	Scientific name	Traditional name	Collection areas				Purpose	Availability
			PA	SF	FLL	FL		
Mount Cameroon Francoline	*Francolinus camerunensis*	Ndolé					Prevent child birth, tourism	Decreased
Mount Cameroon Speropes	*Speirops melanocephalus*	Kolokise a Fako					Tourism	Decreased
Antelope	*Tragelaphus scriptus*	Kaweh	x	x	x	x	Drums, decoration, source of protein, income, energy to walk over longer distances	Decreased
Preuss's monkey	*Erythrotis preussi*	Kema	x	x	x	x	Income, source of protein, tourism	Decreased
Elephant	*Loxodonta Africana cyclotis*	Njoku					Maley traditional dance, tourism, destruction, revenge, fighting	Decreased
Chimpanzee	*Pan troglodytes*	Ewake	x	x	x	x	Income, source of protein, tourism	Decreased
Derby Flying squirrel	*Anomalurus derbianus*	Nguh						Decreased
White nose monkey	*Cercopithecus nictitans*	Kema	x	x	x	x	Income, source of protein	Decreased
Sleeping deer	*Cephalopou rufilantus*	Ngwea	x	x	x	x	Source of protein, income	Decreased
Blue duicker	*Cephalophus moticola*	Ihzeu		x	x	x	Source of protein, income	Decreased
Hair	*Cephalophus africanus*	Ihzeu						Decreased
Cane rat	*Manistricuspus*	Koti		x	x	x	Source of protein	Decreased
Brush-tailed porcupine	*Atherurus africanus*	Ngomba		x	x	x	Traditional hats, income, source of protein, facilitate child birth for women	Decreased

Rat mole or giant rat	*Cricetomys gambianus*	Voh		x	x	x	Charm to win women, income, source of protein, protection against poison	Decreased
Drill	*Papio leucophaeus*	Rzombo						Decreased
Tiger	*Panthera tigris*	Njoh					Provides force and power to individuals	Extinct
Squirrel (Gambian Sun Squirrel)	*Heliociurus gambianus*	Izoweyea		x	x	x	Source of protein	Decreased
Company beef	*Herpestes*	Izembeh						Decreased
Giant pangoline	*Smutsia gigantea*	Iijah		x	x	x	Source of protein, income	Decreased
African civet	*Civetictis civette*	Njuwé						Decreased
Bush pig	*Potamochorus porcus*	Ngoa-Wanga						Decreased
Bush cat	*Herpestes naso*	Ehzoo						Decreased
Scaly francolin	*Francolinus squamatus*	Kwai						Decreased
Red capped monkey	*Cercocebus torquatus*	Mosako	x	x	x	x	Source of protein, tourism	Decreased
Long-crested eagle	*Lophaetus occipitlis*	Kumaleh (birds)						
Great blue turaco	*Corythaeolo cristata*	mokouh (birds)						
Snails	*Archachatina archatina and marginata*	Koh			x	x	Source of protein	Decreased
African goshawk	*Accipiter tachiro*	Jongo						
Turaco bird	*Musophagidae*	Koka						
Gabon viper	*Viper Gabonesis*	Vei						
Leopard	*Panthera pardus*	Njilla						
Black kite	*Milvus migrans*	Ikamba kamba						
Fox	*Vulpes*			x	x	x	Source of protein, income	Decreased
Bat	*Epomophorus gambianus*	Mueme (general name for bats except the lesser flying bat)		x	x	x	Source of protein	Decreased
Bronze mannikin	*Spermestes cucullata*	Mekunda					Announces the approach of dry season	No change
Speckled mousebird	*Colius striatus*	Kondoh						No change
Grey Parrot (bird)	*Psittacus erithacus*	Worzo					Announces the approach of dry season and end of rainy season	No change
PA = Protected area; SF = Secondary forest; FLL = Fallow land; FL = Farm land; **X** = Wildlife species consumed								

Source: Field data, 2018

Furthermore, during the focus group discussions, interviews and questionnaire surveys, respondents recounted their perceived reasons for changes in wildlife occurrences and utilisation. They expressed a decrease in the wildlife population due to deforestation, habitat destruction and alterations in area diversity, caused by the noise of guns, chainsaws, bush burning and droughts, which have pushed animals to the upper sections of the mountain in search of streams and safe havens. Also, some respondents expressed that lava flow during eruptions had killed many animals. During the 2000 eruption, eye witnesses testified to seeing many dead *Tragelaphus scriptus* (antelope), *Erythrotis preussi* (Preuss's monkey), *Cercopithecus nictitans* (white nose monkey) and *Herpestes naso* (bush cat) around the savannah area. Furthermore, plant species such as *Irvingia* sp. and *Turraeanthus africanus*, useful to some wildlife (*Pan troglodytes* (chimpanzee), *Erythrotis preussi* (Preuss's monkey) and *Cercopithecus nictitans* (white nose monkey)), have been destroyed. Moreover, the decrease is also due to the non-availability of food consumed by certain wildlife species. This notion is captured in the following quote:

> *Most food NTFPs and trees have been cut down. Bush mango* [*Irvingia* sp.] *and mokamo* [*Erythrina excelsa*], *especially useful for chimpanzees and monkeys, are not available. Now there is no bush mango in the forest. Bush mango was found in the Etinde area, but it has all been destroyed. Thus, monkeys and chimpanzees no longer have food*.

(**Hunter[7], Bokwaongo, 11.06.2018**)

The interviewees added that the decrease in fauna utilisation and availability was linked to regular control by eco-guards, education provided by conservation NGOs (GIZ, WWF), VFMC members who report illegal activities to MINFOF staff and government punishments for law-breakers, following the 1994 forestry legislation. Furthermore, respondents explained that the promotion of ecotourism in the region had affected attitudes towards wildlife management, since former hunters and youths had been integrated into ecotourism activities. According to a key informant, ecotourism is guided by the principle "*take nothing but pictures, leave nothing but footprints*" (**Ndive Hans, Bova, 21.06.2018**).

Furthermore, interviewees said that food poisoning, a technique used to protect food crops from wildlife destruction, has endangered the lives of wild animals. Again, they expressed that some 30 years ago, the forest was dense – right down to village level – and animals resided near the village. Now they can go for months without sighting any wildlife. Moreover, hunters who took

[7] During focus group discussions with hunters, they did not want to be identified. Thus, no names were provided and no attendance sheet used.

up the activity as a hobby have come of age and hunting is strenuous, challenging and now carried out at night.

Some key informants expressed that the use of wildlife has been affected by the weakening of their traditions and customs by government conservation measures. Respondents from Bokwaongo and Mapanja alluded that, formerly, certain animals were protected because of their spiritual importance, most notably *Pan troglodytes* (chimpanzee), which provide power and force to individuals, and *Tragelaphus scriptus* (antelope) and *Cephalophus africanus* (hare), for their speed and the energy to walk over long distances. Elephants, called the “master” by villagers, were used for revenge, fighting, discipline and destruction, and “maley” for the traditional dance of the Bakweri people. Since the park’s creation, most of these animals have decreased and local protection and use weakened.

Hunters expressed that the decrease in wildlife availability and utilisation was due to the dissolution of hunters’ unions by the government. Former members of Bova and Bokwoango hunters’ unions explained that through this association they were able to provide bushmeat regularly for their families. They carried out traditional rites (libation and dances) to ensure the sustainability of wildlife, and they believed that hunting was organised and sustainable, since they had specific tracks and areas, and they could dictate which animals were totems. Hunting was carried out in the savanna area by bush burning, to attract animals such as *Tragelaphus scriptus* (antelope) that eat ashes, but today, this activity has been banned by the government.

Nevertheless, discussions with experts and stakeholders revealed that the wildlife population in the park is actually increasing, due to conservation measures put in place and the enforcement of forest legislation and regulations. Mammal species such as *Loxodonta Africana cyclotis* (elephant), *Pan troglodytes* (chimpanzee), *Erythrotis preussi* (Preuss’s monkey), *Cercopithecus nictitans* (white nose monkey) and *Tragelaphus scriptus* (antelope) can now be sighted in the park. Respondents perceived that the park has created a safe haven for wildlife, and government actions to conserve biodiversity are dissuading local people from hunting. The respondents’ perceptions of wildlife increase are summarised in Box 5.3. Interestingly, the notion that wildlife species are increasing came from experts and persons involved in park activities. This shows the difference in perceptions between indigenous people and experts.

Box 5.3: Respondents' views on wildlife increase in the protected area

The wildlife is there, but some have been extracted unsustainably. There is a general replenishment of wildlife. Before, the human population was small, but with the increase in population, the wildlife has reduced generally, but we can say that wildlife in the parks is increasing (**Ikomey Nelson, MCNP, 27.07.2018**). Before 2014, it was difficult to see animals, but as years go by, I realise that animal species have increased in numbers. We can now see Class A species from a distance (**Ekpew Enow, MCNP, 25.07.2018**). Elephants were killed in the past, but with the coming of the MCNP the population is increasing (**Eko Evaristus, Bokwaongo, 31.05.2018**). Animals have increased their territory and are occupying more space, due to the increase in numbers (**Luma Franciais, Bokwaongo, 31.05.2018**).

Source: Field data, 2018

Finally, a few respondents, mostly women, provided no response to what they see as reasons for changes in wildlife availability and utilisation. They said hunting is a man's activity, while others said they do not eat bush meat. Male respondents who were members of VFMC, and those who participated in ecotourism activities, refused to answer because they considered hunting a taboo subject. In addition to the explanations provided by the participants on the reasons for changes in the occurrence of food NTFPs and wildlife expressed in the previous subsections, they also communicated perceived changes in medicinal plants, as elaborated in the following subsection.

5.4.3.3 Indigenous knowledge of medicinal plants availability and utilisation

The riches of the MC region, vital to indigenous livelihoods, also consist of medicinal plants (see Table 5.7). Field results reveal that most medicinal plants are used locally, except *Prunus africana* (pygeum), which is commercialised globally. Parts used include leaves, bark, stems, fruits and seeds. During a focus group discussion with the Bokwaongo traditional council, on the subject of medicinal plants, a participant mentioned *Dorstenia barterii bureau* (traditionally called 'ikeneh'). The other participants were sceptical about its existence, and so the transect walk was used to triangulate and validate this issue. The participant who mentioned the plant showed it to the transect team, thus signifying that some medicinal plants are now uncommon and knowledge of their being rests in the hands of just a few people. Table 5.7 summarises the different wildlife species available in the MCNP region, their uses, abundance and collection areas.

Also, the respondents supposed that shifts in the availability and utilisation of medicinal plants are due to unsustainable harvesting by complete off-rooting, tree-felling, usage for fuel wood and housing construction. Plant species negatively affected include *Myrianthus arboreus*, *Voacanga africana*, *Kigalia africana* and *Erythrina excels*, *Treculia africana*, *Piptaniatrum africana*, *Prunus africana*, *Cordia millenii* and *Cythaa cameroonensis*. Also, the decrease in *Plectranthus glandulosus* and the scarcity of *Kigalia africana* (sausage tree) fruit, locally called 'motimbi-limbi' (eaten by elephants and humans), is caused by an increase in consumption during the dry season. Respondents said elephants during dry periods consume *Kigalia africana* fruit because it contains a lot of water, whilst they attributed the reduction in *Acaisia* sp. and *Prunus africana* (pygeum) to destruction by strong winds. Besides, *Entandophragma angolense* (mahogany) is threatened due to over-exploitation, and it is difficult to use its bark for medicinal reasons, since the young trees cannot be debarked. Furthermore, food NTFP utilisation and availability have been affected by changes in area diversity. They illustrated that *Aframomum melegueta* (alligator pepper) is now found further back in the bush, and the younger generation is reluctant to go to foraging sites for collection, due to distance, the time and energy required and ignorance of the plant's importance.

Table 5.7: Indigenous knowledge on important medicinal plants, collection areas, utilisation and abundance

Scientific names	**Common names**	**Traditional names**	**Collection Areas**				**Parts Used**	**Purpose/Use**	**Availability**
			PA	**SF**	**FLL**	**FL**			
Prunus africana (Hook.f.) Kalleman	Canda stick or pygeum	Wotangu	x	x	x	x	Bark, stem, roots	Malaria, Typhoid, sales, stomach ache, fever, fuel wood, fuel wood, income	Decreased
Bidens pilosa L.	Black jack	Ndohdokabatweli			x	x	Leaves	Malaria, tea, headache	Decreased
Ageratum conyzoides	King grass	Ewolavako			x	x	Leaves, stem	Cure poison, headache, eyes, wounds	No change
Ocimum gratissimum L.		Macepo				x	Leaves	Purgative, headache, appetite, malaria, catarrh, cough	Decreased
Eremomastax Speciosa (Benth) *Dandy*	Two-sided leaf, green and red	Majiamainjombeh			x	x	Leaves	Blood shortage, night fire, farm protection, chest pain	No change
Justicia laxa T.Anderson		Maijah maijah			x	x	Leaves	Malaria, fever	Decreased
Celosia isertii C.C.Town.		Ngoleh, mogweh		x	x	x	Leaves	Blood shortage	Decreased
Laportea ovalifolia		Tatweh			x	x	Leaves	Menstrual pains, stomach disorder, eternal pile	Decreased
Emilia Cocciea (SIM) G. Don		Litolangwah (ear for dog)			x	x	Leaves	Stomach ache, fever	Decreased
Agauria salicifolia (*Comm.ex.Lam) Hook.f.e Oliv.*		Ngwelavakoh	x				Leaves	Broken leg	No change
Aframomum melegueta	Alligator pepper	Tondoh	x	x	x	x	Fruits	Eye drop, missiles	No change
Costus afer Ker-Gawi	Monkey sugar cane	Moudandwanieh		x	x	x	Stem, stalk	Purgative, chicken pox, missiles, eye drop, eaten, wound, fever	No change
Labiatae (family)	Mint		x				Bark	Malaria, typhoid	No change

Garcinia kola	Bitter kola, false kola	Livelu-lokoh, nyai	x	x	x	x	Seed, bark	Food, stomach disorder	Decreased
		Enagiejoh				x			Decreased
Glyphaea brevis (Spreng.) *Monach.*	Touch me not	Ngohnoh	x	x	x		Leaves	Purgative, boils, snake bites	No change
Harungana Madagascariensis (Lam ex. Pair)		Wotolongo	x	x	x		Bark, stem	Body rashes, reduce lower abdominal pains for women, fire wood	No change
Macaranga occidentalis (Müll.Arg.)		Ewowoh	x	x	x	x	Bark	Chest congestion, gonorrhoea for mean, syphilis	Decreased
Cordia Millenii Baker		Womba			x	x	Bark	Back, side pain, stomach cleaning	Decreased
Entandophragma angolense (Welm) *C.DC*	Mahogany	Bou	x	x	x	x	Bark	Back pain, side pain	Decreased
Rauvolfia mannii Stapf		Kanjah		x	x	x	Bark	Worms	Decreased
Piper guineense Shum and Thoan	Bush pepper	Njohweh			x	x	Leaves	Stomach ache, cough	Decreased
Voacanga africana stapf		Itongongo	x	x			Roots, fruits, seeds	Worms, hunting	Decreased
Trichilia rubescens Oliv.		Wokaka		x	x	x	Roots, bark	Stomach disorder, purgative, erection	Decreased
Boehmeria macrophylla Hornem		Mbende Pkweh	x	x	x	x	Leaves, fruits	Malaria	Decreased
Momordica foetida Schum. & Thorn		Ndomboh	x	x	x	x	Leaves	Bathing soap	Decreased
Voacanga africana Stapf		Itongongo, intongongo-jaleku		x	x	x	Leaves, fruit	Worms	Decreased
Dorstenia barterii Bureau		Ikeneh	x	x	x		Leaves, roots		Decreased
Mallotus oppositifolus (Geiseler) *Mull. Arg*		Einyayagieh, njororo		x	x	x	Leaves	Cleans intestines, reduces blood pressure	Decreased
Erythrina excelsa . Baker		Mokamo			x	x	Stick	Stomach ache, boundary demarcation	Decreased
Apis malifera	Honey bee	Wooh	x	x	x	x	Liquid	Protein source, cough, sugar, asthma, skin infection	Decreased
Maesa lantanceolata		Nyongeh			x	x	Bark	Malaria	Decreased
Neoboutonia manii		Egwe gwe			x	x	Bark	Malaria	Decreased
Dioscorea sp		Bush yam (Kotoo)			x	x	Fruit	Anti-poison if eaten raw	Decreased
Eucalyptus camaldulensis		Eucalyptus			x	x	Leaves	Malaria	Decreased
Myrianthus arboreus . P. Beauv.		Ekeku			x	x	Leaves	Purgative	Decreased
Kigalia africana	Sausage tree	Woloulay (tree), motimbi-limbi (fruit)				x	Fruits, bark, buds	Stomach cleansing, men erection, elephant dance	No change
Myrianthus arboreus		Wokekuh		x	x	x	Bark	Fever, internal body cleansing	Decreased
Sterculia trangathan		Ndototo		x	x	x	Bark	Breast milk flow	Decreased
Auguaria Salicefolia		Mbweli a Fako	x				Leaves	Joint pains, sperm	Decreased
Cymbopogen	Fever grass				x	x	x	Fever	Decreased

Piper guineense Shum and Thoan	Bush pepper	Jowé		x	x	x	Seed	Cough	Decreased
Pennisetum purpureum Schumach.	Elephant grass	Makoko		x	x	x	Leaves, stem	Gain strength	Decreased
Labiatae (family)	Mint		x	x				Diabetes	Increase
PA = Protected area, SF = Secondary forest, FLL = Fallow land, FL = Farm land, **X** = Collection sites									

Source: Field data, 2018

Furthermore, respondents revealed that medicinal plant availability and utilisation have altered because strangers and the younger generation do not respect the local customs, and due to the lack of knowledge and ignorance. Formerly, a non-native who needed herbs was not allowed to collect any by himself – a villager would harvest the plant and give it to the stranger, in order to maintain its value and ensure sustainability. This tradition is no longer respected. Also, the introduction of modern medicines by the "white man," and the new generation having no trust or confidence in traditional medicines, has influenced the declining use of medicinal plants.

In addition, the respondents said the use and availability of *Prunus africana* (pygeum) has changed over time. A member of MOCAP expressed that:

> *Formerly, people used pygeum as something given by God and always available. Ignorant that if not exploited sustainably, it will become extinct and endangered.*
> **(Kalle Litie, Bokwaongo, 7.06.2018)**

The value of *Prunus africana* led the government to reinforce accessibility, harvesting and sales. Respondents confirmed that its marketing is no longer regular, due to the absence of buyers for over two years. The tree is also affected by *Anomalurus derbianus* (Derby flying squirrel) locally called a "nguh," which eats its bark. Furthermore, participants said that *Prunus africana* is endangered, due to increased commercialisation.

> *I can say that when we were not selling pygeum* [*Prunus africana*] *it was found all over the forest. When the government brought people to start buying pygeum, they entered the forest and cut down all the trees during harvesting. My village chief is very annoyed because of the destruction, but we cannot do anything, since it is the government who sent them. These outsiders have destroyed everything in the forest.*
> (**Elkana Ekema, Bokwaongo, 06.06.2018**)

Elkana's view indicates that *Prunus africana* is perceived to have decreased due to exposure to the market, whilst commercialisation has induced unsustainable harvesting. Its vulnerability is also attributed to the government's authorisation of outsiders to exploit it. Nevertheless, few respondents were of the opinion that *Prunus africana* and *Agauria salicifolia* (locally called 'ngwelavakoh') found in the protected area have increased in population, due to restrictions on entering the park. Also, some interviewees see no change in medicinal plant availability, because they always have the required quantity, since medicinal plants grow naturally and huge quantities are not needed for local use. When flora is scarce, they collect from neighbours' compounds. Finally, respondents who gave no response expressed that they do not use traditional medicines and have no knowledge thereof. Although this subsection explored perceived changes in the occurrence and availability of biodiversity, and the reasons for these changes, it did not examine connectivity to indigenous livelihoods. It should therefore be noted that changes will certainly affect the livelihoods of individuals and communities, as expressed in the following subsection.

5.4.4 Perceived consequences of alterations in forest product occurrence and utilisation on indigenous livelihoods

The natural assets vital to the survival of indigenous populations are encountering negative trends, as examined in the previous segments of Section 5.4. These changes in natural capital are also perceived by the participants to have negatively affected their livelihoods. The survey data (Figure 5.10) illustrate that most respondents felt their livelihoods had been negatively affected by scarcity in forest products. This include food NTFPs (92%), wildlife (85.5%) and medicinal plants (68%). The reduced availability of forest products has affected women, men, food consumption, community life and local development, and the culture of the indigenous people.

During focus group discussions, semi-structured interviews and questionnaire surveys, the respondents provided varied views on the effects of changes in natural resource availability and utilisation on livelihoods. Women expressed that their income, businesses and food provision for their families had been adversely affected, and they acknowledged that the cost of living is high, since they now buy everything from the market, even forest products previously collected freely from the wild. Formerly, their husbands collected NTFPs in the forest, but because of government restrictions, they no longer have food or bushmeat for household consumption. Some women expressed that those whose husbands take part in park activities are "lucky," because they occasionally collect vegetables from the park. In addition, they do not have the energy or time to walk long distances. Some women involved in the sale of *Solanum nigrum* (wild huckleberry), *Gnetum* spp. (eru) and *Thaumatococcus daniellii* (ngogo leaf) voiced that they are uncommon and they do not have sufficient quantities for sale. Thus, poverty has increased and they are unable to meet their personal and family needs. Furthermore, in the study villages, only women operate restaurants. Regular clients are men attracted to eating bushmeat, so the restrictions on bushmeat have affected their turnover. Also, when *Prunus africana* commercialisation was booming, harvesters and farmers had money to buy their food, but since 2016, there have been no buyers, thereby leading to a reduction in customer numbers.

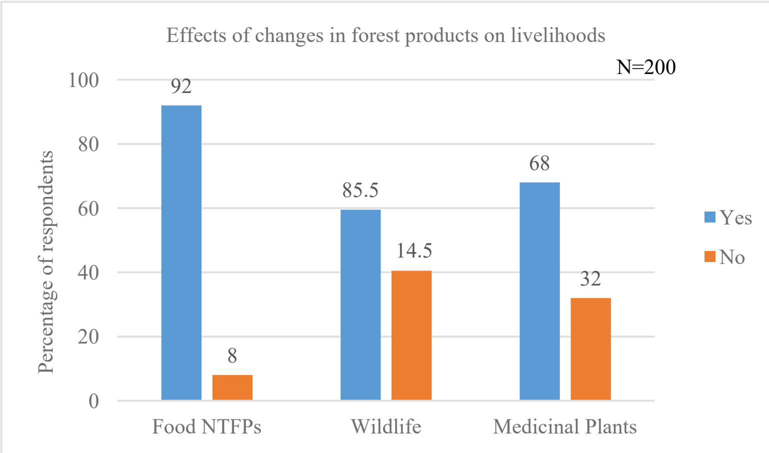


Figure 5.10: Local perceptions of changes in forest products availability and utilisation on livelihoods

Specifically, male respondents indicated that living standards have been negatively affected, since they no longer go to the forest to collect NTFPs for household consumption and selling. Free and open access enabled them to collect required quantities, and household survival was shaped by selling NTFPs, with the resulting money used to meet family needs and children's education. With the creation of the park, they added, bushmeat – a major income and protein source – stopped. This is aggravated by the fact that most of them do not have money to buy other protein sources.

Furthermore, the elderly especially acknowledged that changes in natural resource occurrence have affected their food quality. They are accustomed to consuming forest products, but their eating habits have changed over time because of irregularity in the supply of NTFPs. They said that bushmeat gives soup a taste and a flavour which no other protein source (such as fish) can provide, and so the absence of bushmeat has affected protein intake and consumption. Also, *Piper guineense* (bush pepper) and *Aframomum limbatum* (manjuelli), used as condiments for their food, have become uncommon and been replaced by modern condiments whose flavour in soup is not the same. According to some respondents, although the younger generation is comfortable with these changes, the older generation suffers.

Moreover, the respondents noted that *Celosia isertii* (traditional name 'ngoleh' or 'mogweh'), *Dioscorea* sp. (bush yam), *Agaricus* sp. (mushroom), *Emilia coccinea* ('litolangwah'), Solanum *nigrum* (wild huckleberry) and *Irvingia* sp. (bush mango) are now rarely consumed, with some only being eaten perhaps once a year and even once in two years. They cited that *Agaricus* sp. (mushroom) is a food delicacy which, when available, means they have no need for fish or bushmeat, but its absence has thus created a vacuum. The interviewees acknowledged going for a year or two without eating bushmeat, which was not the case before. Its cost has increased, too; for example, an entire *Athrurus africanus* (porcupine) formerly sold at 6,000 FCFA (10.3 US$) now costs 10,000 FCFA (17.1 US$). They also admitted selling *Vulpes* (fox), which was not the case in the past.

In addition, the interviewees mentioned that community life and local development are dependent on income generated from certain profitable forest resources. For instance, revenue from *Prunus africana* sales is used to finance community projects and individual businesses. Due to the absence of buyers since 2016, villages are unable to execute development projects, and businessmen have seen their capital dwindle. MOCAP villages would use some of this revenue to sponsor cultural activities. One interviewee pointed out that "*the absence of pygeum (*Prunus africana*) buyers has led community life to be quiet*" (**Dabuju Evakise, Bokwaongo, 06.06.2018**). Thus, village cultural activities during vacations are no longer carried out. Other respondents voiced that the youthful population in villages dependent on *Prunus africana* as a cash crop are disappointed with the absence of buyers, and in Mapanja, respondents acknowledged using *Prunus africana* revenue to marry young girls. With the absence of buyers, young girls now refuse to marry, because they do not have money. These marriages are nicknamed "*Prunus marriages*." Besides, farmers disclosed that poverty and borrowing money have increased in the villages, due to irregularity in *Prunus africana* revenue.

Furthermore, the respondents indicated that the Bakwerie culture is depicted in their solidarity and spirit of sharing amongst individuals and communities. They use the forest resources in their environment to extend their goodwill to others. The hunters acknowledged sharing bushmeat collected from the forest with neighbours and extended family members, as this exchange of gifts would enhance solidarity and unity within the village. Restrictions in relation to collecting NTFPs inside the park, however, have reduced availability for local use and affected the exchange of gifts, the effects of which are captured in Box 5.4.

Box 5.4: Interviewees' views on the effects of changes in biodiversity occurrence on livelihoods

We do not have forest animals to eat and sell like before. Now we only eat it once a year, if we are lucky. It is difficult for us to get forest products, since they are far away in the forest. Thus, there is reduced availability for family consumption (**Mbanda William, Mapanja, 10.08.2018**).

Restrictions on collecting NTFPs have brought about poverty. Wotangu [*Prunus africana*] gives money to both young and old people. Restrictions on harvesting it, and using it for timber, have created poverty. Before the reserve, we lived well, due to open access to the forest. Today, the situation has changed (**Njoki Lawrence, Bova, 19.07.2018**).

We ate bushmeat and natural vegetables and never suffered from high blood pressure. Natural vegetables and bushmeat are not contaminated and have a good taste (**Yondo Johnson, Bova, 12.07.2018**).

The movement of animals from farmland to the park reduces wildlife availability on the farmland, and consequently for hunting and household consumption (**Nekoli Emilia, Bokwaongo, 6.08.2018**).

Mushroom [|*Agaricus* sp.] served as meat in the past. Now, due to scarcity, we spend a lot of money to buy meat, which is very expensive (**Emmaculate Ladies Women's Group, Bokwaongo, 5.06.2018**).

We only mange our lives now because most of the vegetables and fruits we collected from the forest are no longer available to prepare food for our children (**Solidarity Women's Group, Bova, 18.06.2018**).

About 20 years ago, NTFPs were available until neighbours shared them with others; now we do not have vegetables, because they are scarce (**Namondo Anastatia, Mapanja, 13.06.2018**).

Young girls are attracted to come to the village because of pygeum [*Prunus africana*] money. They know pygeum money will pay bike riders to go fetch water (**Jonas Mbua, Mapanja, 13.06.2018**).

In the past, our grandfathers relied on forest products. Now we have other food products and do not have time to walk long distances to collect these things. Mostly hunters during hunting collected things in the forest. Now that hunting is restricted, we do not have the free food from the forest. I know they are in the wild, and I have to walk widely in the forest (**Lyonga Rudlof, Bova, 18.07.2018**).

Today, I rarely eat most of the things I collected from the forest for free and was given by God. I can say I eat orango [*Solanum nigrum*] and mushroom [*Agaricus* sp.] twice a year (**Njie Maliva, Bokwaongo, 6.08.2018**).

Source: Field data, 2018

The quotes in Box 5.4 reflect discussions with and narratives offered by individuals and women's groups on livelihood challenges induced by changes in forest products. The stories indicate that life in the villages has become very expensive, due to the scarcity of food NTFPs and reduced access to the forest. Also, interviewees perceive that the quality of food intake has reduced, and health risks increased, due to the non-consumption of forest products, which are considered more nutritious and natural.

Despite the aforementioned negative effects of changes in forest product availability and utilisation on livelihoods, a few respondents, particularly retired civil servants and those with children in "white man country," expressed that the effect is minimal, because they are able to buy fish and vegetables from the market, due to retirement benefits and remittances. A respondent who receives money from abroad stated:

> *Families who do not have access to bushmeat and no children abroad to support them suffer financially*.
>
> (**Mekako Kolu, Bova, 11.06.2018**)

Mekako's statement indicates that remittances provide additional income and play an important role in ameliorating rural livelihoods. Families who do not have children abroad suffer financial hardship and might be unable to meet food needs, since they do not have the capacity to pay for goods. Also, members of the IFOSE Women's Group, Bokwaongo, suggested that livelihoods have improved following *Prunus africana* commercialisation. Money from sales made by individual farms amounted collectively to about 400,000 FCFA (684.23 US$). This money was used to pay for children's education, hospital bills, clothing and food. Lastly, some hunters said their livelihoods have not been affected, because the reproductive rate of *Cricetomys gambianus* (rat mole) is high, and thus it is always available. In addition, they have a mastery of the forest and know where to find animals. Though the preceding section (Section 5.4) has elaborated on perceived reasons for the changes in forest product occurrence and availability, and the effects on livelihoods, it should also be noted that climatic factors also influence the dynamics of forest resources and livelihoods. Section 5.5 explores the vulnerability of livelihoods and forest resources to climate change.

5.5 Indigenous Perceptions of Biodiversity Loss and Livelihoods Vulnerability to the Impact of Climate Change

Local perceptions of rainfall and temperature is one facet of understanding and recording microclimatic changes. Also, historical accounts of events provide chronological trends and consequences of extreme events on the environment and livelihoods. Furthermore, Section 5.4 examined forest products' significance in terms of local livelihoods, perceived reasons for changes in forest product availability and effects on livelihood. It revealed that natural resources are affected by many factors, and the effects are felt by individuals and communities. However, another major focus of this study is the influence of climate change on biodiversity and local livelihoods. Thus, an appreciation of the positioning of climate change in forest-dependent communities, as engendered in this study, entails probing into local agency to comprehend the connectivity between rural forest environments and livelihoods with the influences of climate change. Failing this analysis, comprehension of biodiversity dynamics, in a world in which climate change is shaping landscapes and livelihoods, would be incomplete, shallow and deficient.

The analysis is based on the CVCA, CRiSTAL, SL and PCVCBLA frameworks, to document local perceptions of the vulnerability of forest resources and the livelihoods of forest-dependent communities to the effects of climate variability and change. The section also uses these frames to provide a climate context, as well as to identify livelihood and climate change interconnectivity. It is divided into three subsections. First, the consequences of climate change on food NTFPs are examined, followed by the effects on wildlife and lastly the impacts on medicinal plants. It draws information from survey data, group discussions, interviews and a transect walk.

5.5.1 Climate change influence on food NTFPs and indigenous livelihoods

Respondents were asked if climate change is having a positive or a negative effect on food NTFPs. The survey data (Figure 5.11) indicate that climate change is perceived to have a negative impact on food NTFPs and, consequently, livelihoods. A clustering of all negative responses indicates that the percentage of interviewees (76%) for adverse effects is significant. Interestingly, about 21.5% of respondents said climate change has no impact on food NTFPs. The lowest response was provided by those who said they did not know if there is any impact (2.5%) of climate change on food NTFPs.

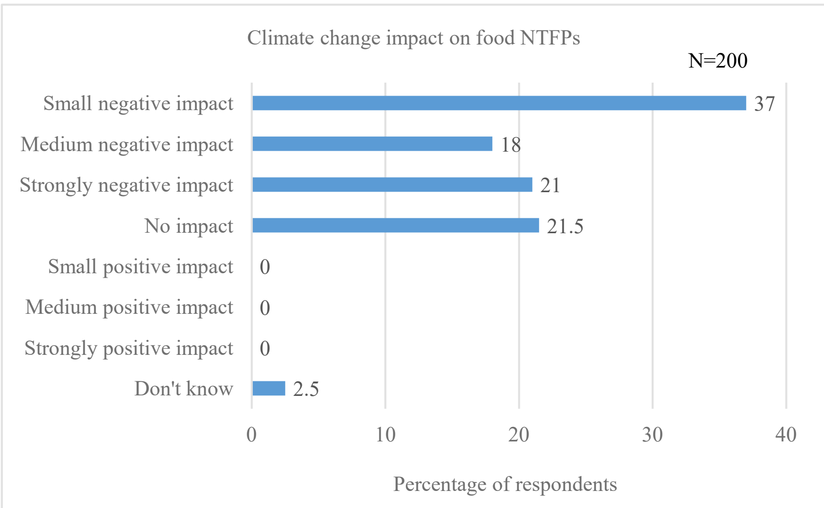


Figure 5.11: Local perceptions of climate change impacts on food NTFPs

In addition, during the questionnaire survey, respondents provided their views on how climate change affects food NTFPs. They could choose more than one answer. As shown in Figure 5.12, most mentioned low productivity of NTFPs to sustain humans and animals (71.5%), followed by changes in forest area distribution (33.5%) and changes in quality of NTFPs (23.5%). A few expressed changes in growth, loss of species and shifts in seasonality. An important number of interviewees also supposed that there is no impact (20%), and only 2.5% of the respondents said they had no idea if climate change affects food NTFPs.

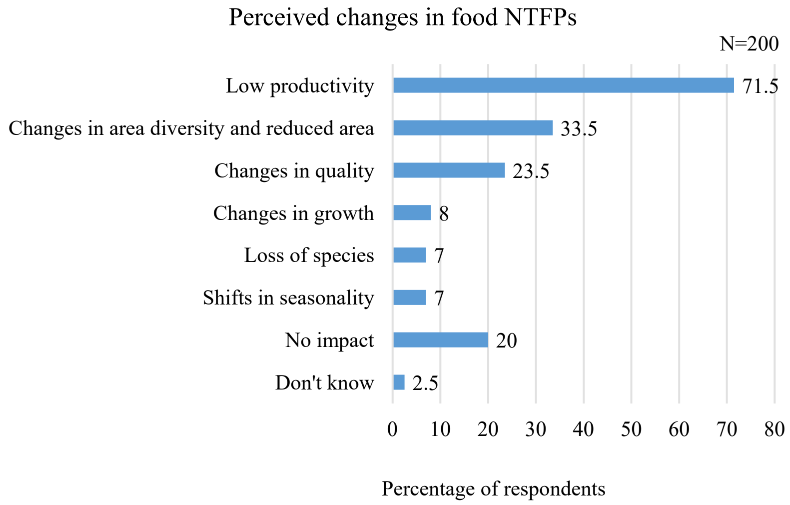


Figure 5.12: Frequency distribution of perceived consequences of climate change on food NTFPs

To elucidate further the effects of climate change on food NTFPs and indigenous livelihoods, during focus group discussions and interviews the respondents reiterated that due to prolonged dry seasons, *Solanum nigrum* (wild huckleberry), *Celosia isertii* (traditional name 'ngoleh' or 'mogweh'), *Piper guineense* (bush pepper), *Bidens pilosa* (black jack) and *Emilia coccinea* (local name 'litolangwah') are unhealthy, owing to the lack of water. They are available but in reduced quantities, and they are not abundant on farmland or around homes, due to destruction in vegetation cover and high temperatures. Furthermore, due to these hot temperatures, the quality of the edible leaves is affected. The effects of climate change on *Solanum nigrum* are expressed in the quotes in Box 5.5.

Box 5.5: The effects of climate change on Solanum nigrum (wild huckleberry)

Orango [*Solanum nigrum*] is very scarce, because of the sun which dries up the leaves and the strong rains in August, which also destroy the leaves. Also, in the past, after bush clearing, orango germinated by itself. Nowadays, because of the hot temperatures and changes in forest cover after bush clearing, one has to be lucky to have it (**Elinge Emilia, Bova, 18.06.2018**).

Heavy rains destroy the leaves of orango by creating holes in it (**Lyonga Rudolf, Bova, 18.07.2018**). Formerly, when seasons where stable, orango could be harvested several times. Now, after the first harvest, it dies (**Martha Nyoki, Bokwaongo, 31.05.2018**). Formerly, Mapanja was cold and orango leaves were healthy, big and broad. Due to the long dry periods, I notice that the leaves are small and have 'rashes' (**Coumus Mokie, Mapanja, 15.06.2018**). In the past, after bush clearing, orango would sprout naturally. Now, even after bush clearing, one is not sure we will have orango. It may be due to climate change (**Ngomba Nsoa, Bova, 10.07.2018**).

Source: Field data, 2018

Furthermore, they conveyed that NTFPs found on farm and fallow land are heavily affected by high temperatures, but those further up the forest have little or no effects, since the vegetation and climate currently remain intact. For instance, *Piper guineense* (bush pepper) is a climbing flora species dependent on other trees and forest canopy for growth. Respondents acknowledged that the destruction in forest vegetation and increases in temperature have decreased its availability. The following excerpt exemplifies this view:

> *In the past, we had thick forest, and thus bush pepper grew naturally. The seeds fell on the ground and we just saw it growing. It is a plant which climbs on trees. Because of climate change and the destruction of forest cover, it is now difficult to find it.*
>
> **(Ngomba Nsoa, Bova, 10.07.2018)**

Some participants feared that in the future they might have fewer NTFPs to consume. Namondo explains in the following quote that if the seasons continue to be capricious, her future will be bleak and revenue affected:

> *If the unstable seasons continue in the future, we shall die of starvation, because all forest products will be destroyed and even cocoyams* [*Colocasia*]. *We shall have no other source of income, no hope. Psychologically, we are disturbed that forest products will be extinct, especially those we use as vegetables, since they do not store plenty of water.*
>
> **(Namondo Anastasia, Mapanja, 13.06.2018)**

In addition, due to hot temperatures, the leaves of *Thaumatococcus daniellii* (ngogo leaf) are folded and brown in colour. Only fresh and green leaves are sold and used for food preparation. Regular rainfall renders the leaves green, large and healthy. Respondents in Mapanja and Likombe who sell it complained of more climatic effects in secondary areas and farmland. Moreover, *Gymnanthemum amygdalinum* (wild bitter leaf) is healthy when the seasons are stable and without climate excesses. According to local knowledge, during prolonged rains, the leaves are soft, rendering them difficult to process for consumption, while during a prolonged dry season the leaves are hard, very bitter and difficult to process.

Furthermore, the respondents indicated that changes in seasonality have affected the availability of *Agaricus* sp. (mushroom). Hot temperatures were said to affect the quality, productivity and availability of *Agaricus* sp. as captured in the following statements:

***Box 5.6: The effects of climate change on Agaricus* sp.**

Mushrooms [*Agaricus* sp.] have reduced in availability because of a lack of rainfall. The dry season destroys them, especially when it is prolonged (**Josephine Ekema, Mapanja, 13.06.2018**). The mushroom species locally called 'mwiemeh' sprouts when there are heavy rains and thunderstorms. Many people call it 'devellish njohjoh'. When the rain does not fall for the thunder to occur, how do we get it? (**Maliva William, Likombe, 22.06.2018**). In the past, when mushrooms sprouted in the forest, they survived for long, but with the hot temperatures the tender shoots become hard and not suitable for consumption (**Mafany Ester, Boakwaongo, 5.06.2018**).

Source: Field data, 2018

Field data further revealed that the local population consumes about five species of mushroom (locally called 'ewondeh', 'ngohteh', 'etuketuke', 'mwiehmeh' and 'wetoloh'). While some sprout naturally from the ground, others, such as 'ewondeh' sprout from dead and rotten trees, but due to prolonged dry seasons, dead trees are too dry to create a favourable growing medium. Also, the interviewees indicated that climate change has altered the flowering and reproductive periods of certain plant species. Due to prolonged dry seasons, for instance, *Irvingia* sp. (bush mango)'s flowering period has changed from February to April. In addition, climate change has affected tree growth and the size of NTFPs such as *Irvingia* sp. A farmer in Bokwaongo indicated that reduced rainfall has affected most trees, in that they are not as big as they once were. Mambo's view is revealed in the following excerpt:

> *In the past, the seasons were stable. We had a long rainy season and cold weather. As a result, trees had enough water and they were very big and tall. These trees also provided water to the soil. Now, trees do not grow big. Big trees provided sizeable wood sheets for our houses. Nowadays, the wood sheets we bring from the forest are small in size*.
>
> (**Mambo Elizabeth, Bokwaongo, 01.06.2018**)

According to Mambo's story, climate change has affected tree sizes and wood for construction. Also, the fact that trees do not get enough water implies they are also unable to provide water to the surrounding soil. According to Ndive Hans (Bova, 18.07.2018), the construction of houses has become more expensive, since more wood is needed. Furthermore, beekeepers also felt that climate variability and change have affected honey productivity, its quality and bee activities. Honey productivity has been unstable and decreasing over the past years, due to changes in seasonality.

Box 5.7: Climate change impacts on apiculture

Climate change has affected honey productivity. In the past, the months of May and June were the peak collection season for honey. I could collect 8 to 10 litres of honey, but in 2018, I only collected 1 litre. Because bees before the rainy season store enough honey to sustain them during the entire rainy period. Now that we are having longer dry periods, the bees are confused and they continue to collect nectar from flowers, and thus they are unable to store honey, which is food for them and for us. Usually, I sell about 30 litres of honey yearly, it is July 2018 and I have been able to sell only 1 litre (**Elinge Francis, Bova, 19.07.2018**).

Honey productivity has been affected by seasonal changes. Normally, bees fill combs from April to May. Due to the heavy rains the productivity period of the bees is confused and altered. We find it difficult to collect enough honey from the hives. The quality is affected and the quantity reduced (**Ngomba Andreas, Bokwaongo, 11.06.2018**).

In the past, when we had stable seasons, plants produced flowers on which bees depended for nectar. Presently, trees such as mangoes, pears and coffee produce little flowers, and consequently not enough nectar for the bees. In 2018, due to the long dry season, many bees died because they lacked water to drink, also coupled with the fact there are no streams in Bova. Bees know that from September to October they have to collect nectar and produce young ones. Furthermore, in 2017, we had heavy rains during this period, and the bees were unable to collect nectar. As a consequence, we experienced a poor harvest during the December harvest. In addition, from January to March 2018, we had heavy and continuous rains, and thus bees could not collect enough nectar for the May harvest (**Lyonga Abel, Bova, 24.07.2018**).

Source: Field data, 2018

These farmers' experiences portray that not only has climate change confused bee activities, but it has affected the quality and quantity available for sale and for household consumption. Field data further revealed that climate variability is affecting plant species valuable to humans and birds. For example, *Impatiens sakerana*, traditionally called 'mboloma', is consumed by both the sunbird and humans. Respondents said it has become very scarce, due to increasing temperatures and deforestation, and they feared that the extinction of this plant in the future might affect the ecotourism industry, since birds are an ecotourism asset. Luma, for instance, an ecotourism guide, explains the vulnerability of *Impatiens sakerana* to the impacts of climate change and the effects on humans and the ecotourism industry:

> *There is the reduction in the availability of* mboloma *[Impatiens sakerana] because of altered seasons and a prolonged dry season. When the rain is expected, it does not come, thereby affecting the usual growth regime. The reduction in* mboloma *in the forest is about 70% due to climate change and 30% linked to human disturbance. The sunbird eats the flower of* mboloma *and humans eat the fruits.* Mboloma *is important for ecotourism. Its absence will surely affect the sunbird, which might look for alternatives such as insects and plants. The sun-bird dependent on* mboloma *might in the future no longer be found in the forest. It might change location and tourists will not be able to see it. Consequently, tourists will stop coming to the MCNP and will visit forests where they can find such bird species.*
>
> (**Luma Francis, Bokwaongo, 31.05.2018**)

Luma's story is evidence that *Impatiens sakerana* is being affected by climatic and anthropogenic factors, and according to her, the extinction of this plant will have a triple effect. First, humans will not have it as food. Second, the sunbird will not also have it to consume, thus leading to migration to other areas, and third, the ecotourism industry will be affected, since tourists will no longer come to the region for bird watching, thus affecting revenue gained by tour guides and porters.

Despite the aforementioned negative effects, a few respondents expressed that climate change is having positive impacts on NTFPs and livelihoods. For example, the *Dacryodes edulis* (plum) and *Mangifera indica* (mango) ripen quickly, due to the change from cold and cloudy weather to hot temperatures. Off-season plums and mangoes can be seen as a result of changing climatic conditions. Farmers expressed that formerly, mangoes and plums were not available in Bokwaongo and Bova, and those consumed were bought from the market or imported from other towns, but now, they have these NTFPs available in their farms. Other respondents did not notice any climate change effects on food NTFPs, since they are seasonal and available when needed. Moreover, they indicated they are created, protected and made permanent by God for man's use. The next subsection explains indigenous perceptions of wildlife loss and livelihoods vulnerability to the impacts of climate change.

5.5.2 Climate change effects on wildlife and local livelihoods

Climate variability and change do not only impact food NTFPs. Wildlife is also an integral part of rural livelihoods. The survey data (Figure 5.13) elucidate that most respondents (51%) perceive no climate change impact on wildlife.

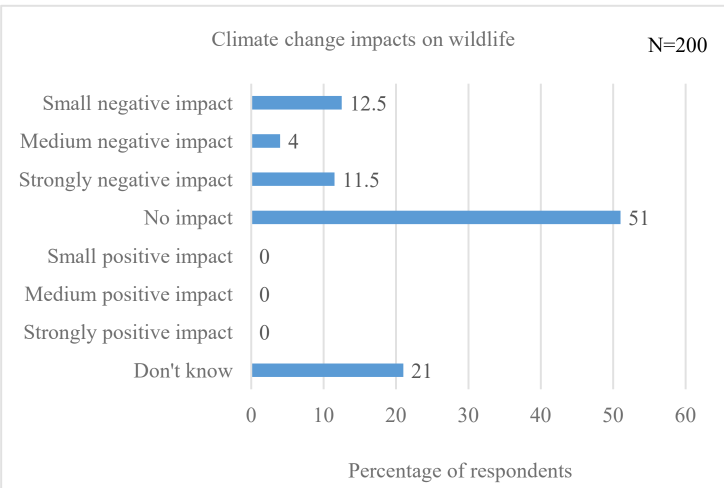


Figure 5.13: Local perceptions of climate change impacts on wildlife

Further clustering of all responses (strong, medium, small) for negative impacts indicates that about 28% of interviewees held that climate change has an undesirable influence on wildlife. Lastly, 21% of respondents did not provide any response.

To broaden understanding further, it is necessary to explore indigenous knowledge on the ways in which climate change influences wildlife (Figure 5.14). Respondents could choose more than one response. Again, most (45.5%) perceived that climate change has no impact on wildlife. Respondents who supposed negative effects said climate change provokes changes in range distribution (26%) and changes in abundance (16.5%). Very few respondents (3%) mentioned loss of species and changes in timing (2%). Interestingly, 21% of respondents provided no response.

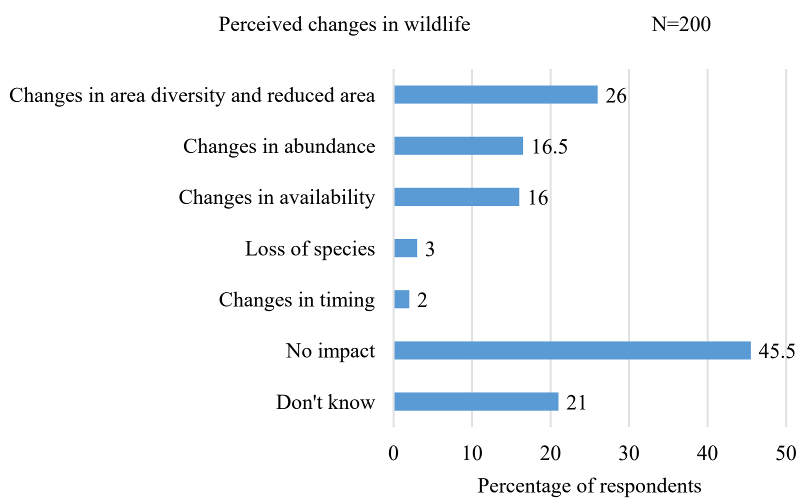


Figure 5.14: Frequency distribution of perceived effects of climate change on wildlife

Respondents during the household survey and focus group discussions expressed that climate change has affected the area's wild animal diversity, due to migration to zones further into the forest in search of water and food. They also said that all streams in the vicinity of the villages are dry, and animals have no water during the dry season and very little during the rainy season, due to reduced precipitation. Also, animals migrate to other sections of the forest, due to wildfires, which are rampant during the dry season. Moreover, one interviewee said that the lack of water and food, an increase in temperature and fire incidents have affected the health and growth of animal species such as *Cricetomys gambianus* (rat mole). These views are captured in some respondents' stories, as depicted in Box 5.8.

Box 5. 8: Narratives on perceived climate change effects on wildlife

In the absence of regular rainfall and water, elephants now eat other plants which have water and go to people's farms to eat plantains and even travel to other sections of the forest, far away, just to look for food and water. Thus, in the absence of water, elephants cause more destruction (**Luma Francis, Bokwaongo, 31.05.2018**).

Animals lack water to drink, and there is little or no forest to protect them. They also lack fruits and grass to feed on. The water spots they drank from are dry. Fruits are not available during the seasons like before. The animals therefore starve, since they do not have water and fruits. Also, they […] run away (**Dabuju Evakise, Bokwwaongo, 05.06.2018**).

Due to the prolonged dry season, fire propagation is very high, especially in the savannah area of the forest. I have seen many dead antelopes around this area. Also, animals have migrated to the Bowando forest area, because it has water. Animal migration happens more during the dry season (**Elias Mokake, Mapanja, 15.06.2018**).

In the past, Buea was very cold and animals loved the cold climate. Now Buea is hot, and I realise that even the rat mole [*Cricetomys gambianus*] we catch now is no longer healthy, due to the increase in temperatures and lack of food (**Ndive Njie, Bokwaongo, 26.07.2018**).

Viomah [*Landolphia landolphioides*] found around farmlands is eaten by humans and animals (monkeys, chimpanzees drills). It is no longer available on the farms, and thus it is difficult to see these animals. The animals are now found in the Bomboko and Debundscha forest areas because of the heavy rainfall favourable for these plants which flower around September and mature between February and April (**Hunter, Bokwaongo, 11.06.2018**).

Source: Field data, 2018

The respondents disclosed that during the dry season, animals migrate to areas with streams and to upper sections of the mountain where there is water, a cooler climate and intact vegetation. This movement has affected livelihoods, in that animals no longer frequent the lower altitudes of the forest. Consequently, hunters do not see wild animals around hunting areas, since they reside further inside the bush and park. Thus, wildlife migration has affected availability of food for household consumption and revenue from sales. The effect on indigenous livelihoods is captured in the interviewees' stories below:

> *In the past, we had* kaweh [*antelope*] *behind our homes and farmlands and even at manns spring in the forest. We did not have to strain too much to make a catch. Currently, we have to walk to the Bomboko and Bakingili sections of the mountain to hunt it, which is not easy.*
>
> (**Ndive Hans, Bova, 16.06.2018**)

> *Climate change has made the animals to go up the mountain, thus my husband stays for 2 years without seeing animals. Consequently, he cannot bring home bushmeat. This has affected us, since we now rarely eat meat, and affected our income source, because income from bushmeat sales has stopped.*
>
> (**Enanga Pauline, Likombe, 21.06.2018**)

These narratives indicate that the migration of wildlife to other forest sections has negatively affected the consumption of and income from wildlife sales. In addition, participants said *Landolphia landolphioides* (traditional name viomah) is consumed by animals such as *Pan troglodytes* (chimpanzee), *Erythrotis preussi* (Preuss's monkey), *Cercopithecus nictitans* (white nose monkey) and *Papio leucophaeus* (drill). It is a climber species heavily affected by hot temperatures. Thus, its scarcity in the Likombe and Bokwaongo forest sections, as mentioned by the respondents, has led these animals to move to other areas of the forest. Besides, they indicated that climate change effects on food and water important for the livelihoods of humans also affect wild animals dependent on them for survival. They alluded to the acidic rain which fell in April 2018 (see Table 5.2) and affected water quality and food crops, surmising that it must have affected animals. Furthermore, they felt that alterations in seasons and prolonged dry seasons might confuse the reproduction cycles of some animal species such as the sleeping deer (traditionally called 'ngwea') and could affect new-born animals. This view was expressed by a hunter in Bokwaongo, as shown in the following extract:

> *It is difficult for animals to adapt, due to unstable seasons. For example, the* ngwea [sleeping deer] *knows that during the rainy season it has to reproduce. Thus, with a prolonged dry season, its young might find it difficult to survive.* Ngwea *reproduces around the month of September. If the sun continues at this rate, it will be very much affected.*
>
> **(Hunter, Bokwaongo, 11.06.2018)**

Furthermore, ecotourism is an alternative source of income instead of hunting. During discussions with some ecotourism groups, they expressed that the effects of climate change on water and food availability have compelled elephants to migrate to other areas, which in turn has affected their presence on trails used for ecotourism. The effect of climate change on ecotourism is clearly expressed in the following statement:

> *Irregularity of rainfall affects elephants and consequently ecotourism. Eco guides and porters use specific trails. The lack of elephants on trails has discouraged tourists who do not see them. Elephants have particular spots where they go for water. The absence of water moves elephants to other forest sections. We know only particular spots, and so tourists are disappointed when we take them there and they do not find the elephants.*
>
> **(Njie Collins, Bokwaongo, 31.05.2018)**

Interestingly, some respondents perceived that climate change has no impact on wildlife because MC is wide, quiet, cold and has thick vegetation favourable for wildlife. Moreover, animals are protected by God and have more food than humans, since they feed on forest products and crops planted by farmers. Also, scarcity of wildlife is not due to climate change. The views of respondents who do not link changes in wildlife occurrence and availability to climate change are captured in the following accounts.

Box 5.9: Participants' perceptions of non-climate effects on wildlife

God created wild animals. Whether there is rain or sun, they eat and carry out their activities (**Mola Kolu, Bova, 11.06.2018**).

Iijah [Pangoline] is very scarce, because we have not seen it for long time now. It is not an issue of climate, because unstable seasons do not affect animals, since God has created them to be able to adapt (**Hunter, Bova, 11.06.2018**).

Climate change does not affect wildlife, because they adapt more than humans and they feed on crops planted by us. For example, cocoyams [*Colocasia*] and plantains are eaten by porcupine [*Athrurus africanus*], and cocoyam leaves are eaten by kaweh [antelopes] and maize eaten by koti [*Manistricuspus*] and voh [*Cricetomys gambianus*] (**Lyonga Abel, Bova, 24.07.2018**).

Source: Field data, 2018

Finally, a few interviewees provided a "do not know" response, because hunting is not their profession. For some female respondents, hunting and knowledge on wildlife is a man's domain, and to others it is left for the animals to explain the effects of climate change, since they live in the bushes without humans. The study also revealed that climate change is affecting medicinal plants vital to native livelihoods. The next subsection thus examines the exposure of medicinal plants to the influences of climate change, and consequences on indigenous livelihoods.

5.5.3 Climate change impacts on medicinal plants and indigenous livelihoods

The study communities did share their impressions and knowledge about the consequences of climate change not only on food NTFPs and wildlife, but also for medicinal plants. Figure 5.15 shows that no respondent perceived any positive climate impact on medicinal plants. Responses for negative effects varied from small, medium and strong. Negative impacts clustered together accounted for 63.5%, followed by no impact (32%) and no response (4.5%).

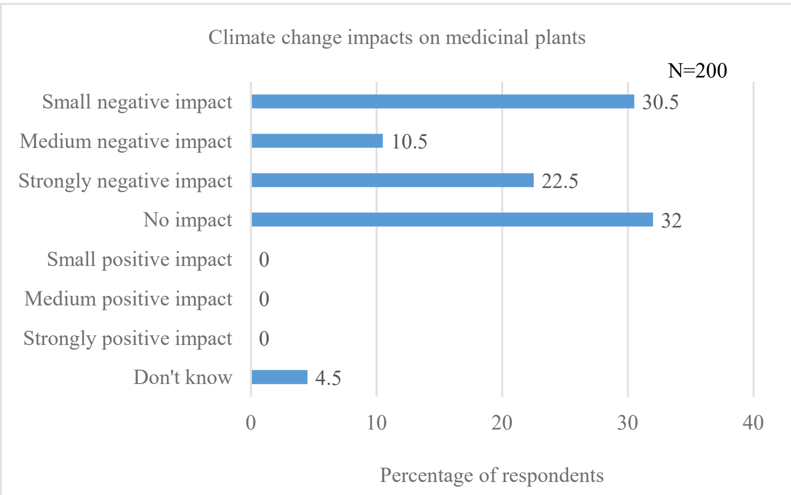


Figure 5.15: Local perceptions of climate change impacts on medicinal plants

The household survey further provided insights into ways that climate change affects medicinal plants. As indicated in Figure 5.16, most interviewees perceived that climate change negatively affects the productivity of medicinal plants (58.5%), followed by no impact (30.5%), changes in forest area distribution (26.5%), changes in quality of medicinal plants (19%), changes in growth (17.5%), loss of species (12.5%) and no response (4.5%).

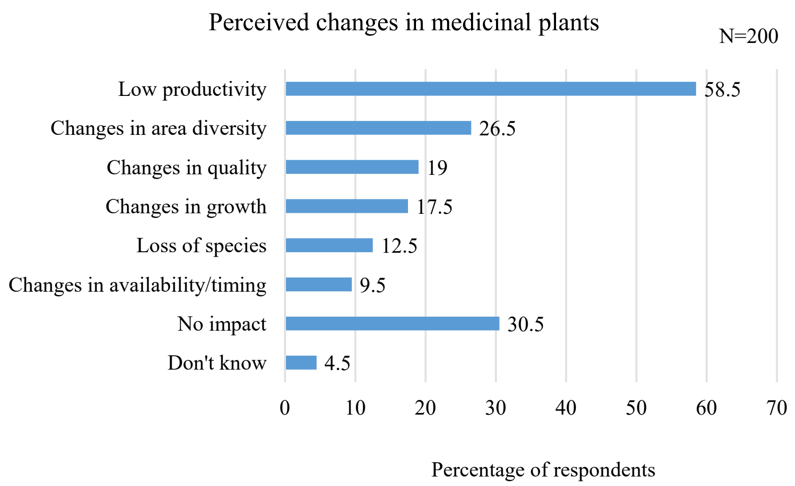


Figure 5.16: Frequency distribution of perceived outcomes of climate change on medicinal plants

During the household survey and focus group discussions, interviewees conveyed that the prolonged dry season has led to the scarcity of medicinal plants around homes and farmlands. Most medicinal plants wither, due to the lack of water and hot temperatures. For instance, *Macaranga occidentalis* (ewowoh) is significantly affected by hot temperatures, as it dries up, explaining why it is mostly used as fuel wood. Field accounts conveyed that *Eremomastax speciosa*, *Costus afer*, *Agauria salicifolia*, *Celosia isertii*, *Justicia laxa*, *Emilia coccinea*, *Cymbopogen*, *Agerantum conzoides*, *Bidens pilosa*, *Laportea ovalifolia*, *Boehmeria macrophylla* and *Ocimum gratissimum* are very much affected by hot temperatures and prolonged dry seasons, because they do not store much water and their leaves wither and fall. This leads to a change in area diversity, which, according to respondents, is a big problem due to the long distances required for foraging. Plant leaves are brown and yellow instead of green, therefore rendering them unusable for traditional treatment. The respondents cited the scarcity of *Ocimum gratissimum* (macepo) and *Bidens pilosa* (black jack) in 2018, during the dry season and August months, due to continuous rains. Moreover, due to prolonged dry seasons, the *Afromomum melegueta* (alligator pepper) fruiting period has changed from September to August, while significant rains mean that *Cymbopogen* sp. (fever grass) rots. The effects of climate change on medicinal plant productivity, quality, availability and livelihoods was expressed by interviewees in the following excerpts.

Box 5.10: Climate change effects on medicinal plants and livelihoods

We use the fresh leaves of medicinal plants for traditional medicines. The long dry season we experience now gives the leaves a brown and yellow colour, which we cannot use (**Ngomba Andreas, Bokwaongo, 11.06.2018**).
The leaves of macepo [*Ocimum gratissimum*] fall off during the dry seasons. With the severity of the sun, almost all the leaves fall off the tree. I have no fresh leaves for medicine. The sun destroys more than 98% of the leaves. It is difficult for me, since I do not have money to buy medicines (**Melvis Eposi, Mapanja, 15.06.2018**).
Formerly, I had fever grass [*Cymbopogen* sp.] around my compound. I took it every morning as tea. It is very good. It gives me strength and cures fever. My fever grass has dried up, and I do not like to use the dry leaves. I now have to walk around in the village to ask if my neighbours have any. I think the hot sun is a problem to us. I do not have money to buy tea leaves (**Ndive Mbella, Bova, 17.06.2018**).

Source: Field data, 2018

Furthermore, results from focus group discussions and interviews revealed that climate change also affects *Prunus africana*. Field results show that it grows well in cold environments, above 1,500 m altitude on MC, but changes in temperatures at lower altitudes have affected its availability. The debarking of *Prunus africana* makes it vulnerable, and it needs more water to recover, but hot temperatures, late rainfall and prolonged dry seasons provide little water available to sustain its growth. The respondents said that *Prunus africana* debarked in the dry season has less chance of surviving than when harvested during the rainy season, whilst trees at lower altitudes are affected by borer disease (insect vector) which prevails in hot conditions. During the transect walk in Bokwaongo village, the team visited *Prunus africana* trees affected by borer disease, and we observed tell-tale dusty particles on their bark. The transect result triangulated and confirmed the views of the focus group discussions and interviews. The respondents added that the infected *Prunus africana* is not harvested for local medicinal use or sale, but is now cut down for fuel wood. The borer disease affects productivity, quality, growth and availability, but changes in seasons have also affected seed productivity. Farmers said that because of the slow recovery of *Prunus* harvested barks, the harvesting period has been shifted by park management and they fear that it might be extended again, due to prolonged dry periods. The climatic effects on *Prunus africana* have affected local revenue and the ability to provide for household needs. Farmers' views on the effects of climate change on *Prunus africana* and livelihoods are summarised in the following extracts in Box 5.11.

Box 5.11: Farmers' views on the effects of climate change on Prunus africana and livelihoods

The harvesting period has shifted from 5-8 years, because the section/portion of the tree harvested does not fully recover after five years, and thus it's extended to 8 years (**Mbanda Paul, Mapanja, 16.06.2018**).

Formerly, wotangu [*Prunus africana*] budded seeds in the months of March and April. Normally, during the rainy season, *Prunus africana* does not produce seeds. Seeds are now available between November and January. The changes in seed availability are due to climate change, which has confused the seed production period (**Kalle Litie, Bokwaongo, 20.06.2018**).

The sickness which affects wotangu [*Prunus africana*] is a big problem to me. I do not know the name but I see insects and a brown substance on the skin of the tree. All wotangu trees I have on my farmland are sick. My friends who have *Prunus* on farms nearer the mountain do not really face this problem. I cannot harvest the bark and sell as others do. I also cannot use the bark when my children are sick with malaria, so I take a bit from other people's farms (**Maliva Mercy, Likombe, 22.06.2018**).

The extension from 5 to 8 years is because of climate change and long dry seasons, and wotangu needs a lot of water for regrowth (**Mbua Jonas, Mapanja, 16.06.2018**).

In the future, if the dry season prolongs more, wotangu will die and the harvesting period may have to be extended to about 10 years. The impact is that we have to wait for longer periods to have wotangu, thus affecting families, businesses, children's education and young boys (**Mbanda William, Mapanja, 16.06.2018**).

Source: Field data, 2018

Despite the perceived negative consequences of climate change impact on medicinal plants and local livelihoods, a few respondents said that it has no effect on medicinal plants, since God always makes available small quantities for use. Also, *Entandophragma angolense* (mahogany) is resistant to hot temperatures and thus not affected by climate change. Finally, the interviewees expressed that medicinal plant species in the park are not affected by climate change, due to conservation and fire control measures. Though the previous section (Section 5.5) has emphasised the influences of climate change on food NTFPs, wildlife and medicinal plants, it is worth noting that climate change also shapes power relations concerning natural resources. Section 5.6 therefore explores changes in access to forest products and social struggles, driven by climate variability and change.

5.6 Biodiversity Related Power Relations Influenced by Climate Change

Climate variability and change have not only altered natural landscapes, forest resource occurrence and utilisation, but have also induced changes in people's livelihoods. Embedded in natural resource dynamics and people's livelihoods are power relations. This section of the study explores perceptual information taken from focus group discussions, interviews and questionnaire surveys. It employs the SL framework to understand the effects of climate change on people's access and right to natural resources – and resultant tensions. This section is partitioned into four subsections. First, it examines the effects on access to food NTFPs linked to climate change, followed by wildlife and medicinal plants. These features are discussed alongside people's attitudes towards access rules.

5.6.1 Perceived climate change influence on access to food NTFPs and attitudes towards regulations

Figure 5.17 shows that most respondents (90.5%) perceived that climate change has not induced access changes for food NTFPs, and about 2.5% signalled restricted access to food NTFPs. Moreover, 7% of respondents expressed having no access to food NTFPs.

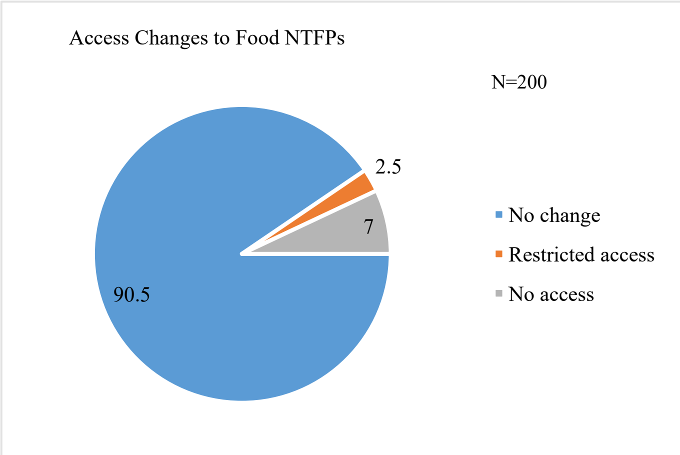


Figure 5.17: Perceptions of climate change influence on access to food NTFPs

Interviewees' views on the influences of climate change on access to food NTFPs are directly and indirectly related with climate variability and change. They expressed that government decision to prohibit honey collection in the forest is geared towards protecting bees, the ecosystem and fight against climate change. Respondents said honey collection is carried out traditionally through the use of fire to send away bees in order to collect the honey. The use of fire interviewees' added kills the bees. It also destroys the forest vegetation although the impact was less felt in the past since the forest vegetation was very thick and intact. Currently, because of the increase in temperature and changes in forest cover, fire easily propagates especially during the dry season. The local population perceives that prohibited access to honey collection is directly linked to climate change since the park has become very exposed to fire.

Furthermore, during group discussions and interviews, respondents were asked if they abide to access rules. The perceptual qualitative data reveal that most respondents do not abide to rules, because there are no rules, since most food NTFPs are open access products. They are found and collected around homes, farmlands and secondary forests, and from neighbours' compounds. Most food NTFPs are not government-protected species and do not figure on government lists of endangered or endemic species. Thus, the government cannot decide when, where and how people should collect them. In addition, the respondents perceived that although climate variability and change have affected availability and use, the government does not care and has not promulgated laws because they are common and not economically valuable to the state. The government considers them as normal vegetables, condiments and fruits. Conversely, information from expert interviews reveals that *Gnetum* spp. is a protected species, and an exploitation permit is required as stipulated in the Cameroon 1994 Forestry Law. In Mapanja and Likombe, a few respondents mentioned that it is available in the forest and collected freely, but they failed to declare that a harvesting permit is required. This local perception can be explained by the fact that *Gnetum* spp. is not common in the MCNP region, and the local population might not have a mastery of the Cameroon 1994 Forestry Law relating to NTFPs.

Furthermore, the few interviewees who indicated abiding to rules perceived that their access to food NTFPs has been restricted by the government, eco-guards and VFMC, in terms of not being allowed to collect honey from the park. They confirmed that access to honey and user rights have been affected by the government in its fight against bush burning and wildfire propagation stemming from climate change. According to the respondents, user rights exist only on paper; in reality, they have been banned from honey collection in the protected area, even for household use. Another area on which interviewees provided perceptual knowledge is on climate-induced access impacts on wildlife and indigenous people's attitudes towards rules, as discussed in the following subsection.

5.6.2 Perceived climate change effects on access to wildlife and attitudes towards regulations

In addition to perceptual knowledge on climate-induced access influences on food NTFPs, respondents gave their views on climate change-induced access effects on wildlife. Figure 5.18 illustrates that most respondents (73%) perceive climate change has negatively influenced access to wildlife. Interestingly, 14.5% gave no response.

Participants' views on the influences of climate change on wildlife access are directly and indirectly associated with climate variability and change. They observed that government actions to protect wildlife, trees and the national park are aimed at protecting biodiversity and consequently to fight against climate change. They also expressed that although the government has been protecting the forest for over the past 40 years, it is only recently that biodiversity protection has become very strict, and NGOs, when explaining the 1994 Forestry Law, educate them not to go into the forest because they have to protect the trees and animals, since the Buea climate has changed and many animals are now scarce.

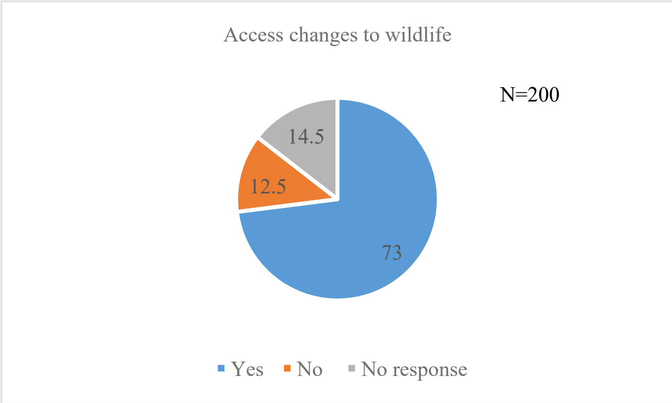


Figure 5.18: Perceptions of climate change influence on access to wildlife

One hunter contended that environmental changes have forced the government and GIZ to be severe with hunters, whose perceptions are encapsulated in the following quote:

> *Although the government has always protected the forest, we carried out illegal hunting in the past and never had severe punishments like today. Currently, many NGOs come to Mapanja to talk about the 1994 Forestry Law and the benefits of protecting the animals and forest. They inform us that our environment is no longer the same, and if we kill animals, most plants will disappear and the temperature will continue to be hot. We think GIZ is stopping us from hunting in the park and even around our farmlands, because of climate change and to protect the environment.*
>
> (**Hunter, Likombe, 22.06.2018**)

Moreover, during focus group discussions, respondents reiterated that the Buea climate is changing and animals important for the ecosystem and humans have become very scarce. According to Monono, government actions to restrict access to wildlife are directly due to scarcity and, indirectly, to protect the environment. Climate change has reinforced government conservation actions to reduce access to wildlife in the forest. Monono's view is summarised in the following:

> *The government has realised that the forest is been destroyed and the Buea temperature increasing, thus they stopped us from entering the park, because they want the forest to remain natural to protect the climate, trees, animals and water. If deforestation continues and the temperatures continue to increase, most animals will become extinct.*
>
> (**Monono Luma, Likombe, 22.06.2018**)

In addition, the hunters revealed that hunting is mostly done around the savannah area of the forest. During the dry season, animals such as antelope visit, and so the area is burnt to attract animals and facilitate hunting. Antelope eat wood ash, and thus bush burning provides them with food. In the past, hunters said bush fires around this area did not spread easily, since the forest vegetation was intact, and so they could burn small portions for hunting, without park management perceiving it. Currently, the savannah vegetation is very fragile and more exposed to fire, due to an increase in temperatures leading to dryness. The participants indicated that prohibiting access to wildlife in the savannah region is a direct consequence of climate change, since the area has become very vulnerable to fire. This view by hunters is corroborated by expert interviews, as depicted in the following statement:

> *In the past, the savannah vegetation was less vulnerable to fire. We hardly found large portions of the forest burnt in the savannah region. When hunters started a fire, we were able to contain it, because the vegetation was almost intact. Now the fire spreads very fast and has destroyed the vegetation in this area. Park management has banned hunting in the park and has reinforced control in this area particularly. I think increased fire propagation is linked to deforestation and also climate change. The mountain temperature is changing slowly, which is a problem to both the animals and plants.*
>
> **(Ekpew Enow, MCNP, 11.05.2018)**

Interestingly, the respondents expressed that government action to protect the environment, and consequently fight against climate change, has affected the access of indigenous people to wildlife, but it has also indirectly provided more access rights to non-indigenes, because in the past they had hunters' unions which controlled hunting, under the authority of the village council. Thus, through the union, they could control access to the forest. Some participants said the banning of hunters' unions by park management has weakened traditional control over the forest. Presently, state control has opened up access to non-indigenes who live in the villages, since they now hunt animals, and indigenous people cannot challenge them like before. This view was expressed in Likombe village by a member of the traditional council. He stated that:

> *Every day, we hear from the GIZ staff that the environment has changed. We too have seen that the village temperature is not the same. The government has taken advantage of this to stop us from collecting bushmeat from the forest. They have instead worsened the situation. Strangers come and go hunting in the forest, and we cannot challenge them, because the government has taken all our powers. People – especially strangers – are no longer afraid of the chief and traditional council.*
>
> **(Njie Luma, Likombe, 22.06.2018)**

Bokwaongo is one of the study villages with a hunters' union in the past. During data collection, this group was reconstituted. Most of the participants who wanted to remain anonymous strongly believed that banning their union was not only intended to protect wildlife, but it was also a climate measure. The accounts by respondents on climate-induced access to changes to fauna are elaborated in Box 5.12.

Box 5.12: Narratives on climate-induced access changes to wildlife

We had a hunters' union which controlled activities, and a constitution which stipulated the number of persons who had to go to the forest each week. Also, we had sub-groups which made up the hunters' union. Each group had a week to go to the forest. The programming of each group was a local way for sustainable management of the forest. They could easily control illegal hunting (**Hunter, Bokwaongo, 11.06.2018**). In the past, strangers were not allowed to hunt because they were restricted by the union and tradition. Strangers could only help indigenous hunters by serving as porters/carriers. They could accompany hunters but were not allowed to hunt (**Hunter, Bokwaongo, 11.06.2018**). Strangers did not have the right to go into the bush. They had to get authorisation from the chief before going to the forest and send someone to accompany him (**Dabuju Evakise, Bokwaongo, 06.06.2018**).

Source: Field data, 2018

The hunters' narratives indicate that through the hunters' union, hunting was organised and exempted from outsiders, thus indirectly protecting fauna species. The organisation of hunters in groups ensured the sustainable management of fauna and controlled the influx of people into the forest. In addition, the hunters conveyed that most streams in the forest have dried up and animals have moved further up the mountain and bushes. When streams were flowing in areas around farmland and secondary forests, animals came to drink water, and so hunters could easily see them and carry out hunting. Now, there are no streams in their forest section, so finding animals in the first instance is very difficult, since they have migrated to other forest areas. In turn, this has greatly affected hunting activities, since they have to walk over longer distances. This notion is captured in the following statement:

> *Formerly, streams were functional during the rainy season. They provided black sand used for construction and flowed down with animals such as antelopes. The antelope was used for meat, and wood for cooking. Currently, the streams no longer flow to the villages. This might be due to temperature increase, earthquakes and volcanic eruptions.*
>
> (**Ndive Mbella, Bova, 10.06.2018**)

Due to the absence of streams and water crises in the villages, park management has reinforced control over deforestation and other illegal park activities to curb further vegetation deforestation around water catchments and streams found in the forest. Contrarily, some hunters explained that the long dry periods have increased their access to wildlife, since they can carry out hunting without disturbance from the rains. Also, the rains destroy traps and guns and disturb dogs used for hunting. Furthermore, the dry periods are suitable, because movement in the bushes is much easier to spot. Animals can also be sighted easily when the grasses are dry. During the dry season, animals migrate up the forest, especially around streams, but during the rainy season, the movement of animals is limited.

Perceptual knowledge on respondents' attitudes to wildlife was based on whether people respect access regulations. First, those who respect access rules said laws on biodiversity management are made by the government and reinforced by park management. Access regulations to forest resources are respected, because the park is protected by the government, which has "overall powers," and villagers said they are afraid of being taken to court, detained or imprisoned. Also, park boundaries and government regulations must be respected, because the park is state property. During group discussions with members of the VFMC and MOCAP, they expressed that as representatives of MINFOF in the villages, they show exemplary behaviour by being the first to respect government laws. They have been warned by MINFOF staff against the dangers of carrying out illegal activities in the park and received education on the Cameroon 1994 Forestry Law. This law has devolved forest management responsibilities to communities living in and around forests, and therefore their role is to educate the population on their responsibilities and sanction defaulters. Also, the interviewees said they respect access regulations because the VFMC and MOCAP members are acting as government spies in the villages. They report illegal activities to the government, consequently making the villagers afraid and creating tensions between the villagers and the VFMC and MOCAP members.

Second, some respondents respect access rules because government actions to protect forest products and the environment are aimed at improving livelihoods, ensuring sustainability for the future generation and protecting the environment. Moreover, it is their duty to ensure that the animals do not become extinct, because they want the future generation to see them. Also, eco-guards intimidate villagers and take their products. Distance to the park was also cited as another reason for respecting rules. Finally, wildlife is important to ecotourism, as it brings revenue to individuals, the community and the state. The communities consider that MC has important game species such as the *Francolinus camerunensis* (Mount Cameroon Francoline), *Speirops melanocephalus* (Mount Cameroon Speropes) and *Loxodonta Africana cyclotis* (elephant), among others, which should be protected for the sustainability of the ecotourism industry in the region. Nevertheless, some do not stick to access rules, because they are hungry and need bushmeat for food and revenue. Besides, hunting cannot be stopped, because it is an important source of food and income for their survival, so it is carried out at night, in order not to be alert the eco-guards. Some animals are nocturnal and can be sighted only at night. Another area explored, to understand perceptual knowledge on access to forest products influenced by climate change, was medicinal plants, as discussed in the following subsection.

5.6.3 Perceived climate change impact on access to medicinal plants and attitudes towards regulations

The survey data (Figure 5.19) reveals that a large percentage of the respondents perceive that climate change has led to access changes on medicinal plants (67%), and followed by no access changes (26.5%).

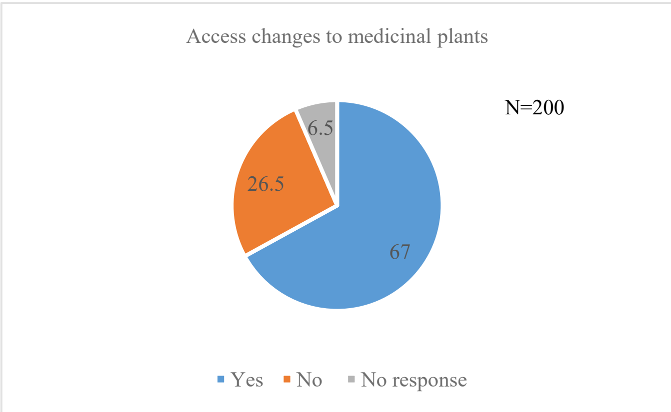


Figure 5.19: Perceptions of climate change influence on access to medicinal plants

The perceptual data from group discussions and interviews indicate that climate change has imposed changes on indigenous people's access to *Prunus africana*. The respondents said that due to increasing temperatures, *Prunus africana* takes long to recover after debarking, and those in the lower altitudes of the forest are affected by the borer disease. This has led park management to reduce access to the tree, as reflected in measures such as regeneration and harvesting periods, collection sites, harvesting sizes (girth) and quantities. Farmers provided the following explanations on how their access to *Prunus africana* has been affected by the impact of climate change, as captured in Box 5.13. The farmers' narratives indicate that changes in access have affected their income, standard of living and user rights.

Box 5.13: Farmers' perceptions of climate-induced access changes on medicinal plants

When wotangu [*Prunus africana*] was not greatly affected by the borer disease influenced by climate, we collected around our farms and even in the park, even though it was illegal. With the increasing effects of climate change on wotangu, the government has reinforced control over its collection. I harvested in the forest to sell and earn a living, but now I cannot harvest, thereby reducing family income (**Mbua Ekwa, Bova, 18.07.2018**).   The effects are too great. Even what we call 'user right' is a problem. I am even afraid to take a small quantity of wotangu for family use. I think even the one on my farm I am not free to use (**Kinge Njie, Mapanja, 08.08.2018**).

Source: Field data, 2018

Perceptual knowledge on respondents' attitudes to medicinal plants was based on whether people respect access regulations. Those who respect access rules made by the government said they are prohibited from collecting *Prunus africana* from the park. MOCAP has numbered all *Prunus africana* trees, and illegal collection is punishable. Furthermore, they are forced to respect regulations on *Prunus africana* because the government determines prices, marketing and the harvesting period. Moreover, only MOCAP has direct access to buyers. Also, the non-respect of *Prunus africana* regulations can lead to extinction, whilst rules are respected for fear of punishment by the VFMC, eco-guards and MOCAP. Access restrictions to *Entandophragma angolense* are respected, because it is an important timber species and medicinal plant protected by the government. Illegal exploiters of *Entandophragma angolense* are imprisoned and pay fines ranging from 500,000 to 1,000,000 FCFA (855.3 to 1,710.6 US$).

Nonetheless, respondents who do not abide to access rules on medicinal plants expressed that except for *Prunus africana* (pygeum), there are no rules related to other medicinal plants such as *Bidens pilosa* (black jack), *Ocimum gratissimum* (macepo), *Piper guineense* (bush pepper), *Justicia laxa* (miajah maijah) and *Cymbopogen* (fever grass) collected from around homes, farmlands and neighbours' compounds. Smaller quantities are required for traditional medicines and for household use, and the government has put no regulations or restrictions on them. Furthermore, *Prunus africana* (pygeum) and *Kigalia africana* (sausage tree) planted on farmlands can be harvested for medicinal purposes. Although the preceding subsections of Section 5.6 have focused on indigenous people's perceived climate change influence on access to food NTFPs, wildlife and medicinal plants, and approaches to regulations, it should be noted that conflicts and tensions are also influenced by climate change, as examined in the next subsection.

5.6.4 Social struggles reflected in forest products changes induced by climate change

Access and rights to forest resources, and rules imposed by stakeholders to ensure conformity, have been dynamic over time. Some people respect rules, while others do not abide by them, and this non-respect for rules is occasionally embedded in conflicts between stakeholders. Encounters vary depending on the type of resource and its value to the different interest groups. Results from the questionnaire survey and focus groups show that tensions arise often from honey collection. Park management has banned this activity because it is carried out using fire, a technique dangerous to forest vegetation and the bees. During the dry season especially, fire used for honey harvesting extends to other forest sections, but despite restrictions not to collect honey from the protected area, the respondents said they continue to do it illegally, because it is not available on farmlands and it is very useful for traditional medicines. Thus, honey is collected at night, in order to avoid forest guards and because bees are less aggressive at night. This tension in honey activities is reflected in the following statement:

> *In the past, we harvested honey in the forest, but we are now restricted. Now we hide and even go to the forest at night for honey harvesting, instead of going to the conservator for authorisation. Some of my friends were caught one early morning when coming back from the forest with honey. The ecoguides wanted to take the honey and even arrest them. There was a serious fight between them.*
> (**Dabuju Evakise, Bokwaongo, 06.06.2018**)

The perceptual information also indicated that conflicts arise between wildlife and humans. Interviewees expressed that the lack of water during the dry season and the scarcity of some food NTFPs consumed by elephants have prompted these animals to move to the lower altitudes of the forest to look for sustenance. The elephants eat food crops planted by farmers and also consume a lot of *Kigalia africana* (sausage tree) fruit (motimbi-limbi). The elephant intrusion on farmland creates conflict between the villagers and elephants, farmers and park management, since it is forbidden to kill it. This elephant-human encounter is articulated in the following statements (Box 5.14):

Box 5.14: Narratives on conflicts between humans and elephants induced by climate change effects on forest products

In the absence of regular rainfall and water, elephants are forced to eat other plants which have water and go to people's farms to eat plantains. Thus, in the absence of water, elephants cause more destruction to our farms. This creates conflicts between us and the elephants (**Luma Francis, Bokwaongo, 31.05.2018**).

Elephants, due to the difficulty finding water during the dry season, come to the farmlands. They consume food crops and fruits which have water. For example, the woloulay (*Kigalia africana*) fruit is difficult to find during the dry season because elephants eat it, due to water scarcity (**Kalle Litie, Bokwaongo, 07.08.2018**).

Elephants are available during different periods of the year. During the dry season, they come to lower altitudes up to about 50 metres above sea level, due to water scarcity and food at higher altitudes. During the rainy season, elephants move to upper altitudes because of water availability, fresh vegetation and the bark of trees with water. People are arrested and punished for killing class A and B animals (**Ekpew Enow, MCNP, 11.05.2018**).

Source: Field data, 2018

Furthermore, discussions with hunters in Bova and Bokwaongo villages revealed that most animals have migrated to other forest sections in search of food and water. Thus, villagers are forced to go to other regions and neighbouring villages for hunting. Also, conflicts ignite during years with longer dry seasons, because of the scarcity of resources such as water and animals. Hunters often encounter problems with villages who accuse them of trespassing on their forest section to carry out illegal hunting activities. A respondent in Bova voiced this view in the following excerpt:

> *People leave other villages to go hunting in the Bova section of the forest. But the government, after controlling, says it is Bova people, whereas we are not the ones.*
>
> **(Ngomba Nasoa, Bova, 24.06.2018)**

In addition, the qualitative data indicate that respondents encounter conflicts stemming from climate change effects on *Prunus africana*. Some farmers suggested that the prolonged dry periods and reduced rainfall have affected the productivity of *Prunus Africana*, particularly on farmlands. Consequently, harvested quantities have reduced, and so to increase sales, they now harvest illegally from other forest sections, which always creates tensions between illegal harvesters and MOCAP. The effects of climate change on *Prunus africana* and resultant conflicts are reflected in the following statements (Box 5.15) made by farmers in Mapanja and Bokwaongo.

Box 5.15: Stories of tensions induced by climate change effects on Prunus africana

All trees need water. The destruction of wotangu [*Prunus africana*] bark, due to long dry seasons and borer, reduces the quantity available during harvesting and pushes people not to respect harvesting rules in search for more income (**Mbanda William, Mapanja,16.06.2018**). Climate change is affecting wotangu [*Prunus africana*] on our farmlands, and the government is doing nothing. The few trees on our farmlands are affected by borer, and they do not grow healthily, due to climate change. To have more to sell, we are forced to harvest from the protected area, which is illegal. I have experienced the seizure of wotangu by government, and I know some illegal harvesters have been jailed (**Dabuju Evakise, Bokwaongo, 05.06.2018**).

Source: Field data, 2018

The farmers' views illustrate that climate change affects growth, recovery and income from the sale of *Prunus africana*. This climate-induced vulnerability has persuaded people to carry out illegal harvesting activities, therefore exposing them to conflicts. Tensions have also flared between village-based forest management institutions (MOCAP & VFMC) and some traditional councils over resolving problems stemming from illegal harvesting. In addition, climate change has reduced quantities, created scarcity and increased vulnerability, thus increasing non-respect of harvesting rules and regulations. Members of Bova village's council noted that cases regarding the theft of *Prunus africana* are brought to them by farmers, but MOCAP and VFMC members indicated it is their responsibility to handle such conflicts as mandated by park management. According to Bova council members, this is not fair, since they were custodians of the forest well before conservation activities began in the region.

Although this section has elaborated on power relations with reference to access and social struggles prompted by climate change impacts on forest resources, it should be noted that the vulnerability of indigenous livelihoods and biodiversity to the effects of climate variability and change has been met by different coping strategies employed by individuals, groups and communities. The next section thus examines adaptation initiatives carried out in the study area to improve on livelihoods and enhance biodiversity.

5.7 Adaptation Measures and Practices Taken to Maintain Biodiversity and Livelihoods

The previous section explored access changes to the impacts of climate change in the MCNP region, but it did not indicate that in the face of climate change, indigenous people carry out certain actions to enhance their livelihoods and the ecosystem. The adaptation analysis is built on adaptation strategies and sustainable outcomes of the PCVCBLA and SL structures. Furthermore, it incorporates the CRiSTAL approach to explore individual, group and community responses to climate change. In line with these approaches, frameworks and objectives of the study, this section is divided into three subsections. First, it examines individual adaptation strategies in the MCNP area, influenced by climate variability and change. Second, adaptation approaches taken by groups and communities, and the influence of external agencies, are examined, and third, it investigates short- and long-term adaptation actions and explores how they improve on people's vulnerable livelihoods and the ecosystem. The analysis is based on information gleaned from the questionnaire survey, and PRA tools, including transect walks, group discussions and interviews.

5.7.1 Local Adaptation Strategies to Climate Change

During the group discussions, survey questionnaire and interviews, participants were asked about adaptation strategies linked to climate change. The respondents expressed having made some adjustments to their livelihood strategies, mostly been prompted by changes in forest product availability and abundance, low agricultural productivity, water scarcity and climate change, which to them is another challenge to their livelihoods. This section explores various individual and household adaptation approaches, consisting of livelihood diversification strategies, alterations in farming practices and rural-urban migration.

5.7.1.1 Modification of farming strategies

During focus group discussions and interviews, participants conveyed having effected some changes in their farming activities, to improve on crop yield, and adjusting their livelihoods to cope with climate change challenges. Modifications in agricultural praxis consisted of a reduction in shifting cultivation and bush burning, the introduction of new crop varieties, the use of organic manure, crop rotation, contour farming, tree-planting and protection, organic pesticides, changes in tree-planting distance, use of wood ash to fight against pest invasion and reduced tree-felling. Their narratives on alterations in farming strategies, as delineated in Box 5.16, indicate that the changes were aimed at increasing household income, reducing soil erosion, forest dependence, fighting against deforestation and forest degradation. Some of the strategies are linked to climate change, but others are indirectly related.

Box 5.16: Participants' alterations to farming strategies

Many farmers no longer practice shifting cultivation. Also, the use of herbicides has affected our soil quality. Some farmers use herbicides and others do not, due to the lack of money. The introduction of new crop varieties by the Environment and Rural Development Foundation (ERUDEF) and PSMNR-SWR has helped us. We now have improved plantain varieties and practice mini-set yam production, which has increased productivity and assured a good harvest. We can now harvest and sell yams and plantains several times a year (**Lyonga Abel, Bova, 24.07.2018**).

I use organic manure on my farmland, to increase soil fertility and crop productivity. I have also stopped bush burning. The grass I cut is used as organic manure. I also plant trees to shade my crops from sunlight, fight against deforestation and practice agroforestry to prevent soil erosion. I stopped bush burning to prevent soil organisms from been destroyed (**Ndive Hans, Bova, 19.07.2018**).

In the past, we had vast tracts of land and practiced shifting cultivation. We even left our old farms to fallow. This is not possible now, because the park occupies about 70% of our land. This is the reason why even orango [*Solanum nigrum*] has become scarce, since it germinates when we open new farms. We now do farming on the same piece of land continuously. This affects crop productivity, because the soil has been used for a long time. I now apply pig dung and use compost manure to improve on soil fertility and crop productivity (**Elkana Ekema, Bokwaongo, 16.06.2018**).

Mboloma [*Impasiance sakeriana*] has become very scarce, due to climate change and deforestation. To protect this plant and ensure sustainability during my ecotourism activity whenever I come across the plant, I clean its surroundings so that neighbouring plants do not disturb its growth. I also replant wotangu [*Prunus africana*] (an ecotourism plant) in the forests. If a wotangu plant is not well-positioned, for example along a trail, I plant it in a position where it can grow well. That is, I plant it in a favourable environment. The planting of wotangu helps fight against climate change, because it grows into a big tree, protects the soil from too much sun and provides good air in the atmosphere (**Teke Moknoye, Bokwaongo, 31.05.2018**).

Before, I did not use herbicides. Now I use "glycot" and "gramazone," which kill bad and good herbs. I realised that it even affects food quality. Many farmers use herbicides to reduce workload, and out of laziness. I was told that the herbicides are produced by the white man, but they are sold to us by Nigerian businessmen (**Elinge Molombe, Bokwaongo, 16.06.2018**).

Due to the increasing effect of climate change on wotangu [*Prunus africana*], I have changed the planting technique. Instead of a spacing of 5-5 metres, I now practice 10-10 metres spacing to enable the tree to grow well. I do wotangu regeneration to ensure that the tree is always available, and to fight against climate change and deforestation (**Kalle Litie, Bokwaongo, 07.06.2018**).

Our soil quality has changed and has become very poor. If I plant vegetables without fertilisers and chemicals, they do not do well and the productivity is low (**Embola Lucy, Bova, 20.07.2018**).

I keep pigs and have about six. Though pig farming is very difficult, it is also very lucrative now. Few people do pig farming, and thus I sell them for a lot of money for village ceremonies such as marriages and funerals. I use the pig dung as manure in my garden. The vegetables in my garden grow healthily because of the pig dung, which is natural manure. The fertiliser we purchase to use on vegetables gives us diarrhoea, but I have never experienced it since using pig dung. I also have two goats whose dung I also use as manure (**Nasoa Eliva, Bova, 07.07.2018**).

As farmers we use wood ash and spread it around wotangu [*Prunus africana*] to send away insects disturbing its growth. Also, we have reduced deforestation by stopping shifting cultivation and have stopped tree-felling on farmland (**Dabuju Evakise, Bokwaongo, 06.06.2018**).

Now I spray chemicals on my farm to kill the grass and trees. Chemicals affect our food quality and even make some people sick. I am afraid, because my neighbour's children and almost the entire family fell sick and were hospitalised in Limbe. I hear the doctor said it was due to food poisoning. I am really afraid and do not know what to do. I have no choice but to use the chemicals, since I do not have the strength to clear my farm (**Nyama Jonas, Mapanja, 16.06.2018**).

Source: Field data, 2018

The statements of some farmers (Box 5.16) illustrate that some farming adaptation practices are linked to climate change, including tree-planting for reforestation and shading of crops from sunlight, as well as tree protection by clearing around *Impasiance sakeriana* (mboloma) and *Prunus Africana*, which are affected by climate change. Furthermore, during the transect walk, some farmers presented *Prunus africana* trees on which they had poured wood ash around the stem to fight against pests and insects that favour hot temperatures. They told me that although the use of wood ash is not very effective, it nevertheless reduces the rate of *Prunus africana* infection. Moreover, this is the only solution, since the government has been silent on the issue. In addition, the farmers indicated facing some challenges in terms of reduced crop yields and soil fertility which are not necessarily climate-related. These problems are addressed through the use of organic manure and fertilisers. Besides, they no longer practice shifting cultivation, due to government occupation of much of their land. As a consequence, they practice agroforestry by planting food crops and trees, and installing beehives, on the same piece of land. They therefore carry out many actions to adapt their farming activities to the effects of climate change and the challenges of soil fertility and reduced crop productivity. In addition to farming adaptation strategies directly and indirectly related to climate change, participants also diversify their livelihood activities.

5.7.1.2 Individual and household livelihood diversification actions

The empirical results indicate that individuals and households carry out alternative livelihood activities, due to decreasing agricultural yields and links to climate variability and change. The following livelihood activities were identified in the study villages: animal husbandry, the sale of plantlets and palm wine (local wine), cassava processing, cocoa and coffee farming, bee-farming, flower gardening, trade in NTFPs, water trading, local restaurants and shops. Besides farming, respondents mentioned the following alternative activities expressed in Box 5.17.

Box 5.17: Participants' alternative livelihood strategies

I am engaged in pig-rearing. I have two pigs. Since Bova does not have water, and I do not have money to buy water, I cannot rear many pigs. I do not have money to buy food for the pigs, since the food harvested from my farms is not enough to feed my family and take care of animals. Thus, I have to limit the number (**Moki Agnes, Mapanja, 15.06.2018**).

I already have wotangu [*Prunus africana*] growing naturally on my farm, thus I only take care of them. I do not plant it (**Maliva Emmanuelle, Bokwaongo, 06.08.2018**).

At times, I sell cooked food in the village, to assist my husband financially and have some money to provide for my personal needs and buy other food items from Buea market (**Itabi Regina, Bokwaongo, 06.06.2018**).

I plant wotangu [*Prunus africana*] because it provides fresh air, since Bokwaongo is getting hotter. *Prunus africana* also provides income for my family (**Hunter, Bokwaongo, 11.06.2018**).

I keep goats and chickens. I sell the goats to people for traditional ceremonies. Since very few people rear goats and chickens in the village, I make a lot of money, because they are expensive. I use the money to visit my brother who lives in town (**Monono Luma, Likombe, 22.06.2018**).

I practice flower gardening, to increase household income and reduce my search for NTFPs in the forest which have become very scarce. I plant flowers as cash crops and sell them in Douala (**Njie Ndive, Bokwaongo, 26.07.2018**).

I carry out multiple activities. I do bee-farming and plant flowers and pears to feed the bees. I have 15 beehives. I do not plant wotangu [*Prunus africana*], because it takes many years to mature, but I do maintain those that grow naturally on my farmland. I prefer planting yams, because we have improved varieties. Also, I sell the pears when they are matured. Money from one activity is invested in another activity (**Elinge Francis, Bova, 19.07.2018**).

I was a hunter in the past. Since the government prohibited hunting, I have been involved in ecotourism activities from which I get some money. As a porter, I carry tourists' luggage, and I am paid on a daily basis. Since the Anglophone crisis started, tourists no longer visit the mountain. This has affected my income. Also, I own farms on which I plant bananas, plantains and coco yams (**Mbua Ekwa, Bova, 18.07.2018**).

I am involved in many income-generating activities. I assist researchers when they come to the village, and they give me money. My husband and I have about 4000 wotangu [*Prunus africana*] plantlets in our nursery and about 300 wotangu trees on our farmland. We also plant mahogany, because we sell the wood and use it to build houses. We have about 30 mahogany plantlets in our nursery and about ten trees planted on our farms. These trees are planted alongside food crops. We even nursed and planted eru [*Gnetum africanum*], but it all died. Money generated from these activities is very helpful, because I pay fees for my children at Buea University and secondary school (**Embola Lucy, Bova, 20.07.2018**).

I have planted about 55 wotangu [*Prunus africana*] trees. This is because the government educated us that we can sell it to have additional income. I also plant guavas and mangoes as fruits for the family and sell some to get money (**Ngomba Nsoa, Bova, 10.07.2018**).

Alongside working with the government, I do beekeeping, to substitute my income. I have about 30 beehives planted around my farmland. I plant cassava and fruit trees such as pear, mango and guava. I plant yams in large quantities and engage in bee-farming. I am not interested in wotangu [*Prunus africana*], because I have to wait for many years to start getting money from it. I prefer planting food crops, because even if there is no market, my family can consume the food. I do mixed farming, with yams, vegetables, plantains, pears, guavas and beehives all found on the same piece of land (**Lyonga Abel, Bova, 24.07.2018**).

I plant huckleberry around my home, since orango [*Solanum nigrum*] is almost extinct. I also have about one hectare of eucalyptus trees. The huckleberry is for family consumption, and eucalyptus is sold as fuel wood, thus increasing my income to take care of my children's education (**Martin Likiye, Bokwaongo, 06.06.2018**).

I plant "eye for fowl" [*Ageratum conyzoides*], because it has become very scarce due to the hot temperatures. I plant it because I use it for my tooth ache (**Njie Paul, Likombe, 21.06.2018**).

I sell ngogo leaf [*Thaumatococcus daniellii*] collected from the forest at the Limbe market. I do not plant it, because it grows naturally. The only problem I have is that the leaf quality is affected by the hot temperatures. The money is used to buy food and clothes for the family. I also use it to buy water, since there is no water in Mapanja (**Ebie Hannah, Mapanja, 13.06.2018**).

I have planted wotangu [*Prunus africana*] on my farmland. I have about 20 stems. I plant them for commercialisation, since I need money to take care of my family, and for re-forestation. I have also planted maijah maijah [*Justicia laxa*] to reduce my distance to the foraging sites, since I am old and cannot walk over long distances to collect it (**Keka Monoke, Bova, 10.07.2018**).

I have about 15 wotangu [*Prunus africana*] trees planted on my farmland. I also plant orango (*Solanum nigrum*), since it has become very scarce. The matured orango seeds, which have a black colour, are opened and scattered on the ground. I plant it on the soft soil around "wiley." This permits me to have orango all year round, except for heavy rains, which destroy them. I plant orango under sticks so that heavy rains will not affect it (**Josephine Mbua, Bova, 10.07.2018**).

I have planted bush pepper [*Piper guineense*] to increase food availability and because it is not available in the forest. My son, who worked with a white man at Penja, taught me how to plant it (**Nasoa David Kulu, Bova, 10.07.2018**).

I have planted bush pepper next to my home, because I have trees which shade the area, it is cold and the bush pepper can climb on the trees (**Kalle Litie, Bokwaongo**, **07.06.2018**).

I have about 10 beehives. I am also involved in flower farming for commercial purposes. I have planted about 200 *wotangu* [*Prunus africana*]. These activities are meant to increase household income, food availability and reduced deforestation, which is causing climate change. I also train people on bee-farming (**Njie Mambo John, Bokwaongo, 07.08.2018**).

I planted wotangu [*Prunus africana*] as a boundary fence only. Wotangu takes long to mature, and thus I do not depend on it (**Maliva Samson, Bokwaongo, 06.06.2018**).

Source: Field data, 2018

According to the respondents' narratives captured in Box 5.17, indigenous people are involved in pig- and goat-rearing on a small scale, alongside agricultural activities. Few are involved in livestock rearing, due to the scarcity of water and food, which they said is not sufficient for them, and thus they cannot provide for animals. The livestock is sold mainly for ceremonies, such as marriages and funerals, and when faced with difficult situations. The money is used to educate children, bury the dead and boost community life. Furthermore, the respondents' stories indicate that tree-planting is an important livelihood strategy for farmers. Trees planted include *Prunus africana*, mahogany, eucalyptus and iroko, and they are used for traditional medicines, timber, building construction and commercialisation. The sale of *Prunus africana* plantlets is also a very lucrative business, although farmers indicated that planting it has reduced, due to the absence of buyers. Farmers also plant fruit trees such as guavas, pears and mangoes on their farms and around homes for "fresh air," shade from sunlight, income and food, and to provide nectar for bees. Some farmers added that tree-planting is a reforestation measure aimed at protecting the environment and coping with climate change. The commercialisation of flowers was only mentioned by some farmers in Bokwaongo, and they are sold in Douala markets. Flower marketing is facing challenges caused mainly by bad roads, distance to markets, high costs of transportation and the political crisis in the Anglophone regions that has rendered movement to Douala almost impossible.

In addition, some interviewees indicated practicing ex-situ conservation of some food NTFPs, namely bush pepper (*Piper guineense*) and orango (*Solanum nigrum*), to increase food availability and to fight against scarcity. They also plant medicinal plants such as "eye for fowl"

(*Ageratum conyzoides*) and maijah maijah (*Justacia laxa*), due to their usefulness in resolving certain health issues. During a focus group discussion with the Solidarity Women's Group Bova, one member indicated that she plants orango (*Solanum nigrum*) on her farm to ensure continuous availability (see Box 5.17). The group members generally accepted that this vegetable is affected by heavy rainfall, long dry seasons and changes in forest cover, but they did not agree with the fact that *Solanum nigrum* can be planted.

Moreover, the conversations captured in Box 5.17 indicate that livelihood diversification is made possible through the influence of external NGOs and projects instigated to build capacity and create demonstration plots and nurseries, in order to provide improved seedlings and plantlets for free to farmers. The role of government and NGOs will be developed in subsection 5.7.2.2. Knowledge on NTFP planting is acquired from people's encounters with those from other towns and nations. This is depicted in Nasoa David's account on how he learnt about the planting of bush pepper (*Piper guineense*). In addition, some respondents are involved in conservation activities by serving as ecotourism porters and guides, and providing assistance to researchers. In addition to diversifying livelihood strategies, the interviewees also mentioned that many people, especially the youthful population and young girls, have left the villages and migrated to the towns in the search of a better life. The next subsection therefore examines rural exodus patterns in the study villages.

5.7.1.3 Rural-urban migration

Erratic climatic conditions bring about crop failure, low productivity, poor income and poverty, and so youths move from rural areas to seek greener pastures. Migration in the study area is expressed by the younger generation moving to the towns in search of jobs and also to avoid difficult living conditions in the villages, due to water scarcity. The empirical data revealed that the migration of the younger population to the towns is rampant in Mapanja and Likombe, because they are far away from the major cities such as Limbe and Buea. Persons who live in Bokwaongo and Bova could easily commute to work in Buea on a daily basis, due to the availability of roads and shorter distances. Thus, in Bokwaongo especially, many people lived there and worked in Buea. The respondents also mentioned that water scarcity is a major push factor in migration to the city, as it is experienced during the long dry seasons because of the drying out of streams and water catchments. In addition, while in Bokwoango people have access to pipe-borne water occasionally, in Likombe, Bova and Mapanja it is impossible. The respondents mentioned buying water from neighbouring towns by giving containers to taxi and car owners, and bike riders, who charge them per container. The challenges faced by the local population due to water crises, and the effects on their livelihoods, are summarised in the following excerpts in Box 5.18.

Box 5.18: Migration dynamics and livelihood effects

Life has become very expensive. I pay about 600 FCFA (90 euro cents) per container of water, which is very costly. In addition to sending my children to school, I have to buy water for the entire family. Where do I get the money? (**Dabuju Evakise, Bokwaongo, 05.06.2018**).
My children do not want to spend their holidays in the village. This has increased my farm labour, because there is nobody to help me. Even during holidays, when I am expecting my children to come home so that we can work on the farm, they refuse and want to live with other relatives in towns (**Liombe Mary, Mapanja, 13.06.2018**).
In Mapanja, young boys are unable to find girls to get married, because the girls refuse them, since there is no water. Young girls of today cannot persevere like us older women. My son's wife left because of hardship caused by water scarcity. Some of the boys now take their wives to towns, which is not easy, since they are unable to find jobs there (**Lifongo Mokie, Mapanja, 15.06.2018**)
When the wotangu [*Prunus africana*] business was booming, many young girls came to the village. We had money to pay bike riders to bring us water, and thus the girls could stay with us. Since the wotangu buyers stopped coming, girls no longer come to the village either, and what we called "*Prunus* marriages" have been affected (**Motome Paul, Likombe, 22.06.2018**).

Source: Field data, 2018

The narratives in Box 5.18 illustrate that migration to towns in the study area is influenced by hardship induced by lack of money and jobs in the villages, and environmental factors such as water scarcity. Household farm labour is affected, since children do not want to stay in the villages. Furthermore, local hardship is exacerbated, since villagers expressed not having money to buy water regularly or to meet other household needs. The empirical data showed further that adaptation approaches to protect ecosystems and enhance livelihoods were also dependent on communal actions and driven by external institutions. The explanation that follows in the next subsection thus explores adaptation strategies employed by groups and driven by external NGOs and government institutions.

5.7.2 Collective efforts, NGOs and government support to adaptation strategies

This section examines adaptation strategies carried out by groups and communities. It also discusses related approaches influenced by external institutions to improve indigenous livelihoods and protect the environment. The previous subsection examined individual livelihood diversification approaches and changes in farming practices to adapt to the impacts of climate variability and changes to livelihoods and the ecosystem. This section adds further to adaptation knowledge by first addressing community and group actions, before moving on to the role of institutions in adaptation.

5.7.2.1 Community and group adaptation initiatives

In the study area, women have organised themselves into groups to enable them to share knowledge, and enjoy the advantages of economies of scale such as transportation, bulk purchasing, access to loans and market information, to ameliorate living standards and solve common problems. Some of their actions are also linked to environmental changes influencing their livelihoods. Through these groups, the women have been able to build resilience to external stresses such as climate change, which is a new challenge to them. The women of Likombe and Mapanja villages decided to organise the marketing of *Thaumatococcus daniellii* (ngogo leaf) due to climate-related effects on availability, concerns surrounding the increase in the number of persons involved in commercialisation and instability in sales. A female farmer in Mapanja shared her view on how they have organised themselves to meet the challenges linked to the *Thaumatococcus daniellii* leaf commercialisation:

> *The hot temperatures have affected the quality of ngogo leaf (Thaumatococcus daniellii). The leaves are brown, and the quality and appearance are at times not good, and thus we do selective harvesting. We find it difficult to harvest huge quantities for sale. We have now divided ourselves into two groups, the Tuesday group and the Friday group. Because we realise that the quantity in the forest is reducing, hot sun too is affecting it, the population of women trading in this NTFP have increased, and when we all go to the market on the same day, we are unable to sell. We also do this to control the quantity harvested, to ensure continuous availability.*
>
> (**Katrine Lifongo, Mapanja, 15.06.2018**)

Katrine's story indicates that the collective efforts by the women to reorganise *Thaumatococcus daniellii* sales are climate- and non-climate-related. The quality, quantity and productivity of *Thaumatococcus daniellii* have been affected by the long dry periods experienced in the region, and so, in order to sustain availability and marketing, they have decided to organise themselves into groups, thereby empowering them financially to meet their needs.

Also, during discussions with the IFOSE Women's Group Bokwaongo, members mentioned that they are involved in several alternative income-generating activities, which are carried out jointly and individually. Tree-planting is an individual activity, and varieties include *Cedrela odorata*, *Voacanga africana*, *Prunus africana* and *Pterocarpus soyauxii* (camwood) (called by group members "destimanantoes"). It was difficult for the researcher to understand the tree species "destimanantoes," and even the transect team found it difficult to identify, since the name used by the group is neither local nor scientific. This challenge was resolved during the transect walk when a group member identified the plant. Group members said trees planted were introduced by the GIZ project and used for fuel wood, construction, to provide fresh air and medicine. One group member expressed the importance of tree-planting in the following extract:

> *Tree-planting reduces our rate of going to the forest for fuel wood, thereby reducing deforestation and consequently the temperature from getting hotter. With the population increase, more will be needed in the future for fuel wood and construction. Tree-planting provides fresh air in the village*.
>
> **(Elali Alice, Bokwaongo, 07.06.2018)**

Elali's perception indicates that the group members see tree-planting as a strategy to reduce vulnerability to increasing temperatures and as a reforestation measure. To ensure future sustainability in line with potential population increases, it is important for them to plant trees now, to meet future needs. In addition, the women are engaged in bee-farming as a collective activity introduced by the Forestry, Agriculture, Animal and Fishery Network (FAAFNET**)**. This indicates that alternative activities are introduced by external NGOs to the communities through existing women's groups. The execution of IGAs through village groups is expressed in the following view of a farmer:

> *We plant trees such as* wotangu [*Prunus africana*] *and* itongongo [*Voacanga africana*]. *The government encouraged us to plant trees through the use of existing village groups. The government brought seedlings to the chief's palace for the villagers to use for planting*.
>
> **(Dabuju Evakise, Bokwaongo, 06.06.2018)**

The women said their involvement in these activities had improved their financial contribution to the family, and decision-making power. An example is Ndive Agnes, who is able to pay her children's fees and support her husband through income gained from bee-farming. She said her husband is old, but through her financial support she is now involved in family decision-making. Her narrative is captured in the following statement:

> *I have planted many trees important to me and my community. I sell the trees when they are mature to people who want to build houses and also sell* wotangu [*Prunus africana*] *bark. I am also involved in bee-farming activities in my group. The income from these activities enables me to pay fees for my children, provide food and assist my husband when he has financial difficulties. This group has changed my life, since my husband is old and cannot provide for the family like before. My husband now respects me at home and cannot take decisions without seeking my opinion. I am happy for the help I give to my family*.
>
> **(Ndive Agnes, Bokwaongo, 07.06.2018)**

Furthermore, some women's groups indicated being involved in cassava and maize farming. This is the case of the Hands on the Ground Women's Group, Mapanja, members of which expressed planting cassava and maize to increase food availability and income, and to reduce poverty. They said cassava processing activity is still currently underdeveloped, since Mapanja does not have water and cassava-processing requires a lot of water. As a result, most of the cassava rots. The frustration experienced by the women due to inadequate water is summed up by a female farmer in the following statement:

> *Streams are found up the mountain, and it is only elephants that have water to drink, not humans*.
>
> (**Eposi Elizabeth, Mapanja, 13.06.2018**)

Eposi's account indicates how frustrated Mapanja women are with the fact that they as humans do not have water for daily use. They regret the fact that animals instead have water. In addition to group and collective adaptation strategies undertaken by the women, government and NGOs also play an important role in local adaptation strategies, as examined in the next subsection.

5.7.2.2 Government and NGOs involvement in local adaptation strategies

The previous subsections have provided information on livelihood diversification, changes in farming practices and individual and collective adaptation strategies directly or indirectly related to climate change. The discussions have also shown how adaptation strategies are aimed at improving livelihoods and ecosystems, and they have provided some clues on government and NGO initiatives in facilitating the adaptation efforts of individuals and groups in the community. This subsection provides detailed information on government and NGO actions in the enhancement of adaptation strategies employed to ameliorate rural livelihoods and improve ecosystem vulnerabilities. The participants explained that the government and NGOs (GIZ, ERUDEF) have introduced alternative IGAs into communities, such as tree-planting, environmentally friendly ecotourism, training on yam and plantain production and local forest management institutions to reduce forest encroachment and tree-felling. Government and NGOs' support for participants is explained in Box 5.19.

Box 5.19: Government and NGO support for local adaptation actions

The government and GIZ encourage tree-planting as a principal weapon in environmental protection (**Elkana Ekema, Bokwaongo, 06.06.2018**). As a member of the VFMC, I ensure that people do not go to the mountain. I check encroachment and tree-felling, though at times it is not effective (**Mese Elkana, Bokwaongo, 06.06.2018**).

We had a nursery for the multiplication of plantains and also for wotangu [*Prunus africana*], mahogany [*Entandrophragma angolense*] and country onion [*Afrostyrax lepidophyllus*], introduced by ERUDEF around the year 2012. We shared the plants with the following villages: Bonakanda, Bova, Ewonda and Buea town (**Nganjo Embola, Bova, 26.06.2018**).

GIZ asked us which IGAs we wished to carry out to reduce forest dependence. GIZ thus created multipurpose nurseries for bitter kola [*Garcinia kola*], palms, bush mango [*Irvingia* sp.] and plums. This nursery provides alternatives to the communities, since they have no access to the park (**Molombe Ngomba, Bova, 16.06.2018**).

I have planted wotangu [*Prunus africana*], iroko [*Milicia excels*], pears, mangoes and mahogany [*Entandrophragma angolense*]. In addition, I am a member of the VFMC. I encourage people to plant trees such as wotangu and mahogany. We had a nursery for these trees created by ERUDEF. The plantlets were distributed to the villagers for free. I also sensitise the population not to kill Class A animals such as elephants, cross the park boundary lines or burn down trees to maintain soil quality (**Lyonga Rudolf Elinge, Bova, 18.07.2018**).

During nights spent in the forest as ecoguides, we clear about 4 metres around eco-lodges to protect the forest environment and reduce fire spread, which might come from the kitchen (**Ndive Hans, Bova, 11.06.2018**).

The MCNP taught us IGAs. We also have a village nursery for wotangu (**Keke Monoke, Bova, 24.06.2018**).

The project taught us how to plant improved varieties of plantains. They are consumed and sold to individuals. The money helps us to pay fees for our children and resolve family and village problems. Since I have income from plantains, I concentrate on it and forget about the forest. The activity helps me, and that's why I do not go to the forest. The major problem we have is a lack of water, especially during the dry season. We buy water from Buea and Koke villages. We buy water in the sense that we pay for containers used to transport the water (**Elinge Rudolf, Bova, 26.06.2018**).

The PSMNR-SWR selected Bova village as one of its project villages. They trained us on mini-set production, meaning using one yam, cutting it into small pieces and nursing in an incubator for them to shoot. After one or two months, the plantlets are taken to the farm for planting. The PSMNR-SWR promoted yam production because it is an activity already carried out by most farmers. I was trained on how to do mini-set production, and I am a community-based trainer for bee-farming. I have trained many people (**Lyonga Abel, Bova, 24.07.2018**).

Source: Field data, 2018

The information in Box 5.19 indicates that government and NGOs have supported participants in their agricultural activities by introducing improved plantain varieties and mini-set yams to enhance farmers' agricultural productivity and ameliorate livelihoods. Farmers are provided with commercially viable trees such as *Prunus africana*, *Entandrophragma angolense* and fruit trees for free. Also, as illustrated in subsection 5.7.2.1, villagers – especially women – are empowered financially through training provided on alternative IGAs. Moreover, participants indicated that the park service and GIZ introduced the conservation credit to encourage them to conserve the forest. Some participants said it is an indirect climate change strategy, since it is related to environmental protection. Although it was introduced by these agencies, the interviewees said it is also a community strategy to fight against climate change, since they are not obliged to respect the terms of the agreement in order to benefit from the conservation credit. This notion of community involvement in environmental protection activities is also expressed in a hunter's view about the prohibition of hunting around the savannah region:

> *The savannah zone is very fresh during the rainy season. From October, November and December, it becomes dry. Fire tracing and early burning is carried out by the community and park management to enable new vegetation to grow. Another objective is to prevent hunters from doing early burning for hunting purposes. Animals leave the savannah region to come to the forest,*

where hunters have put traps. Animals in the savannah include antelopes, cane rat and deer. Early burning is done between December and January, when the dry season is not at its peak. The park service does fire sensitisation before the beginning of the dry season by telling villagers that burning brings about climate change and water dryness, and kills animals and vegetation.

(Hunter, Bokwaongo, 11.05.2018)

The hunter's story indicates that organised bush burning is carried out as an adaptation strategy to curb fire spread during the dry season in the savannah region. Hunters specified that they accepted early burning as a result of education received from GIZ that the vegetation and fauna in this area are vulnerable to bush fires and temperature changes. This section on adaptation in addition to examining individual and group adaptation strategies and the role of external agencies in adaptation, also requires specific analysis of participants' views on short- and long-term adaptation strategies and perceptions of how they enhance livelihoods and the ecosystem, as expressed in the following subsection.

5.7.3 Local perception of short-term and long-term adaptation strategies, and their enhancement of livelihoods and ecosystems

The previous subsections explored the adaptation strategies for livelihood improvement and coping with challenges imposed by climate change, and government and NGO roles in promoting adaptation in the MCNP region. However, a proper exploration of adaptation strategies should entail a detailed examination of how indigenous people perceive and appreciate them. This subsection draws information from household surveys, interviews and focus group discussions. It addresses participants' understanding of short- and long-term adaptation strategies, and their contribution to the enhancement of indigenous livelihoods and the natural environment.

5.7.3.1 Local perceptions of short-term and long-term adaptation measures

Table 5.8 presents adaptation strategies engaged by interviewees, and the reasons why they are carried out. The field data reveal that the population defines short- or long-term adaptation by the number of months and years they have to wait to reap benefits from an adaptation activity. Short-term adaptation strategies such as bee-farming, home gardening and the cultivation of plantains and yams through the use of improved varieties were defined as providing financial benefits flowing over short durations. The respondents understood long-term adaptation actions as referring to activities which offer benefits once or twice a year. Moreover, they said that some adaptation actions are long term, because they have to wait for more than 15 years in order to reap the benefits, such as tree-planting (*Prunus africana*, *Entandophragma angolense* and *Milicia excels*) activities. A few adaptation measures were considered, both short- and long-term, comprising the planting of medicinal plants and fruits trees.

Table 5.8: Short-term and long-term adaptation practices and their rationale

Adaptation strategy	Perception of adaptation		Perceived reasons for short-term and/or long-term adaptation
	Long term	Short term	
Conservation education	x	x	Biodiversity protection, improve livelihoods, fight against climate change, awareness on the 1994 Forestry Law, change of attitudes.
Village development fund (conservation bonus and credit)	x		Conservation bonus is provided once every two years, and park management does not respect the delay. Thus, revenue not consistent. Conservation credit not yet operational.
Tree-planting (*Prunus africana, Cedrela odorata, Milicia excelsa, Pterocarpus soyauxii, Acaisia* sp., *Voacanga africana, Kigalia Africana, Entandophragma angolense*	x		*Prunus africana, Cedrela odorata, Entandophragma angolense and Pterocarpus soyauxii* take more than 20 years to mature. *Voacanga africana* takes about five years for the seeds, used for oil, to mature. *Prunus africana* sales are not regular, due to rotation rules and irregular buyers.
Apis mellifera		x	Honey can be collected about thrice a year.
Piper guineense (bush pepper)	x	x	Takes about 5 years before it starts producing fruits, due to cold climate. After maturity, availability is seasonal and yearly.
Fruit trees (avocado pear, guava and mango)	x	x	They take about 3-4 years to maturity before start bearing fruits, and later productivity is yearly.
Food crops (cassava, plantains, yams, bananas)		x	They are always available and considered the only regular income source.
Marketing		x	Rotational sales period of *Thaumatococcus daniellii* (ngogo leaf) by Likombe and Mapanja women ensures constant availability of the plant and income flow.
Planting medicinal plants: *Cymbopogen* (fever grass), *Ocimum gratissimum* (macepo), *Garcinia kola* (bitter kola), *Ageratum conysoides* (king grass) and *Bidens pilosa* (ndodokabatweli, black jack).	x	x	*Garcinia kola* (bitter kola) takes about 8-10 years to reach the fruit-bearing stage. The mature plant later bears fruits yearly. The others take about a year before maturity, since a few leaves are used for medicinal purposes. Usage starts when collectors feel harvesting a few leaves will not kill the plant.

Source: Field data, 2018

Interviewees mentioned that environmental education and village development fund (conservation bonus and credit), are influenced by ecosystem stresses comprising climate change. They added that environmental education is carried out in collaboration with the government, local NGOs and VFMCs. Moreover, the conservation bonus is only provided to villages who participate in conservation activities and are not involved in illegal activities such as poaching, tree-felling and encroachment. Thus, the conservation bonus, according to the interviewees, is a geared towards reducing environmental pressure and, consequently, climate change. The next subsection further explains adaptation strategy contribution to the improvement of livelihoods and ecosystems.

5.7.3.2 Adaptation strategy contribution to the enhancement of livelihoods and ecosystem

Table 5.9 captures respondents' perceptual knowledge on how adaptation strategies improve local livelihoods and protect the environment.

Table 5.9: Adaptation strategy improvement to livelihoods and ecosystems

Adaptation strategy	Livelihoods	Ecosystem
Conservation education	Provision of alternative income-generating activities. Awareness-raising on *Prunus africana* to enhance access and benefit-sharing.	Sustainable use of natural resources, environmental protection, knowledge on the 1994 Forestry Law, promotion of ex-situ conservation, change of attitudes and people becoming environmentally friendly.
Village development fund (conservation bonus and credit)	Community development and improves village life (water, chairs, health).	Dissuades people from carrying out illegal activities in the park, since villagers who do not respect rules have their conservation bonus reduced.
Food crops (cassava, plantains, yams, bananas)	Improvement of agricultural techniques. Food availability for families. Revenue from sales of food crops. Enhances community resilience to environmental change.	Reduced dependence on the forest for NTFPs.
Tree-planting (*Prunus africana, Cedrela odorata, Milicia excels, Pterocarpus soyauxii, Acaisia* sp., *Voacanga africana, Kigalia Africana, Entandophragma angolense*)	Commercialisation of *Prunus africana* barks and seedlings provides income to families. Timber species provide wood for construction and revenue generated from sales. Increase availability of fuel wood and medicinal plants. Protects homes from strong wind destruction.	The planting of these tree species on farm and communal lands reduces forest exploitation. The practice of agroforestry maximises land use and controls farming expansion. Ensures durable availability of important tree species.
Bee-farming	Income, medicine, sugar and cough medicine. Reduce distance to the forest, since hives are found around homes and farms.	Sustainable bee-farming around homes and farmlands reduces bush fires and forest dependence.
Bush pepper (*Piper guineense*)	Availability of condiments and vegetables for consumption. Increase household revenue. Cultivation also reduces distance to collection sites.	Reduces forest dependence.
Planting medicinal plants: *Cymbopogen* (fever grass), *Ocimum gratissimum* (macepo), *Garcinia kola* (bitter kola), *Ageratum conysoides* (king grass) and *Bidens pilosa* (ndodokabatweli, black jack).	Reduced income spent on modern medicines. Ensures constant availability of medicines for local use. Source of revenue for traditional doctors. Maintains a healthy population. Reduces distance to collection sites. Protects people's dignity, since they collect out of eco-guards' jurisdiction.	Reduced dependence on the forest for medicinal plant collection.
Fruit trees (avocado pear, guava and mango)	Provides fruits and revenue for families. Beautifies and gives "fresh air" in the village.	Reduces forest dependence for food NTFPs.

Source: Field data, 2018

Participants' perceptions, summarised in Table 5.9, indicate that adaptation strategies increase household income, provide food and herbs for traditional medicines, reduce distances to NTFP foraging sites and improve village life in general. In addition, adaptation strategies diminish indigenous people's dependence on forest products and the exposure of biodiversity. The next section provides major highlights and a conclusion to the data analysis.

5.8 Conclusion

Chapter 5 focused on data analysis and the findings of the study. The data were analysed following the research goal and objectives, and this analysis was based on the CRiSTAL and CVCA frameworks, which provided guidelines on the methods to employ for researching, the steps for analysing livelihoods, biodiversity and climate risks and linkages between forest-dependent livelihoods and climate change. Furthermore, the use of the SL and PCVCBLA structures in the research revealed that the indigenous people of the MCNP region are dependent on natural assets for survival. Forest products are used for consumption, commercialisation, ecotourism and traditional medicines, but they have decreased generally over the past 20 years, albeit with some increase noticed in conservation areas. The occurrence and utilisation of forest products have been influenced by factors such as markets, globalisation and modernisation, deforestation, government legislation and unsustainable harvesting. Moreover, changes in the occurrence and availability of forest resources are affecting the livelihoods of the local population.

In addition, the data highlight that temperatures in the MCNP region are increasing and rainfall decreasing. The population is perceiving alterations in seasons and projecting future temperature increases. Climate variability and change are major challenges to the ecosystem and livelihoods of the native population, and indigenous livelihoods are negatively affected in this regard, since they are unable to find sufficient quantities of forest products for household use and sales. Climate change has affected the livelihoods of indigenous people through its influence on the productivity, availability, quality, growth, distribution and range of food NTFPs, wildlife and medicinal plants. Climate variability and change are also affecting access and rights to natural assets such as *Prunus africana* and wildlife, as well as increasing the distance to NTFP collection sites. These multiple effects are affecting the health, culture, income, community life and nutritional habits of local people.

Using a political ecology approach, the data inform this research that climate variability and change are linked to issues of deforestation and timber exploitation. Furthermore, land tenure is a major obstacle to the livelihoods of the poor – and to the advantage of the rich. Moreover, park creation is seen by the local population as an attempt by the government to expropriate their land and reinforce its grip over the territory. Chapter 5 also elucidates that climate change has influenced government laws and policies, in that it has reinforced and implemented laws, such as the 1994 Forestry Law, and measures including the creation of VFMC and MOCAP, aimed at protecting the environment. These institutions and laws have indeed weakened the influence of traditional regimes in forest management, but they have also reduced the privileges of the local population over natural resource access and use rights, since non-indigenes and indigenes are all submerged under the same rules, thereby providing non-indigenes with the opportunity to challenge local customs and authority. Moreover, the local population has not always respected government regulations, especially those relating to commercially valuable medicinal plants, such as *Prunus africana*, and wildlife. Some of the conflicts are as a consequence of climate-induced effects on NTFP availability necessary for both human and animal survival. In addition, the data indicate that the dissolution of hunters' unions is a government strategy utilized to weaken the role of indigenous people in environmental protection and disconnect them from forest use.

The data revealed that some adaptation initiatives are directly and indirectly linked to climate change. Besides, the indigenous population has adopted collective and individual actions and diversified survival strategies to adapt and build resilience to the challenges influenced by climate change. Also, communities in the study area are suffering from water scarcity, an indispensable natural resource to human survival. The government and NGOs are instrumental in providing alternative IGAs and building the capacities of the local population in their struggle against poverty and environmental protection. External support has been possible either through existing village groups, especially women's groups, or through general community mobilisation. To enhance the resilience and sustainability of livelihoods in the face of climate challenges and depleting natural resources, the local population is involved in both short- and long-term adaptation actions, each providing immediate and future benefits. Using this analysis and the chapter's findings as context, the next chapter (Chapter 6) attaches more meaning to the empirical data by juxtaposing it with existing scholarly literature.

CHAPTER 6: DISCUSSION AND INTERPRETATION OF FINDINGS

6.1 Introduction

The preceding chapter presented findings from the empirical fieldwork and contributed to the major goal by exploring the research objectives and questions. This chapter provides more meaning to the findings in relation to existing literature and the concepts discussed in Chapters 2 and 3. Furthermore, it fills research gaps and throws more light on the subject under study. Discussions address the research objectives and questions, and themes generated by the study. The chapter is divided into seven sections. Each section is further separated into subsections, addressing related and specific issues. Following the introduction, Section 6.2 discusses forest products and their contribution to indigenous livelihoods. Section 6.3 explores food security challenges linked to biodiversity and efforts engaged in mitigating food insecurity. The subsequent sections address issues connected to climate change, indigenous livelihoods and forest products. Section 6.4 addresses indigenous interpretation and understanding of climate change, followed by Section 6.5, based on climate change effects on fauna and flora and native livelihoods. Section 6.6 discusses power-related issues of access, user rights and conflicts induced by climate change, and lastly Section 6.7 is based on adaptation initiatives to climate variability and change in the study area.

6.2 Forest Products and Indigenous Livelihoods

6.2.1 Forest resources and forest dependence

Forests are important to indigenous populations living in peripheral areas in sub-Saharan Africa (Ngane et al., 2012). Native livelihoods and natural resources are interdependent, as presented in this study, whereby households are reliant on different forest products and services. Food NTFPs, medicinal plants, wildlife and timber and fuel wood collection represent the varied ways in which forests contribute to local livelihoods. Forest vitality to indigenous communities in Cameroon (Ambrose-Oji, 2003; Ndoye and Tieguhong, 2004; Abugiche, 2008; Lambi and Ndenecho, 2010; Bele et al., 2011; Ngane et al., 2012; Ingram, 2014; Awono et al., 2016) and in other parts of the world (Promova et al., 2012; Pavageau et al., 2018) is also depicted in numerous research studies. The significant forest dependence in the MCNP region is depicted by the use of some forest products for food and medicines, namely *Gnetum africanum* (eru), *Kigalia africana* (sausage tree), *Garcinia kola* (bitter kola), *Apis malifera* (honey bee), *Bidens pilosa* (black jack), *Piper guineense* (bush pepper), *Celosia issertii* (ngoleh or mogweh), *Emilia* *coccinea* (litolangwah), *Aframomum melegueta* (alligator pepper) and *Costus afer kergawi* (monkey sugar cane). Locatelli (2016) expresses that indigenous people are dependent on natural resources because of the absence of alternatives and the minimal need for monetary and human endowments for gathering ecosystem products. While this study affirms this view, it adds that forest dependence is also due to customs cultivated over the years.

Forest resources are a vital source of food and income to indigenous people (see also Lescuyer, 2010; Ngane et al., 2012; Awono et al., 2016), and fight against food insecurity by bridging nutritional gaps during hard times (Awono et al., 2016). The study communities expressed a general decrease in the commercialisation of forest products despite access to markets which would normally provide improved livelihoods and income. The decrease in availability and preference for consumption produces negative consequences for livelihoods and community resilience (Tougiani et al., 2009). Concerns about the decrease in ecosystem products are not new and have been well documented by many researchers (Bokwe and Ngatoum, 1994; Sunderland et al., 2003; Ndoye and Tieguhong, 2004; Ingram, 2014; Lambi and Ndenecho, 2010).

The results further indicate that NTFP collection sites of primary importance to respondents are farmland, fallow and secondary forest, due to being prohibited from collecting forest products from protected areas. This conforms with Ngane (1999), while Awono et al. (2016) also observed that NTFPs are collected not only from forest lands, and the local population depends largely on areas outside the park for forest goods and services. The respondents signalled a decrease in natural resources in areas out of the park, and abundant within the park, due to strict regulations and conservation measures which prohibit their use. This finding validated the view that conservation activities and donor interests are concentrated in protected areas rather than in forest regions, thus providing indigenous people with goods and services but exposing these regions to greater vulnerability (Ambrose-Oji, 2003).

6.2.2 Medicinal plants

The vulnerability of indigenous livelihoods is depicted by changes in the occurrence and utilisation of medicinal plants, which vary from one forest region to another and form an integral part of natural assets vital for primary healthcare services in native communities. According to Zeeshan et al. (2009), nearly 80% of the world population rely on medicinal plants for primary medical care. Frequent foraging sites are found around homes, farm land, fallow and secondary forest, with a perceived decrease in availability and scarcity of certain species such as *Dorstenia bacteria bureau* (local name 'ikene'). This scarcity is due to deforestation and forest degradation, an increase in farming, the use of herbicides and increases in temperature, thus threatening the traditional health system and indigenous livelihoods. Doubts voiced by indigenous people on the existence of some medicinal plants such as *Dorstenia bacteria bureau* confirms the view that knowledge holders in local communities could be unique and socio-ecological information on some plant species not noticeable through natural sciences (Wong, 2016). The perceived scarcity of specific medicinal plant species by individuals in the community is consistent with the view that close cooperation is required between all stakeholders on all levels, as well as various socio-cultural and knowledge regimes (Weber and Schmidt, 2016), to comprehend biodiversity dynamics.

6.2.3 Food NTFPs

The vulnerability of rural livelihoods is a function of the ability to collect and use food NTFPs. The findings reveal that food NTFPs vary according to seasonality and enhance local nutrition and survival. They have consumptive and financial value and are vital in traditional pharmacopeia, thereby constituting part of the entire household economy. The regular availability of food NTFPs ensures the constant sustenance of rural livelihoods, confirmed by Ngane et al. (2012), who state that the reliance of most native people on food NTFPs guarantees domestic food and monetary security. The consumptive use of forest products and their central role in household economies in native societies is confirmed in other research (Falcon, 1990; Mensah et al., 2008). In the study area, food NTFPs which improve livelihoods include *Solanum nigrum* (wild huckleberry), *Agaricus* sp. (mushroom), *Gnetum* spp. (eru) and *Thaumatococcus daniellii* (ngogo leaf). However, most food NTFPs have decreased in abundance and are not domesticated by the local population, further rendering livelihoods vulnerable. Ex-situ conservation is practiced for *Piper guineense* (bush pepper) and *Apis malifera* (honey bee) by a few people, thereby validating the view that some forest products of importance to indigenous people are considered for domestication (Ambrose-Oji, 2003). Additionally, the sale of NTFPs, though profitable, is not regular, due to scarcity and seasonality, which reveals that food NTFPs contribution to local livelihoods is unstable – as noted also by studies in the West Coast region of MC (Ambrose-Oji, 2003) and the Kupe Mountain region (Ngane et al., 2012).

6.2.4 Wildlife

The MCNP region is endowed with many wildlife species, which are used for consumption, trade and traditional medicines. The wildlife population has decreased over time. Wildlife consumed by the local population is collected from all forest habitats, with a good deal of collection happening outside the park. Similar findings were reported in the Bayang-Mbo Wildlife Sanctuary (Abugiche, 2008) and Central Africa Republic (Eves and Ruggiero, 2002). Despite the general decrease in the wildlife population, narratives from experts and some interviewees reveal an increasing trend in protected areas. This finding is confirmed by impact assessment studies and park management reports, which indicate a minor increase in wildlife species and encounter rates of Class A species (Eno-Nku, 2013; MCNP, 2017; PSMNR-SWR, 2017). Nevertheless, most of the respondents disputed the idea of a wildlife increase, perceiving that this would mean being able to see fauna species regularly around farm land, fallow and secondary forest, as was the situation a few decades ago, thus implying a general decrease in the wildlife population, especially in areas outside the park – as confirmed by the PSMNR-SWR Report (2017).

In the Banyang-Mbo forest region of Cameroon, elephants, leopards and buffalo are considered as totems and spiritually belonging to individuals. Hunters expressed that custom and tradition have an important role to play in the availability of these fauna species (Abugiche, 2008). This study also reveals that in the MCNP region, tradition and witchcraft in the form of totems have a role to play in the perception of the occurrence and importance of certain fauna species, such as the *Panthera tigris* (tiger). Thus, although *Panthera tigris* has never existed physically in the country, spiritually it did so, and contributed to people's livelihoods. This notion is in line with the sense-datum theory (see Section 3.3) based on perception by imagination. Thus, objects perceived and imagined should not always exist, but they can be visualised and imagination can be real, since different persons and communities could have different views and interpretations about objects or happenings in their environment (Butchvarov, 1970; Kumar, 2009; Allen, 2019b).

6.3 Biodiversity Dynamics and Livelihoods Challenges

6.3.1 Alterations in NTFPs occurrence and utilisation

This study mirrors two aspects of food security: availability and utilisation. The vulnerability of the local population is a function of availability and their ability to use natural assets. Food security is a multifaceted occurrence representing a mixture of issues that have been elaborated by many authors (Webb et al., 2006; Renzaho and Mellor, 2010), as well as the multidimensional nature of household food security examined in South Africa by Altman et al. (2009). Food insecurity in the study area is a function of the following factors: markets, modernisation, changing cultures, unsustainable harvesting techniques and minimal practice of ex-situ conservation, deforestation, reduced soil fertility, post-harvest technology, population increase and chemical weeding. The MEA (2005) documents these issues and expresses that they affect the occurrence of flora and fauna species. The study reveals that the indigenous population suffers from food insecurity, due to their inability to find enough of the required species of forest products for household consumption and sales. They are also unable to collect reasonable quantities of botanical NTFPs, namely *Gnetum* spp. (eru), *Irvingia* sp. (bush mango), *Agaricus* sp. (mushroom), and bushmeat to exchange as gifts with friends and relatives. The sharing of forest products with friends and family members has also been registered by Awono et al. (2009) and Nnama et al. (2012). Thus, changes in availability and utilisation affect the socio-cultural and religious values which append indigenous people to nature (Bayrack et al., 2013) and could lead to a sense of loss of place and culture (Lynn et al., 2011).

6.3.2 Unsustainable harvesting techniques

This study reveals that the collection of *Gentum africanum* (eru), *Prunus africana* (pygeum), *Irvingia* sp. (bush mango), *Piper guineense* (bush pepper), honey and bushmeat is unsustainable. The effects of this harvesting of forest resources on abundance and livelihoods have been recorded in the south-west region (Nchinda and Che, 2008; Ingram, 2014) and other regions of Cameroon (Lahjou, 2008; Lambi and Ndenecho, 2010). Unsustainable methods such as cutting down whole vines and trees during harvests have affected productivity and rendered some plant species almost extinct; for instance, *Gnetum africanum* (eru) was affirmed as a threatened species in 1995 and a ban almost envisaged in 1999 (Fondoun and Tiki-Manga, 2000). See also Kupper (2014) on reasons for changes in medicinal plants. The indigenous population confirmed using unsustainable hunting techniques (guns, dogs and wire traps) which arbitrarily kill game species, corroborating MCNP reports which record the use of guns, live cartridges, wire snares and cartridge shells (PSMNR-SWR, 2011; Besong, 2015, 2016, 2017).

Unsustainable hunting techniques (wire traps) have also been reported in Central Africa, attributed to the reduced costs in acquiring materials and their ease of use (Noss 1998, 2000). Furthermore, respondents involved in hunting revealed that bushmeat consumption and commercialisation have decreased due to legislation, scarcity and the risks involved in night hunting. They added that bushmeat is highly demanded and very profitable in the area, as established by PSMNR-SWR (2017).

6.3.3 The influence of markets and globalisation

The popularity of certain NTFPs has increased over time (Mensah et al., 2008; Ingram, 2014), due to exposure to other cultures, modernisation, the internet and market demand. This is the situation for bushmeat, *Thaumatococcus daniellii* (ngogo leaf) *Gnetum* spp. (eru) and *Irvingia* sp. (bush mango) whose usage, demand and price have changed over the past years. In Mapanja and Likombe villages, much of the collected *Gnetum* spp. (eru) is sold in nearby markets. Also, the traditional use of *Thaumatococcus daniellii* (ngogo leaf) by the local population has changed, due to globalisation and modernisation, which has influenced the introduction of plastic bags by Nigerian businessmen and the West. This result reflects the reasons documented by Ambrose-Oji (2003) for changes in the use of *Maranteceae* leaves.

Native populations whose livelihoods are dependent on collecting and marketing forest resources are more exposed to and might encounter a remarkable decrease in welfare (UN, 2009). Forest products contribute to household, personal and community development. The interviewees noted that the most commercially viable and profitable NTFP in the region is *Prunus africana* (pygeum). In the past, it was used locally for fuel wood and traditional medicine, but its capitalisation has placed it in a special category which, according to Ngane et al. (2012), is arbitrary from the local user perspective. The commercialisation of *Prunus africana* contributes to children's education, the execution of village development projects, socio-cultural activities, dowries and financial capital for businesses. Thus, natural capital provides an outlet for the local population to indulge in new activities or develop current pursuits (Dorward et al., 2009, Mansure, 2015), by enhancing the purchasing power of *Prunus* "dealers" and contributing to the sustainability of small businesses such as shops and restaurants. The multiple benefits of *Prunus africana* have been documented (Ndam and Marcelin, 2004; Tieguhong et al., 2008; Ingram, 2014), reflecting that NTFPs support the attainment of MDGs such as eradicating poverty and hunger and universal primary education. This notion is also supported by other research (Defang et al., 2014; Awono et al., 2016). The increased financial benefits to communities of some NTFPs such as *Prunus Africana*, according to FAO (2010), is due to strict harvesting and monitoring regulations put in place by stakeholders, enhanced market access, ex-situ conservation and benefit-sharing mechanisms. In the study area, the trickling down and dissimulation of benefits is realised through the involvement of MOCAP and government efforts to promote access and benefit-sharing (MINEPDED, 2012, 2016).

While market access is a development measure for poverty alleviation, it can have negative effects (Belcher and Schreckenberg, 2007) on indigenous livelihoods and forest products, encourage unsustainable exploitation and endanger resources. This is the case with *Prunus africana*, whose monetarisation has led to resource degradation, conflicts, land degradation and the abuse of user rights, as reflected in Taylor's (2015) notion on the negative effects of capitalist productive influences. This situation is worsened by the unstable market for the tree, which has further endangered livelihoods of already vulnerable households and communities. Thus, the dependence on *Prunus africana* as a safety net has turned out to be a poverty trap for the local population, due to the irregularity of buyers, the implementation of a quota system and reduced availability due to climate effects, changes in area distribution and population increase. This notion is also confirmed by Pramova et al. (2012).

6.3.4 Distance to foraging sites

In the study area, respondents had seen a decrease in NTFP consumption, due to scarcity and distance to collection sites. NTFPs vital for household consumption, but not regularly consumed, include *Aframomum melegueta* (alligator pepper), *Solanuim nigrum* (wild huckleberry), *Thaumatococcus daniellii* (ngogo leaf), *Agaricus* sp. (mushroom), *Celosia isertii* (ngoleh, or mogweh) and *Dioscorea* sp. (wild yam). In rural households, men and women's contribution to family survival are complementary and different. Nevertheless, women are more concerned with guaranteeing household nutrition (FAO, 2003) and are dependent on climate-sensitive natural resources for food supply (IPCC, 2007). Despite their position as primary care givers, forestry regulations and climate change are widening gender inequalities and affecting women by depleting biodiversity (Jalloh et al., 2011). In the study area, elderly men and women expressed their inability to walk long distances to foraging sites, due to the time and energy required. The emerging findings reveal that the effects of distance to NTFPs collection sites are not gender-neutral. The increasing distance to NTFP foraging sites is also validated by the study of Awono et al. (2015), illustrating that in most communities found in the south-west region of

Cameroon, indigenous people walk for more than an hour to NTFP foraging sites. Moreover, single women especially suffer from a decrease in NTFP consumption compared to married women whose husbands are involved in park management activities and have the privilege to collect NTFPs in the protected area. This finding resonates with the view that some women suffer from starvation and increased vulnerability because of complete access exclusion and the indirect privatisation of user rights. The "enclosure of the commons" is therefore beneficial to some persons and unprofitable to others (Wasonga et al., 2010), with men indirectly provided with extended access over resources and single-mother households more vulnerable (Liard et al., 2010).

6.3.5 Knowledge of the local environment

Natural resource availability and use are also influenced by education, information and regular interactions with the local environment, confirmed also by Escobar (1999). These features determine livelihood actions and outcomes, and while some respondents expressed a decrease in the occurrence and use of NTFPs, others have experienced no change because of their understanding and mastery of the forest environment, and the required patience and courage to search for NTFPs in the "black bush," which most people lack. Also, the younger generation and non-natives do not have knowledge of most NTFPs or their locations in the forest. This finding confirms de Haan (2000, 2008, 2012), in that indigenous people's understanding of their environment is not only down to education, but also the continuous use of the forest.

6.3.6 Mitigating food insecurity

The livelihoods of the people in the MCNP region are affected by changes in the occurrence and utilisation of NTFPs, as expressed in the household survey and respondents' narratives. In the eastern and southern regions of Cameroon, about 95% of the 530 households said that frequently used NTFPs are very scarce and risk extinction, thereby worsening their diets (Awono et al., 2015). In the study area, respondents highlighted many features mitigating the vulnerability of their livelihoods. Mekako's narrative showed how remittances and pension allowances enable households to buy food and meet other needs (see Section 5.3.4), depicting an association between income and food security, and reflecting the findings of Awono et al. (2016). In addition, the study reveals that park creation and conservation measures, forest legislation (1994 Forestry Law), ecotourism, the creation of co-management institutions such as the VFMCs and the promotion of alternative IGAs mitigate the vulnerability of forest communities and ecosystems. Conservation measures have curbed the effects of chainsaws, farming, the destruction of forest vegetation and habitat and hunting activities on biodiversity, thereby corroborating findings that protective measures and increases in biodiversity are closely linked (Susan et al., 2013). Additionally, reports from the MCNP indicate that mitigation measures have reduced anthropogenic activities, increased animal presence in the park and decreased illegal timber exploitation (Eno-Nku, 2013; Besong, 2015, 2016, 2017).

6.4 Interpretation and Comprehension of Climate Variability and Change

6.4.1 Local perception of precipitation and temperature trends

This study indicates that the indigenous people of the MCNP region have perceived climate change over the past 20 years in terms of alterations in seasonality, prolonged dry seasons and short rainy seasons. The study population pessimistically forecast future increases in temperature, and local experiences of climate change include late rains, lack of rainwater and poor water quality, high temperatures, changes in planting seasons and poor crop productivity. The local perceptions of seasonal changes and effects on livelihoods tie in with those expressed by climate change research in the north-west region of Cameroon (Ndoh et al., 2016; Azong, 2018), which also confirms the findings of other researchers on the perceptions of climate change elsewhere in Cameroon (Deressa et al., 2011; De Wit, 2011; Mandleni and Anim, 2011; Techoro Prosper, 2013) and in other parts of the world (Gabriel and Willcocks, 2004; Ishaya and Abaje, 2008; Apata et al., 2009, 2010; Ayanwuyi et al., 2010; Krishna et al., 2010; Chaudhary and Bawa, 2011; Pyhälä et al., 2016). A study by Acquah de Graft (2011), employing descriptive statistics also showed a remarkable rise in temperature and a decline in rainfall. From the findings, the participants associated changes in the thickness of nimbus cloud to reduced rainfall, corresponding with research in Uganda where the indigenous people used physical weather observations depicted by dark clouds covering the sky to tell if the rains would come or not (Orlove et al., 2010).

6.4.2 The use of local parameters

Local indicators of climate change enable indigenous people to comprehend and cope with environmental changes. The many parameters employed in the study area to understand and envisage ecological changes comprise high temperatures, fruiting and flowering of trees, the behaviours and movements of bees and birds, water levels in streams and rivers and the drying of valleys. They are visual representations, objects and images perceived by the local population to give meaning to their lives and surroundings. Drawing from the perception theory of naïve realism, these parameters illustrate that indigenous people's understanding and observation of climate change are not separated from the physical environment. Similar results on indigenous parameters in terms of climate change have been documented in the Sudano-Sahelian region of Cameroon (Techoro Prosper, 2013). Also, Levick et al. (2010), through the use of airborne imaging and structural assessment, demarcated termite mounds and concluded that termites are indicators of climate change in Africa. In addition, Salick and Byg (2007) documented that indigenous people have markers which signal changes in seasons, such as flowering of plants, birds, the appearance of insects such as dragonflies and the mating of animals.

6.4.3 Perceived causes of climate change

This study reveals that the reasons for climate change in the MCNP region, as in most African communities, vary and rely on many factors. The belief in God the creator and caretaker of livings things, and connectivity to nature, is predominant in the study villages. Local communities believe that changes in the natural environment are pre-ordained by God, and thus inevitable, and natural resources are destined to be available because God created them and climate variability and change have no effect on forest products. The belief in wildlife's continuous existence because these animals are created by God is also confirmed by the study by Abugiche (2008), while indigenous beliefs reported by Mertz et al. (2009) in Eastern Saloum, Senegal, view environmental changes as celestial occurrences over which only God is in control. Unlike in the study area, where the belief in God's control over nature is strongly upheld, research from the Sudano-Sahelian region, Cameroon (Techoro Prosper, 2013) and Nigeria (Ukachukwu, 2007) shows that people still believe in local traditions by consulting witch doctors, offering sacrifices (goats, chickens, sheep) and organising all-night prayers for the rains to come.

Furthermore, study participants attributed climate change to man's sins, corroborating studies from the north-west region of Cameroon showing that climate change is caused by socio-cultural and supernatural factors (De Wit, 2011; Ndoh et al., 2016; Azong, 2018). Also, Apata et al. (2009) validate this notion in a study in south-western Nigeria, where communities relate climate change and an increase in floods to divine resentment and punishment, due to the increase in the number of sinners. In addition, the interviewees perceived that climate change is caused by many factors, such as population increase, deforestation, modernisation, politics and civilisation. Similar results were mentioned in a study on local perceptions of climate change and adaptation in the Jema'a local government area of Kaduna state (Ishaya and Abaje, 2008). Moreover, respondents' perceptions that politics has an influence on climate change reflects the view that politics is entrenched in the natural world (De Wit, 2011). The diverse and multi-dimensional perceived reasons for climate change in the study area imply that comprehensive approaches and measures are needed to fight sustainably against climate change and its impacts on the environment and human livelihoods.

6.4.4 Extreme events and local livelihoods

In sub-Saharan Africa, about 30% of the population lives below the poverty line and continue to be submerged in a malicious poverty cycle, due to the increasing frequency of extreme events (Naude, 2010). Study communities around the MC region have witnessed extreme events such as floods, prolonged dry seasons, volcanic eruptions and bush fires, all of which have negatively influenced local livelihoods through the loss of lives and properties, and the destruction of infrastructure, biodiversity and food crops. This view is strongly supported by studies in Cameroon (Forboseh et al., 2011; Bokwe, 2013; Balgah and Buchendrieder, 2014; Balgah et al., 2015; Ayonghe, 2017) and West Africa as a whole (Apata et al., 2009; Mertz et al., 2009), where extreme events have destroyed assets and livelihoods (see also Gabriel and Willcocks, 2004; Stern, 2007; Hepburn and Stern, 2008; Mendelsohn, 2009; Yanda et al., 2010; Mogato, 2013; Harris et al., 2015). This study shows that the lack of pipe-borne water and dry valleys in the MCNP region is due to climate change and the series of volcanic eruptions which have occurred in the region. The attribution by the local population of water scarcity to volcanic events is confirmed by Iles and Hergel (2015) and Wong (2015), who studied patterns of water flow and volumes in rivers and streams, and saw a relationship between water flow decrease, the drying up of water courses and volcanic eruptions. Moreover, water crises in the study villages have increased the cost of living, since the population buys water from neighbouring villages, as endorsed by the study of Lambi and Kometa (2009) in the upper villages of the MCNP and elsewhere (USGCRP, 2009). The emerging results indicate that extreme events in the MCNP region vary in character and magnitude and render the local environment and livelihoods more vulnerable. Also, sustainable development efforts in the region will face serious setbacks, since volcanic eruptions and climate change are unpredictable, and definitive solutions to resolve them are yet to be found.

6.5 Climate Change Effects on Biodiversity and Livelihoods

6.5.1 Perception of climate change and ecosystems

The study communities perceive climate change is negatively affecting the fauna and flora of the MC region. Features such as abundance, availability, quality, productivity, growth, regeneration and distribution constitute some of the impacts of climate change on biodiversity, thus rendering communities more vulnerable to climate variability and change, impacting the vitality of natural ecosystems, increasing the exposure of many species' actual habitat and threatening the extinction and decline of flora and fauna (Brown et al., 2010; Guariguata et al., 2012; Pyhälä et al., 2016). It also threatens the survival, nutrition and well-being of the population, as confirmed by other studies (Reid, 2004; Sonwa et al., 2012). The future negative effects of climate change on ecosystems are supported by the majority of respondents, who perceive that temperatures will continue to increase in the future, indicating that the influences of climate variability and change on the environment are currently being felt and will continue to be felt in the future (Hepburn and Stern, 2008).

6.5.2 Climate change influence on fauna and livelihoods

This study reveals that climate change is threatening the existence of wildlife and its habitats. Climate change is affecting the availability, area distribution, timing and abundance of species in the study area, validating Boko et al. (2007) view that about 5% to 40% of game species in conservation zones in sub-Saharan Africa are threatened. Climatic and non-climatic threats to wildlife in the study area include temperature changes, water shortages, changes in vegetation cover and anthropogenic activities such as bush burning, an increase in farmlands and noise from chainsaws. Reid (2004) also expressed the dangers of climate change and non-climatic features to wildlife survival. The knock-on effect is illustrated by the movement of wildlife from the lower to upper sections of the forest, where they find more favourable conditions. This finding on species movement and variations is confirmed by other studies (Hansen et al., 2001; USEPA, 2009; Julius et al., 2013), which implies that animals will not be available to hunters in lower sections of the forest. Consequently, the local population will be short of bushmeat for commercialisation and household consumption. The movement of wildlife to upper sections of the park, however, could boost the ecotourism industry and the realisation of conservation goals, since biodiversity protection measures are concentrated in areas within the park.

Climate change presents a risk to endangered species, and one in six risks extinction as a result of future increases in temperature and current policies (Clee et al., 2014). Even species not endangered by extinction are facing major changes in population, interactions and disseminations, with resultant impacts on ecologies and other amenities to humans (Urban, 2017). The respondents attributed wildlife scarcity in some forest sections to the reduced availability of forest resources, linked to climate change. For instance, *Landolphia landolphioides* (viomah) consumed by *Pan troglodytes* (chimpanzee), *Erythrotis preussi* (Preuss's monkey), *Cercopithecus nictitans* (white nose monkey) and *Papio leucophaeus* (drill), and *Myrianthus arboreus* (wokekuh) eaten by *Athrurus africanus* (porcupine) and *Manistricuspus* (cane rat). The IPCC (2007) report expresses that climate variability and change are reducing wildlife space, food and water availability and geographic location. The reduced wildlife occurrence around farmlands, fallow and secondary forest was also said to be affected by changes in vegetation cover and lack of streams, each influenced by climate change. Wildlife changes over space and time, and exposure to extinction at lower altitudes, have also been documented by researchers (Parmesan and Gabriath, 2004; Morzilla and Alig, 2011).

The native population further perceived alterations in the reproductive capacity and distribution of wildlife species, especially small mammals. Fauna species such as *Cricetomys gambiannus* (rat mole), mostly found on the lower slopes of the forest and perceived to reproduce multiple times yearly, were said to have reduced in abundance. The decrease in the small mammal population affects the protein intake of the indigenous population, since the Cameroon 1994 Forestry Law permits the hunting of small rodents for household consumption. Consequently, the large mammal population might become more vulnerable, since the local population in the absence of small mammals could turn to hunting and consuming them instead. Other studies posit that large mammals that reproduce annually are most at risk of climate change-related issues (Tewksbury et al., 2008; Issac, 2009). Although their finding is valid in terms of the reproductive nature and population of large mammals, study respondents perceived that they are mostly found in the protected area and living in favourable conditions, as shown by undisturbed vegetation and a good climate and food availability. On the contrary, small mammals are more exposed to both climatic and non-climatic factors affecting ecological regions beyond conservation zones. Perceived drivers and the vulnerability of small rodents in the MCNP region include changes in forest cover and increasing temperatures at lower altitudes, the presence of agro-industrial plantations, population increase, seasonal alterations, deforestation, increased farming and the use of chemicals (see also Körner, 2004; Harsch et al., 2009). These features confirm the supposition that wildlife at lower forest elevations is more endangered and exposed to climate change (Parmesan and Galbraith, 2004). In addition, climate change effects on fauna could also include disruptions that induce modifications in their habitat (Morzillo and Alig, 2011), shown in the effects of bushfires on fauna species. This is particularly true for the savannah area of MC, which is vulnerable to bush fires from hunting and honey harvesting. Hunters burn the savannah region as a strategy to attract antelope which feed on the ashes, and thus fire prevalence has affected wildlife and habitats in the savannah area.

6.5.3 Impact of climate change on flora and livelihoods

6.5.3.1 Medicinal plants

The indigenous population perceives that climate variability and change are negatively influencing the productivity, growth, quality, abundance and seasonality of medicinal plants. According to the analytical framework (see Figure 3.2), these features depict the “knock-on” effect of climate change on medicinal plant species, and consequently indigenous livelihoods. Research from Ogbomosho, Nigeria, indicates that increasing temperatures hinder the proper growth and development of plants (Ayanwuyi et al., 2010). This study indicates that due to prolonged dry periods, the leaves of most medicinal plants become dry and fall off, and so it is difficult for the local population to find fresh leaves. Some respondents indicated that they walk long distances to find small quantities required for local treatment. Also, living costs have increased, since most people do not have sufficient money to attend hospitals. The adverse effects of climate change on medicinal plants depict a correlation between climate change, primary health systems and livelihoods, thereby confirming that climate change effects on medicinal plants challenge progress made by governments in the Global South to improve on health and achieve SDGs (Marley, 2017; OECD, 2017).

This study also reveals changes in the fruiting period of *Prunus africana* due to unstable seasons. *Prunus africana* flowering normally takes place in March and April, but the local population have realised it also bears fruit from November and January (see also Pouakouyou, 2002, Eben, 2015). Krishna et al. (2010) also revealed changes in availability, alterations in flowering and fruiting time and increased vulnerability of medicinal plants due to prolonged dry seasons, a lack of water and unstable seasons. Several authors have theorised that due to temperature increases and forest age, diseases and insects such as beetles are affecting tree species, diminishing resistance to pest attacks, increasing the mortality rate and reducing the extent of forests (Berg et al., 2006; Ryan et al., 2008; Callaway et al., 2010; Lal et al., 2011;

Morzillo and Alig, 2011; Susan et al., 2013). A similar scenario is perceived in the MC region, where farmers observed that *Prunus africana* is shifting in altitude, due to vulnerability caused by climate change. Borer and ants that thrive in hot temperatures, coupled with decreased rainfall, are affecting the growth, structure, distribution, productivity and survival of *Prunus africana* especially at lower altitudes. This finding corresponds with the view of Boko et al. (2007) that biodiversity outside conservation zones is more exposed to climatic and other stresses. The effects of insect pests on *Prunus africana* growth and death have also been recorded in the study area (Eben, 2015).

In the MC region, *Prunus africana* productivity is affected by climate variability and change. The effect on productivity, quantities harvested and consequently sales revenue has affected livelihoods and diminished the motivation to engage in alternative IGAs. Furthermore, the interviewees divulged the effects of heavy and continuous rains and high temperatures on some medicinal NTFPs. For instance, *Cymbopogen* sp. rots due to heavy rains, and *Bidens pilosa* and *Ocimum gratissimum* are vulnerable to continuous rains. The negative effects of the present environmental changes on medicinal plants, if accompanied by respondents' perceived future temperature increases and decreases in precipitation trends, might lead to rigorous resource exploitation, insufficiency and challenges for traditional health regime and sustainability efforts (Paavola, 2008; Fisher et al., 2010).

In Cameroon, no financial estimates or economic costs on the vulnerability of NTFPs to climate variability and change, specifically the impacts of borer and ants on *Prunus Africana*, are available. The local population, however, perceives it to be enormous, considering its monetary significance to local businesses, community development, education and family life. The consumptive value of medicinal plants, though not considered by stakeholders, could be higher than any financial value. A study on the marketing and management of *Prunus africana* in the MC region highlighted that out of 3,379 trees, with all diameter classes put together, around 30% are affected by borer and ants (Eben, 2015). Study respondents expressed that the infected tree bark is neither commercialised nor self-consumed, signifying an important loss to national and local economies, and confirming the view of Grieg-Gran (2008) that climate change is the market's paramount challenge. The lack of data narrows understanding on the contribution of medicinal plants to the national economy and household economies, and it is an indication that forest policies are not grounded on clear evidence (Awono et al., 2016). The consequences of the borer effect on *Prunus africana* should not be underestimated, as depicted in a study by

Ruth et al. (2007) on the effect of *Dendroctonus frontalis Zimmermann* (pine beetle) on pulpwood availability, in which they recorded a yearly loss of about 1% of gross national product.

6.5.3.2 Food NTFPs

Furthermore, this study indicates that climate variability and change are influencing food NTFPs and their habitats, shown by low productivity, changes in growth, quality, area distribution and loss of species. The decrease of food NTFPs due to climate change is validated by other research (Brown et al., 2010; Guariguata et al., 2012; Pyhälä et al., 2016), thus echoing an association between climatic effects on food NTFPs and changes in availability and utilisation. In addition, increasing temperature, water scarcity due to reduced rainfall and the drying up of streams are perceived to negatively affect the availability of most food NTFPs, especially *Kigalia africana* fruit (motimbi-limbi), which contains a lot of water and is consumed by elephants and humans. The local population have observed an increase in the consumption of the "motimbi-limbi" by elephants, so climate change influence on food NTFPs sways wildlife food choices, preferences and consumption patterns. This consequently affects food NTFP availability and increases pressure on forest products (Lal et al., 2011), and it could result in a decrease or expansion in the nature of the forests and flora species currently living in different forest zones (Ryan et al., 2008; USGCRP, 2009).

Moreover, apiculture farmers expressed a decrease in both the bee population and honey productivity. They indicated that flowering of most forage plants has altered, elucidating alterations in output. Factors contributing to this phenomenon include the use of herbicides and pesticides, aligned with changes in seasonality which have altered and "confused" bee activities. The non-flowering of plants, as expected due to climate change, is linked to poor honey production. Similar findings have been recorded in the north-west region of Cameroon (Ingram, 2014), and elsewhere, studies reveal that bees make available food and pollinate flora species such as *Cola* spp., *Raphia* spp. (Rodger et al., 2004) and *Prunus africana* (Hall et al., 2000; Were et al., 2001). This reveals that climate variability and change have multiplier and interrelated effects on the abundance and availability of ecosystem goods and services.

In addition, this study indicates that climate change has affected food utilisation and intake in the MCNP region, as local communities over the years have become so accustomed to food

NTFPs that they perceive other alternatives as less nutritious. More nutritional value is placed on products which grow naturally in the wild. Forest food is considered safe, nutritious and socially acceptable, particularly by the elderly generation. The indigenous population perceive the following climate influences on food NTFPs and consumption: changes in the number of times they harvest vegetal food NTFPs such as *Solanum nigrum* (wild huckleberry), alterations in the sprouting of *Agricus* sp. (mushroom) species, locally called "ewondeh," and modifications in the availability and productivity of *Apis malifera* (honey bee). Variations in the flowering period of *Afromomum melegueta* (alligator pepper) from September to August (see also Visser and Both, 2005; Yanda et al., 2010; Gonzalez, 2011). The indigenous people are unable to say specifically when NTFPs such as *Mangifera* (mango) and *Dacryodes edulis* (plum) will be available in the rainy season, due to changes in seasonality. Alterations in availability and utilisation due changes in seasonality are limiting indigenous people and households in their livelihood strategies. They are uncertain about quantities and productivity, since nature has become very capricious, and thereby they are unable to attain sustainable livelihoods. This corroborates with findings by Hesselberg and Yaro (2006) and Codjoe and Owusu (2011) that Ghanian households suffer from low food insecurity due to late rains, floods, high temperatures, a lack of natural assets and alternatives. Also, confirmed by the views of some researchers, climate variability and change lead to uncertainties in forest products, changes in productivity and availability and consequently increases in food costs (Lal et al., 2011; Lynn et al., 2011).

Despite the negative effects of climate variability and change to some food NTFPs, the increase in temperatures in the MCNP region has led to better availability and earlier fruiting for *Dacryodes edulis* (plum) and *Mangifera* (mango). Thus, some food NTFPs not formerly available for local consumption are now obtainable due to increasing temperatures. Research in the Kupe Mountain region of Cameroon, by Ngane et al. (2012), also corroborates that off-season *Dacryodes edulis* are now available in Kupe East due to hot temperatures. It is also confirmed by climate change research in the Belo-kom and Oku regions of Cameroon that ripe mangoes and pears are available, due to hot temperatures – unlike in the past (Azong, 2018).

The study further reveals the significant role of some vegetal NTFPs such as *Solanum nigrum* (wild huckleberry), *Piper guineense* (bush pepper), *Thaumatococcus daniellii* (ngogo leaf) and *Emilia coccinea* (litolangwah) to local livelihoods, but quantities sold have been affected due to climatic effects, which have increased the dryness of leaves, changed their quality and caused irregular availability. The climate-induced vulnerability of vegetal NTFPs has also affected consumption patterns, since only healthy and green leaves are consumed. The climatic effects on availability and utilisation, coupled with other stresses, question the role of NTFPs as safety nets, since indigenous people perceive their livelihoods as uncertain, offset and unstable due to climate change. According to Defang et al. (2014), this entrenches the local population in poverty, since food NTFPs are a major source of income and food, especially in terms of protein. The outcome is starvation and malnourishment as a result of decreased availability, which will further render households more vulnerable to climate variability. The reduced availability of food NTFPs for sale is also affecting household revenue vital for food, health and education. The negative effects of climate change on food NTFPs and local livelihoods are also documented in research by Defang et al. (2014), positing that indigenous people of Muyuka, Cameroon, have observed a decline in revenue caused by climate change, with resultant consequences on children's education. This confirms the notion that climate change is hindering advancements made in the attainment of MDGs, i.e. the eradication of extreme hunger and poverty, and universal education for all (UN, 2009), diminishing opportunities for the poor, a force for anti-development and increasing the gap between the rich and the poor (Human Development Report, 2007/2008; Taylor, 2015).

6.6 Power Relations Induced by Climate Change

6.6.1 Access changes to forest resources

Political ecologists stress the practices and processes through which climate change is exercised and discussed (Little, 2013). The analytical framework (see Figure 3.1) reveals that access to natural capital is a function of structures and processes, and a determinant of livelihood outcomes. Access denotes the distribution and choice of food and can be comprehended as the ability to acquire the right kind, amount and quality of food (Connolly-Boutin and Smit, 2016). Sustainable development entails ensuring access to natural environmental resources to present and future generations that will permit them to live and prosper (UN, 2009). The aptitude and ability of indigenous people in the study villages to obtain forest products is guided by political processes reflected in government policies, conservation approaches and environmental changes. Thus, access to natural resource assets is shaped by institutional arrangements, revenue levels, policies and the socio-economic and physical environment (Renzaho and Mellor, 2010). Communities on the periphery of MC have peculiar vulnerabilities. The data reveal that the indigenous people are restricted to park boundaries and consequently are restrained in terms of space and land possibilities. The park boundary is an environmental protective measure which has prohibited access to natural resources, and access changes have affected household income and the freedom and capacity to choose what to eat, reduced livelihood options, enhanced unequal access to forest resources and further degraded areas outside the park. This finding is also recognised by Devereux and Maxwell (2001), Kelly et al. (2003) and Misselhorn (2005). The participants perceive that the increase in temperatures in the region, and consequent effects on biodiversity and livelihoods, has led the government to reinforce protective biodiversity measures. Strict controls on hunting and deforestation are being implemented through regular patrols by eco-guards and the banning of hunters' unions, which in turn have weakened traditional forest management regimes, as expressed by the data that non-indigenes especially enjoy almost equal access to the forest, since state regulations no longer respect traditional control.

Access changes influenced by climate change are affecting indigenous livelihoods in the following ways: decreases in household revenues and a lack of game, protein and gifts for relatives and friends (see also Abugiche, 2008). Native people perceive the Bakwerie culture as being deeply rooted in customary ways of collecting and sharing, which are now being affected by restricted access to forest products, especially bushmeat, used as gifts to relatives and vegetal NTFPs collected and shared with neighbours and friends. The data illustrate that the savannah region of the MCNP, vulnerable to bush fires, is now experiencing specific bush fire control, surveillance, regular patrols and prohibited hunting. The restricted access to NTFPs vital to indigenous livelihood security casts into doubt the supposition that local livelihoods in Africa are biodiversity-dependent, thereby implying that the consequences of climate variability and change on indigenous livelihoods cannot be understood without considering concerns around power relations (O'Brien, 2006).

6.6.2 Climate change and NTFPs access related conflicts

Coping with environmental changes has often been met with conflicts, as revealed in studies which have linked climate change to conflicts over natural resources in Africa (Nyong et al., 2006; UNDP, 2007; Ayodele, 2010). This study records conflicts and tensions between indigenous people and government officials over medicinal plants, particularly *Prunus africana*. The local population does not respect access regulations on medicinal plants, motivated by the need to have huge quantities of *Prunus africana* for sale. Access is controlled by the government through strict market control and harvesting quotas. The capitalisation of

Prunus africana has reinforced conflicts within the communities, weakened traditional authority and control over resources, affected livelihoods and watered down indigenous resource tenure, since the government controls the commercialisation and collection of the tree, even specimens found on private farmland. Scarcity due to bad climatic conditions and ownership claims by different communities increase inter- and intra-village conflicts. Similar results have been recorded in the Kilum-Ijim Forest, Cameroon (Stewart, 2007b; Ingram, 2014). Furthermore, conflicts arise from the non-respect of exploitation regulations, harvesting plots and quantities (see also Page, 2003; Samdong, 2010; Awono et al., 2014). The inability to harvest sufficient quantities beyond the park, due to the borer and ant effects caused by climate change, forces collectors to carry out illegal harvesting in the protected area. This emerging finding indicates that limited access and illegal actions could be climate-motivated and indications of a lack of freedom to exercise the liberty to survive (Sen, 1999).

This study indicates that conflict over the need for bushmeat is endangering the lives and livelihoods of indigenous people, especially hunters, who resort to night hunting. Participants expressed conflicts between hunters and local government representatives. The struggle over wildlife is on the one hand linked to the need for protein and income by the local population and the other hand related to a government resolved to conserving wildlife. In addition, the prohibited access to bushmeat has increased its cost and value. The effects of conservation policies and indigenous people's recourse to illegal practices for survival have been recorded by several studies (Neumann, 1998, 2000; Bloomer, 2009), as well as conflicts over wildlife registered in annual reports of the MCNP, illustrated by data on the numbers of guns confiscated (Besong, 2015, 2016, 2017). This finding also reflects research from south-east Cameroon (Samndong and Vatn, 2012) and Central Africa (Nasi and van Vliet, 2009), where the profitability of the bushmeat trade to households has augmented illegal hunting and conflicts with logging companies and park management.

Moreover, the data illustrate that some participants do not respect access regulations to wildlife, due to the need for survival and lack of alternatives, confirming the results of Abugiche (2008) on reasons for wildlife conflicts and motivations for hunting in the Banyang-Mbo Sanctuary in Cameroon. Thus, the lack of alternative livelihoods is a catalyst to illegal activities in the study area, validated by Lambi et al. (2012), who theorise that natives will not go back to the forest if feasible and practicable livelihood alternatives are provided. This implies that the success of conservation efforts relies on their alignment with livelihood needs, while the sustainability of livelihoods and biodiversity cannot prevail amidst conflicts which, according to Ayodele (2010), render the poor more vulnerable and affect local development and innovation.

6.6.3 Access changes, legislation and forest management regimes

According to the World Resources Institute (WRI), 'forest management' refers to the institutions, practices and laws that shape the governance of forests (Williams et al., 2012). Inherent in this definition are political processes embedded in landscape management (von Hellermann, 2015). This study indicates that collaborative management of biodiversity in the MCNP region is aimed at achieving conservation goals, improving livelihoods and ensuring local development. It is also meant to enhance the involvement and mainstreaming of forest-dependent communities in the sustainable management of ecosystem resources. The VFMC and MOCAP are indigenous forest management institutions linking local communities and the state in biodiversity conservation. They determine access to, and the use and management of, natural resources (Belsky and Siebert, 2016). Although the collaborative paradigm has gained legitimation in the same way as "participation" in the 1980s and 1990s, its implementation and misinterpretation mean it is diminishing (Leal, 2010) and might lose its rationale and conceptual meaning. The presence of VFMC, MOCAP and eco-guards is considered by the population as a major obstacle to accessing resources, since they report and reprimand illegal forest activities – to the disadvantage of indigenous communities (see also Lescuyer, 2007; Ambinakudije, 2011; Samndong and Vatn, 2012; Kemmler and Baumgart, 2014).

In addition, access to natural resources in the MCNP region has a political and institutional underpinning, coherent with Sen's (1981) view on entitlement and his validation that entitlement challenge results in food insecurity. The presence of VFMC and MOCAP in the villages has instead met with conflict with other villagers and traditional institutions whose interests they are meant to preserve; in essence, villagers feel that they serve state interests and are state-driven – a view also confirmed by Kemmler and Baumgart (2014). Power is a factor in shaping the features of environmental change (Little, 2013). In the Bova community, participants expressed tensions between the village council and VFMC over who has the legitimate responsibility to resolve forest-related conflicts. Such power relations could render vulnerable traditional authorities and social cohesion, and question the effectiveness of forest management institutions. This finding corresponds with the view that conflicts between stakeholders lead to institutional incapacity and social disintegration (Homer-Dixon, 1999). The VFMC and MOCAP might have limited influence in the attainment of conservation objectives, and consequently climate change adaptation goals, due to the suspicion surrounding their activities and a lack of collaboration with local communities, which affects information trickle-down. Therefore, for local institutions to be effective in addressing climate change adaptation, more capacity-building should be provided and collaboration enhanced (Agrawal et al., 2012). The limited success of village forest management institutions is depicted by documentation on illegal forest activities in the region (Tieguhong and Zwolinski, 2008; Gardner et al., 2001; Besong, 2015, 2016, 2017; PSMNR-SWR, 2017).

The Cameroon 1994 Forestry Law places restrictions on NTFP access by enforcing regulations and punishments on those perpetrating illegal activities. The study reveals that some respondents respect wildlife access regulations for fear of being punished, but those who do not respect access rules are fined or taken to court, as confirmed by Ayonghe (2017) in relation to the MCNP region. The park's annual reports also record convocations and court sessions with defaulters (Besong, 2015, 2016, 2017). Wily (2012) indicates that state prosecutions of local users further encourage the non-respect of laws, creating a conflictual situation between the 1994 Forestry Law and customary practices. The non-respect of access regulations governing forest resources is motivated by the need to survive, hunger, lack of income and alternative livelihoods, and according to some researchers it mirrors policy inefficiency, weaknesses in governance and the quest for survival (Blackman and Rivera, 2010; Kaufmann et al., 2010). This implies that for indigenous forest users and the state to live in harmony, they must have the same objectives (Long and Long, 1992).

6.6.4 Capitalisation of forest products and user rights

Indigenous livelihoods are shaped by drivers such as globalisation, the capitalisation of natural resources and conservation politics (Ambinakudije, 2011). *Prunus africana* was initially freely accessed by local communities for traditional medicines, but its globalisation and capitalisation, according to de Haan (2012), gave it an economic and neo-liberal outlook. *Prunus africana* capitalisation has met with contestation and mixed feelings from the local population, as it has integrated the local space into the global economy, a modus operandi not comprehended at all. This conflictual situation mirrors Weber and Schmidt's (2016) notion that decisions concerning local communities and their livelihoods are made outside of local spaces, therefore leading to social tensions. It also depicts the position of local communities in terms of power relations and decision-making (Baumann, 2000). The advocates of globalisation theorise (Guttal, 2010) that it will improve living standards, enhance innovation, create wealth, reduce poverty, bring about progress and ensure the equitable distribution of resources. This study reveals a contrary view that the capitalisation and globalisation of *Prunus africana* by national and international economic regimes have subjugated indigenous people's control and freedom of use. It has additionally led to over-exploitation, environmental depletion and tension, all of which affect the sustainability of livelihoods.

This study portrays that state influence and control over medicinal plants depend on their economic value. Thus, use rights to important plant species such as *Entandophragma angolense* and *Prunus africana* are regulated by the state, due to high demand and economic value. These products are labelled "special forest products" (SFPs) in the 1994 Forestry Law (GoC, 1994). This special status supposes that the government decides on exploitation, monitoring, management and harvesting. However, the 1994 Forestry Law is not clear on the criteria for the inclusion of species on the SFP list, therefore creating space for several interpretations and applications which may be detrimental to less economically valuable species. The obliqueness of the law could also render invisible the threats to medicinal plants used locally, by selectively valorising a few valuable products. Moreover, the survey data reveal that unclear user rights to forest resources have induced conflicts between the local population and the state. Indigenous people expressed that the denial of their right to cut trees for construction, and interdiction not to collect NTFPs in the park, is an abuse of user rights, confirmed by findings in the region (PSMNR-SWR, 2011). Also, the 1994 Forestry Law allows the local population to hunt Class C animals and collect NTFPs from the park for household consumption, but forestry authorities turn a blind eye to indigenous livelihoods through repression by forest authorities. This undercuts the user rights of forest-adjacent communities and compels people to go against the law to sustain livelihoods (Samndong and Vatn, 2012). The abuse of user rights diminishes indigenous motivation to protect the forest, and it relaxes the involvement of traditional institutions, as their user rights are abused. According to Lambi et al. (2012), this creates a double tragedy for forest-dependent communities: first, through climate variability and change affecting biodiversity, and second, as a result of the government refusing forest-dependent communities their basic livelihoods and means of survival.

This study also illustrates that access to most food NTFPs in the MCNP region is not formally regulated, because they are not financially valuable to the government – and thus no special status is placed on them. Moreover, most food NTFPs are found and collected from people's backyards, farm and fallow lands and secondary forest. This collection is done without permission, supporting research in the lowland humid forests of the south-west region of Cameroon (Ingram, 2014). Thus, the state is in charge of readdressing which natural resources are important, from where forest products can be collected and the best way to ensure benefit sharing. Following the respondents' narratives, the local population is prohibited from collecting food NTFPs abundant in the park. The ban on collecting honey from the protected area is due to unsustainable harvesting by farmers through the use of fire, which is dangerous to the park's biodiversity, implying that the protection of species is conservation-motivated and not in line with the protection of livelihoods (Ingram, 2014), and endorsing the view that entitlement collapse could lead to food insecurity (Sen, 1981). Section 8 of the 1994 Forestry Law stipulates that local communities have user rights to natural resources for personal use, except for protected species (GoC, 1994). The local populations express their user rights are not respected, since they are not allowed to collect honey and other food NTFPs in abundance in the park. Although the data illustrated open access to most food NTFPs, this practice could have negative effects, such as forest and resource degradation, and create conflicts between stakeholders (Berkes, 2007).

Access to natural resources and user rights are shaped by de facto or de jure rights which determine livelihood outcomes (Schlager and Ostrom, 1992), and capital and power are influential forces (Bayrack et al., 2013). Prohibited access to forest resources and land tenure were registered as features which affect women's livelihood in the face of NTFP scarcity. Some female respondents from Mapanja and Likombe indicated that forest land from which they collected *Gnetum* spp. (eru) had been sold to an individual. Their user right was affected by the privatisation of the forest patch, affecting *Gnetum* spp. (eru) availability to women for sales and household consumption. Thus, land tenure is an important source of power and a determinant of food security in the study area. The changes in tenure right have swayed the balance of power from customary to private hands, excluded the poor from forest use and widened the gap between the rich and the poor (de Haan, 2000; Olaf, 2011). When women are deprived of the opportunity to collect NTFPs from forests which give them security, they face economic and nutritional uncertainty, because they are refused a vital source of livelihood. The implication is that women's vulnerability is enhanced over time (Azong and Kelso, 2016) and aggravated by changes in land ownership which guarantee access to productive resources and are vital for environmental justice (Schultz et al., 2001). The changes in land tenure have also been recorded in the Littoral region of Cameroon, where forest land is now privately owned by persons who forbid open and free access (Ingram, 2014). Furthermore, the local population perceives that the park's creation has affected use and access to forest products, confirming studies in other protected areas of Cameroon, such as the Takamanda Forest Reserve (Zapfack et al., 2001; Sunderland et al., 2003) and Korup National Park (Nchinda and Che, 2008; Wirsiy et al., 2010).

6.7 Adaptation to Climate Variability and Change

6.7.1 Livelihood practices and climate change adaptation

The outcome of the research on adaptation reveals that indigenous people in the study area are engaged in various farming practices that are directly and indirectly related to climate change. The employment of new farming strategies and techniques is aimed at ameliorating crop productivity and improving household livelihoods. Though farming strategies were mostly linked to crop productivity, climate change is a new challenge and an additional push to changing strategies. Climate-related concerns about reduced crop productivity include water scarcity, the drying up of streams and increasing temperatures. Mitigative practices consist of agroforestry, reforestation, the protection of young trees found in the forest through planting in safe areas, the use of wood ash to fight against insect infection and agro-ecological farming as opposed to shifting cultivation. These practices enhance soil fertility and improve crop yield. The multiple techniques and strategies employed by farmers imply that different reactions are utilised by indigenous people to ameliorate livelihoods and cope with climate change. This finding confirms Azong (2018), in that indigenous people exposed to climate change vary their adaptation strategies. Also, this study indicates that native people use herbicides, which have negative effects on vegetation, soil quality, human health and food quality. Thus, adaptation practices might have disproportionate consequences on well-being and ecosystems (Kate, 2002), and herbicides are detrimental to local livelihoods and development, as confirmed by negative health consequences recorded in other studies (Baudoin et al., 2013; Azong, 2018).

According to Agrawal and Perrin (2008), development actions that centre on improving household livelihoods, with no consideration of how people can tackle variations in their livelihoods, might not be suitable for confronting the effects of climate variability and change, since they sideline climate change effects on livelihoods and overlook indigenous people's concerns about averting starvation and poverty. This is true for the MCNP region, where the diversification of adaptation strategies by indigenous people is induced by poor crop yields, and the struggle to climb out of poverty and to cope with environmental changes. Adaptation actions are geared towards providing outlets during hard times and creating avenues to engage in other alternative activities. Native people are involved in single and combined adaptation initiatives to improve on their livelihoods. The many alternative adaptation strategies indicate that no one action can tackle the fight against poverty and climate change. Adaptation actions engaged in by the study population suffer setbacks such as unstable markets, poor farm-to-market roads, political unrest, increasing temperatures and water scarcity. These challenges affect the ability of the local people to achieve positive adaptation outcomes, and moreover, the connection between livelihoods and climate change is significant for adaptation initiatives, owing to the relationship with policies, equity, fairness and justice components of the development agenda (Thomas et al., 2005).

People’s livelihood requirements and perceptions of benefits from a livelihood activity are important determinants for adaptation. Many respondents are aware of changes in their environment but consider a lack of income and food as most important. This study reveals a correlation between activities geared towards enhancing household income and food availability, and actions to reduce vulnerability to climate change. This corresponds with research by Ayanwuyi et al. (2010) in Ogbomosho, Nigeria, which revealed that some villagers planted food crops to cope and mitigate climate change, and echoes Awono et al. (2016), in that there is an indisputable association between income and food security. Moreover, Brown and Sonwa (2015) expressed that local communities concentrate activities to enhance livelihoods and improve economic status – and not specifically to adapt to climate change. As in this research, they did not find a direct relationship between livelihood actions taken by local communities and climate change adaptation. This could be explained by the many years of NGO presence in the study area and discourse focused on biodiversity protection through the promotion of alternative income-generating activities. The manner in which people perceive the effects of environmental change on livelihoods may influence livelihood strategies and outcomes. The local population perceives that forest products, even during periods of scarcity, are available in small quantities. This mentality by some respondents, to always “find the little needed,” blinds people to the early pointers and severity of climate change, and it could be misleading and further endanger rural livelihoods.

Agroforestry refers to diverse actions involving planting food crops, tree species and/or animal rearing on the same piece of land and/or at the same time. It enables indigenous people to disseminate and absorb survival risks, livelihood insecurity and uncertainty in a changing environment (Eakin, 2000; Salick and Byg, 2007; Verchot et al., 2007). In all the study villages, agroforestry is practiced in order to diversify income sources and protect the environment by cultivating food crops, NTFPs, timber and medicinal plant species on the same piece of land. AGED (2014) carried out a study in Burkina Faso on the household experiences of climate change impacts connected to droughts, concurring that farmers employ agroforestry and introduce new varieties as adaptation measures. The importance of agroforestry is depicted in its objective to enhance forest conservation, reduce forest dependence and improve social and economic well-being. In the study area, economically valuable trees such as *Prunus africana* (pygeum), *Entandophragma angolense* (mahogany), *Cedrela odorata* and *Pterocarpus soyauxii* (camwood), and other NTFPs such as *Irvingia* sp. (bush mango), *Dacryodes edulis* (plum) and *Garcinia kola* (bitter kola), are planted on farmland alongside food crops. These trees are capital assets used by the population for construction and livelihoods. Moreover, the planting of fruit trees as shade around homes, gardens and farmlands is meant to regulate temperatures and humidity, and protect houses from extreme events like storms and harsh winds (Lin, 2010). The importance of agroforestry is also highlighted in the north-western region of Cameroon, where farmers plant trees on farmland to enhance soil fertility, diminish runoff, increase crop productivity and safeguard against income threats (Ndoh et al., 2016).

6.7.2 Short- and long-term adaptation strategies

Indigenous people of the MC region carry out several adaptation actions to improve living standards and resource sustainability. Adaptation initiatives could be reactive or participatory, or in the short or long term (Serrat, 2017). Indigenous people's adaptation strategies to environmental changes are not a distinct and established set of activities (Füssel, 2007). In the MC region, the rationale for adaptation strategies is guided by the necessity to enhance livelihoods and food availability, reduce forest dependence and fight against climate change, with activities varying across different communities. The multiplicity of adaptation practices is guided by present and future expected changes in climate, the need to distribute risk and environmental, socio-political and economic features that greatly differ across areas (Smit et al., 1999; Füssel, 2007; Wright and Priston, 2010). In the study area, some adaptation actions were geared towards reducing forest dependence, since people find alternative ways of making available NFTPs that have become rare and are valuable to livelihoods. These include the ex-situ conservation of NTFPs such as *Irvingia* sp. (bush mango), apiculture, the planting and selling of medicinal plantlets such as *Prunus africana*, cultivation and bee-farming. This implies that prohibited access to food NTFPs through park creation is a push factor to adaptation actions, suggesting the park is still seen as an important source of livelihood for the local population.

The many short- and long-term adaptation options ensure livelihood sustainability, due to survival diversification. Adaptation activities which provide immediate gains to indigenous societies have been documented (Eyzaguirre and Iwangi, 1996; Ellis, 1998; Huq and Reid, 2004), and the scenario in the MC region is no different, with more short-term adaptation activities carried out in all of the study villages. Furthermore, they provide short-term benefits and therefore cannot assure livelihood sustainability, unlike long-term adaptation actions which are more sustainable (Pettengell, 2010). The variation in adaptation strategies across communities was also identified by Thomas et al. (2005) in South Africa, where rural households employed different short-term strategies to improve their livelihoods and adapt to environmental changes. These activities set the foundation to build resilience against potential climate change shocks (Yanda et al., 2010). Moreover, actions geared towards reducing forest dependence could certainly increase carbon sequestration and, consequently, climate change mitigation. For example, indigenous actions such as tree-planting, apiculture and ex-situ conservation of forest products (*Piper guineense, Prunus africana*) equally protect biodiversity and offer climate benefits. This leads to the conclusion that there is an irrefutable correlation between various adaptation actions taken to reduce forest dependence and fight against environmental change.

Long-term adaptation mechanisms are promoted to enhance progressive economic and ecological paybacks to stakeholders (Van Bodegom et al., 2009), based on the premise that climatic conditions affect biodiversity, and modifications in the natural environment influence climate change (Mansourian et al., 2009). However, the contribution of adaptation strategies to livelihoods is questionable, since most long-term strategies such as *Prunus africana*, which generate income for the community, are not consistent. Pramova et al. (2012) concur that such adaptation strategies can serve as poverty traps for locals, and thus they cannot stand alone. This study also indicates that collaborative (conservation bonus) and educational adaptation initiatives have to be constant and sustainable, by addressing the needs of current and future generations. Such adaptation measures could offer about 25% of the emission decreases required to fight climate change efficiently (Stern Review, 2007), enhance the value of the ecosystem and produce greater returns (Wasonga et al., 2010) and enrich local livelihoods, soil restoration and carbon sequestration (Yanda et al., 2010).

6.7.3 Group adaptation strategies

Natural resources reduce indigenous people's vulnerability to climate variability, change and food insecurity (Paramova et al., 2012). Women in the Global South play an important role in the provision of food and income needs for households. In the study area, they are actively involved in NTFP collection and commercialisation. The women indicated that the availability and quality of marketable NTFPs such as *Thaumatococcus daniellii* (ngogo leaf) have been affected by climate change. Thus, their attachment to nature, and their vital role in climate adaptation, is indisputable. Salick and Byg (2007) express that indigenous people with market accessibility sell food crops and forest products to supplement household income, with the intention to enhance living standards. This is the case in Mapanja and Likombe, where women individually commercialise *Thaumatococcus daniellii* (ngogo leaf) and *Gnetum africana* (eru) to enhance livelihood resilience, corroborating with studies in Cameroon (Bele et al., 2011) and Bolivia (Robledo et al., 2004) and illustrating the role of biodiversity in rural livelihoods and climate vulnerability. To ensure sustainability in the sales and profitability of *Thaumatococcus daniellii*, the women divided themselves into sub-groups, each assigned a specific "market day." This innovative practice has rendered their livelihoods more resistant to market failures and uncertainties, enhanced the economic capacity of the women and could increase resilience to climate change (Brown and Sonwa, 2015). Also, group actions are driven by external actors and extension services, as well as the perceived need by the women to diversify livelihoods and enhance financial autonomy. External support helps the women innovate and empowers them to adapt in a changing environment. Their important role in climate change adaptation is also stated in other studies (Ndoh et al., 2016; Azong, 2018). Group and collective actions could be major pathways through which indigenous people mobilise their capabilities to boost resilience linked to climate change risk (Thomas et al., 2005). The data indicate that women are involved in alternative activities which could help reduce the burden of poor farm productivity and augment environmental protection. They come together to find solutions to challenges facing their lives. In Mapanja, the Hands on the Ground Women's Group is involved in cassava processing, and the IFOSE Women's Group Bokwaongo is engaged in tree-planting and bee-farming, implying that group initiatives are aimed at improving livelihoods and reducing vulnerability to the impacts of climate change. The PSMNR-SWR Report (2014) validates that income-generating activities involving women result in better social assets, i.e. women's agency could serve as an asset for climate change adaptation actions and economic empowerment essential to their resilience to climate variability and change (Azong, 2018).

6.7.4 The role of NGO's in climate change adaptation

Institutions, both formal and informal, determine people's entitlement and endowments and shape the accomplishment of adaptation strategies among forest-dependent communities (Scoones, 1998; Agrawal and Perrin, 2008; Ingram et al., 2012; Ingram, 2014; Sanginga et al., 2010; de Haan, 2012). This study reveals that through groups, NGOs promote ex-situ conservation measures such as bee-farming and tree-planting in the villages. Thus, human and social capital is important for adaptation to be effective. Isham (2002) validates the important role of social capital for fertiliser execution in Tanzania and provides arguments on the vitality of social capital. Furthermore, Gbetibouo (2009) studied farmers in the Limpopo Basin, South Africa, to examine perceptions and adaptation strategies, and realised that exposure to external stakeholders and services provided knowledge and awareness on climate change and livelihood alternatives. Many governmental development organisations such as GIZ have facilitated the introduction and implementation of income-generating activities in the study area, and they still promote conservation and development actions. In addition, they shape adaptation and indigenous livelihoods by deciding how coping reactions should be structured individually and communally (Agrawal and Perrin, 2008). Groups and institutions in the communities present a social asset that NGOs use to promote conservation and alternative IGAs. They are scaled up for climate change adaptation by heightening the consciousness of community stakeholders and ascertaining the best strategies (UN, 2009) necessary to cope with and recover from exterior pressures influencing the resilience of communities (Agrawal and Perrine, 2008). Also, the long-term relationship which exists in the study area between NGOs and communities is useful in helping augment the struggle against climate change. Given the limited resources available to local NGOs, and their limited lifespan, existing village groups and institutions can fill the gap. This is certainly true in Kenya, where indigenous establishments decrease local exposure and enhance well-being in regions affected by climate change (Washington-Ottombre and Pijanowski, 2013).

In addition, park management, in collaboration with GIZ, executes activities such as conservation education classes, village development funds and park boundary opening. These activities mentioned in Bokwaongo and Bova villages are aimed at protecting the forest and improving indigenous livelihoods, thereby confirming views that such measures diminish environmental threats (Innes et al., 2009). Moreover, actions such as conservation bonuses and credits have environmental underpinnings and are useful in building resilience to climate change adaptation measures. They are carried out by NGOs and MINFOF via financial support chanelled to communities, capacity-building, awareness-raising and collaborative forest management. These features are vital on the local level in reducing vulnerability to climate variability and change (Yanda et al., 2010), and they could support the emergence of new challenges posed by climate change, if adaptation values of proximity and people's collective aptitudes are also enhanced (Buclet and Lazarevic, 2014).

6.7.5 Climate change and migration

Migration in this study means mainly the movement of people from villages to towns in search of jobs. Migration is also induced by water, which is vital to agricultural productivity and for household use. Migration occurs mostly among the youthful and active population. It is different from migration tendencies in other regions of Cameroon. While in the study area people migrate to the nearby towns of the south-west region, the people of the Belo-Kom north-west region migrate to the western and south-western regions to work on plantations (Azong, 2018). Thus, some people migrate over long distances and others short distances, depending on the availability of economic opportunities that will benefit their livelihoods. Following narratives on the reasons for and knock-on effects of migration, this study indicates that due to water hardship, children prefer to spend their vacations in towns and not with their parents in villages. The effects are mostly felt by women, especially single women, who rely on their children for farm labour. Thus, women's workloads increase both at home and on the farm, and their vulnerability can be severe, due to the influences of climate variability and changes to agriculture and NTFP productivity, which are pivotal to livelihoods in the region.

Furthermore, water is a vital resource for livelihood and community sustenance, due to the multidimensional role it plays in human and ecological stability (Fogwe and Muwahnjong, 2016). This study shows that water scarcity has been caused by climate change and a series of volcanic eruptions which have disrupted the flow of streams in the region. The lack of water has rendered life difficult and expensive, since the local population has to stretch already limited income at their disposal to buy water, as confirmed by Lambi and Kometa (2009). Water scarcity has influenced social issues, too, as revealed in the study whereby some men are unable to find wives, the younger generation is refusing to stay with their parents and whole families are leaving their villages. This indicates that water scarcity is also a central determinant of migration, not only economic factors and the search for fertile lands as recorded in other studies (Sakdapolrak et al., 2014; Sakdapolrak et al., 2016; Azong, 2018).

CHAPTER 7: SYNTHESIS, CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This chapter seeks to present important aspects of the research in connection with the existing literature mentioned in Chapters 2 and 3 on the vulnerability of natural resources and livelihoods to climate change in the MCNP region. It summarises salient results on changes in the occurrences and utilisation of forest products, effects on livelihoods and adaptation strategies employed by the local population to enhance their livelihoods and the ecosystem, therefore illustrating the role of this study in relation to the current body of knowledge on climate change and indigenous livelihoods. Furthermore, it provides conclusions drawn from the study by following the research goal and objectives, and it ends with recommendations for further research and policy implications.

7.2 Key Findings and Contributions to Knowledge

The main idea presented in this research is that climate variability and change are affecting forest products and the livelihoods of indigenous communities in the MCNP region. This view is confirmed by the existing literature on the influences of climate change on ecosystems, and the notion that forest-dependent communities are more affected by climate change (Swyngedouw, 2010; Lal et al., 2011; NTNC, 2012; Barua et al., 2013; Niang et al., 2014; Harris et al., 2015; OECD, 2017). This study adds to the existing literature, which points out that local perception is a useful approach for exploring indigenous people's vulnerability to climate change, thereby signifying the important role of indigenous perceptual knowledge in examining climate change influences, as opposed to the notion that climate variability and change can be comprehended using scientific models.

The data have proven that food NTFPs, medicinal plants and wildlife are affected in terms of productivity, quality, area diversity, growth and loss of species. The consequences are felt by local people, who are unable to find sufficient quantities for consumption and commercialisation. Also, changes in seasonality have created uncertainty in forest product occurrence, and thus native people are unable to decipher when these products will be available. Though climate change has affected forest products, some participants feel that the changes in occurrences and availability of NTFPs are caused by a supernatural being, and only God can explain the dynamics and extinction of forest products. Wildlife especially does not face any challenges, since He provides for their needs. This notion is also recorded in other studies (Abugiche, 2008; De Wit, 2011; Ndoh et al., 2016; Azong, 2018).

Furthermore, the study has used a political ecology lens to reveal that changes in the occurrence and availability of NTFPs are not only linked to climate change, but also to other factors such as deforestation, unsustainable harvesting, politics, land tenure, legislation, park creation, tree-felling, volcanic eruptions, habitat destruction and the presence of forest guards. These features, alongside climate change, have rendered vulnerable the local ecosystem and livelihoods. The findings herein concur with political ecologists' arguments that politics is embedded in ecological and climate change processes (Bryant and Bailey, 1997; Little, 2013; Weber and Schmidt, 2016). As indicated in this research, the participants perceive that the park's creation is political tool by the government and utilised to prohibit them from collecting natural resources, thereby refusing them access to and control over nature. Also, local forest management regimes serve state interests and weaken traditional authority. Moreover, state privatisation of some parts of the commons is to the advantage of the rich, who have the financial power. This creates a situation of haves and have nots, and it subsequently widens the gap between the rich and the poor. For instance, women in the study area were unable to collect NTFPs from a particular forest patch which was sold to a rich man. This suggests that people who do have money to acquire land are more vulnerable to the effects of climate change.

This study contributes further to the climate change and livelihood debate by showing that indigenous people's increasing access to forest products will enhance their livelihoods and reduce vulnerability to the impacts of climate change. This view depicts indigenous people's request for environmental justice and equity on the local scale (Martinez-Alier et al., 2014; Martinez-Alier et al., 2016). The perceptions of native people in the Global South, and particularly the MCNP region, are different from those of West, who view the territorialisation of biodiversity as a sustainable livelihood measure for present and future generations. Indigenous people consider the park a means by the government to stop livelihood flow and benefits. This research also indicates how local livelihoods are vulnerable to the impacts of climate change, and it highlights the necessity to reflect on the connectivity between climate change, livelihoods and natural resources in shaping indigenous people's adaptation to climate change effects. With the advent of perceptual research on climate change, the top-down approach to this research is challenged in terms of its significance to forest-dependent communities, hence validating the need to recognise differences in views and experiences, in order not to sideline the most vulnerable (Weber and Schmidt, 2016).

The concept of sustainable livelihoods, which is dominant in livelihood research, has made an important contribution to understanding the vulnerability of local livelihoods and biodiversity to the impacts of climate change. This study indicates that indigenous livelihoods are indeed under threat, since people are unable to find the necessary and required quantities of forest products for consumption and commercialisation. NTFPs regularly used by the population have become very scarce and endangered, and the effect is mostly felt by the poor and elderly, who find it difficult to modify their food habits. The inability to find the required quantities of NTFPs indicates that some households might suffer from starvation. In addition, prohibited access to NTFP collection sites, and conflicts encountered during collection, indicates that indigenous livelihoods are far from being sustained. Women particularly are affected, since they are unable to walk long distances to foraging sites, due to the time and energy required, and single women especially are disadvantaged, since they have no husbands to assist in this regard. Thus, even though women's vulnerability may vary, they are more vulnerable to the impacts of climate change than men. Moreover, most respondents are involved in short-term adaptation activities that provide immediate benefits, thus rendering their livelihoods more vulnerable.

In addition, this study indicates that the indigenous people of the MCNP region are not silent in the midst of climate change challenges. They change farming practices, diversify livelihoods, engage in alternative IGAs, migrate to towns and work individually and in groups to adapt to climate change and ameliorate living conditions. It also shows that native people carry out ex-situ conservation to reduce forest dependence, improve livelihoods and protect the environment. This is evident in the important role of individuals and groups in engaging in adaptation initiatives which are directly and indirectly linked to climate change. The implementation and success of adaptation actions are made possible through the influence of external actors. Moreover, the study has revealed that perceived factors influencing food insecurity in the MCNP region consist of globalisation, markets, unsustainable harvesting of NTFPs, distance to foraging sites and mastery of the forest environment. This study also unravelled ways in which the indigenous people mitigate the effects of food insecurity, namely through remittances and engaging in alternative IGAs and in paid conservation activities.

This research provides significant methodological support through in-depth information provided using local perceptual knowledge and PRA tools in understanding the vulnerability of natural resources and livelihoods to the impacts of climate variability and change. Indigenous perceptions have been employed in assessing local livelihood vulnerabilities, but they are still to be explored in climate change research, to reveal the linkages between indigenous people's livelihoods and natural resources and climate change. Through the use of local perceptions, the importance of forest resources to native livelihoods, local perceptions of climate variability and change, the vulnerability of fauna and flora species to climatic and non-climatic influences and impacts on livelihoods, access changes and conflicts induced by climate change and local adaptation initiatives to climate change were better explored and comprehended. Also, perception is determined by age, gender, education, livelihood activities, peer group, social attachment and level of interaction with the environment. In addition, the PCVCBLA framework (Figure 3.2) developed by the author is appropriate for use in many fields of research, including botany, sociology and anthropology, environmental science, human geography and political ecology (see Table 3.1) in the Global South, and indigenous communities in particular. Moreover, the Perceptions, Climate Variability and Change, Livelihoods, Biodiversity, and Adaptation (PCVCBLA) and Sustainable Livelihood (SL), Climate Variability and Capacity Analysis (CVCA) and Community-based Risk Screening Tool - Adaptation and Livelihoods (CRiSTAL) frameworks and tools used in this research have revealed that the vulnerability of indigenous people is multifaceted and requires multiple perspectives and approaches to achieve sustainable outcomes.

7.3 Conclusion

This study has tapped into indigenous perceptions to reveal that the MCNP region is endowed with varied fauna and flora species important to local livelihoods. Forest resources contribute to the socio-cultural and economic development of the local population as well as to the national economy. The commodification and capitalisation of natural assets have enhanced local livelihoods in the domains of health, business and community development. Despite the important role of forest products to indigenous livelihoods and the economy, their impact is diminishing, due to exposure to climatic and non-climatic threats, and somewhat worryingly, most consumptive and economically valuable NTFPs have become scarce.

Many scholars have documented climate change and outlined devastating consequences for humans and the environment. It is only recently that climate variability and change have become a major concern at international and national levels, with some sceptics still questioning its authenticity. Little attention has been placed on climate change on the local scale, or the effects on people living in these environments. This study reveals that those at the grassroots level, dependent on forest products, perceive that the climate and the natural environment are no longer the same as they used to be. They understand and see a link between climate change and natural resources and their livelihoods. A stable climate to the indigenous people occasions abundance, the constant and timely availability of forest products for consumption and commercialisation and water availability. They perceive that increasing temperatures, longer dry periods and reduced rainfall are affecting their survival and NTFPs. Also, climate change is threatening their culture, survival, landscape and rural innovation, by affecting productivity, growth, area diversity, habitat and the very land available to plants and animal species. Moreover, climate change has led to the scarcity and inadequacy of NTFPs for consumption and sales, confusion in crop-planting seasons, water scarcity, the drying up of streams, starvation, poverty, conflicts and reduced access to natural resources. In addition, extreme events are frequently waging wanton destruction on properties, food crops, human lives and the local ecology. These indigenous representations depict that climate variability and change are influencing the ecologies of parks, mountains and forests and thus indigenous livelihoods. The study proves that climate change is creating uncertainties, widening gender inequality and the gap between the rich and the poor and diminishing survival opportunities and choices for forest-dependent communities.

Largely affected by climate variability and change are ecological regions and natural resources away from conservation zones and thus exposed to multiple threats. Less attention is paid to areas beyond protected zones but on which the local population is dependent daily for livelihoods. Paradoxically, conservation measures and regulations put in place are ameliorating indigenous livelihoods and biodiversity and also reducing people's access and rights to the commons and use of forest products, thereby indirectly affecting the very livelihoods they seek to improve. Human survival is therefore faced with a double challenge. First, climate variability and change threaten the existence of forest goods and services, and second, the government (1994 Forestry Law) and NGOs are tightening their control over the commons. In either scenario, indigenous communities are disadvantaged, since they rely daily on forest products for survival and have very few alternatives to fall back on. The outcome is illegal activities, increasing conflicts and tensions between stakeholders and inefficiency in regulations.

To reduce vulnerability to food insecurity and a changing environment, individuals, groups and communities carry out several adaptation strategies and initiatives. Government institutions and NGOs at the grassroots level play an important role, as they promote alternative income-generating activities, build local capacity, raise awareness, introduce new agricultural techniques and food varieties and encourage biodiversity conservation. However, most of the adaptation actions are short term, due to the immediate need for food and income and the inconsistencies, uncertainties and strict regulations surrounding profitable long-term livelihood activities. Few livelihood strategies are directly aimed at addressing climate change, even though it is a major – and growing – challenge in the region. This questions the notion of sustainable livelihoods and hampers efforts made to achieve development agendas and conservation objectives.

The scientific community is quick to note and document the effects of climate change on economically valuable fauna and flora species, but it fails to see its effect on the many forest products important to the daily livelihoods of the indigenous population. Climate change is reshaping local space and identity, and increasing costs of living. Climate change is brutally real and presents a challenge to the native people represented in this study. Some people may overlook the effects of climate change in exchange for political gain, but the local population sees it as something that brings pain and hardship. The effects of climate change are present and visible, and we should not overlook it, because nobody is exempted from its consequences. Climate change should be treated with passion, and its effects on the poor with empathy. The indigenous people’s stories and narratives in this research are inspiring, because they give us an insight into how they see, live and cope with and adapt to climate variability and change. Climate change has kept them away from vital forest resources and manifested itself in food shortages, financial hardship, extinction and scarcity of forest resources, poor crop yields, water crises and health challenges. Native people’s perceptions of future temperature increases and rainfall decreases provide a gloomy image of climate change with no expiration date. Thus, its effects will continue to be felt within the natural environment and on local livelihoods. Some people might think that environmental measures at the international and national levels are achieving good results and that climate change is not an immediate threat. Mama Gentile’s narrative (see Chapter 1: introduction) and the research findings, however, indicate that indigenous people are in a situation of uncertainty concerning livelihood flows, as they want a regular flow of forest products and not be pinned down under the fiery flames of climate change.

7.4 Recommendations: Policy Implications and Perspectives for Further Research

During the study, it was difficult to find data on temperature and precipitation. Most weather stations are not operational, and existing ones have inconsistent data and/or data mainly focusing on rainfall. The reason is that rainfall data are used by agro-industrial plantations present in the area and by the transport sector, specifically aviation. This highlights the scant attention given to climate change and ignorance of its multidimensional effects on humans and the environment. This study recommends that both temperature and rainfall data vital to comprehending environmental changes and human livelihoods be given equal importance. Human development is multifaceted, complex and requires climate information vital to inform research and policies.

Furthermore, the MCNP area is divided into six clusters. This research was carried out in the Buea 1 and 2 clusters, but they do not have the same socio-economic and geographical characteristics. Thus, the findings cannot be generalised to other clusters. Also, the MCNP region faces several challenges such as eruptions, bush fires, increasing population, floods, water crises and food insecurity. These encounters are climatic and non-climatic, and their effects on humans and biodiversity are obvious. Climate change effects on natural resources may vary, and people's livelihoods will therefore be affected differently. A multidisciplinary research and analysis on the impacts of climate change on natural resources and livelihoods in the entire region should be carried out, and the findings will shape conservation strategies, policies and regulations, and reduce the vulnerability of forests and people to climate change. They will also be useful in the design of management plans, conservation zones and the realisation of sustainable development goals.

Access to natural resources is a facet of food insecurity in the study area, due to incoherence in terms of regulations, polices and climate knock-on influences. The indigenous people of the villages perceive that natural resources are abundant in the protected area, and yet they still suffer from starvation. This deprivation is unjust, since stakeholders mobilise efforts and resources to protect the environment and enhance livelihoods. These stakeholders should review laws and conservation practices affecting the access and user rights of forest communities. Given that the MCNP is divided into conservation zones and villages, the issue of user rights should be discussed at the cluster level, be clearly defined and ensure that measures are stipulated in the park management plan. Some valuable consumptive NTFPs should be made accessible to the locals, albeit with the sort of organised collection and control procedures currently afforded to *Prunus africana* in the region. This will reduce power struggles and the vulnerability of the indigenous population and give them a sense of place and belonging.

Furthermore, most research in the MC area, as in other forest regions of Cameroon, focuses on the abundance and use of natural resources. Generalised notions of natural resource occurrences are provided. Furthermore, many research studies on climate change are grounded in generalisations; for example, "climate change is a threat to biodiversity". This statement does not depict the real picture. This research has shown that forest resources (food, wildlife, medicinal plants) are affected differently, and it provides vital details on the natural resources affected and the nature of these impacts. Such details provide a clear indication of the scale of threat to the forest environment. The sustainable conservation and management of fauna and flora will remain an illusion without comprehensive knowledge on changes in occurrences and utilisation. Thus, climate change should be part of all research relating to natural resources. This implies that stakeholders and researchers have to be climate-sensitive and conscious, in order to mainstream climate change in all actions.

When forest conservation incentives improve the livelihoods of people and communities, there is the likelihood that they will see the need to participate in conservation programmes. The social and financial gains from conservation bonuses were hailed in all of the study communities. However, the benefits have not been regular and durable, thus affecting people's motivation to participate in such schemes. The conservation bonus and credit project (not yet operational) should be regular and could be translated, for instance, to a "climate incentive bonus" to enable people to see the link between conservation actions and climate change.

The study unveils that indigenous people are first-hand knowledge holders of their environment. They have a mastery of the forest and know where natural resources are found, as well as changes over time and challenges encountered. The integration of traditional knowledge and perceptions in conservation programmes and planning is therefore important in the effective management of the forest and its biodiversity.

In the MC region, conservation activities are concentrated within the confines of the park, and areas outside the park boundaries are not considered for conservation. The study has revealed that conservation actions are producing positive outcomes, as seen in the increase in natural resources in the park and a decrease in areas beyond its borders. The fact that people are unable to find NTFPs in peripheral forest regions might push them to indulge in illegal collection and will compromise conservation efforts. Thus, park management should consider carrying out conservation activities and reinforcing income-generating actions in the communities, to ensure sustainability of livelihoods and forest products in all ecological zones.

Many researchers have highlighted the local and global importance of *Prunus africana*, but they have also documented its vulnerability; however, they fail to see the link between its vulnerability and climate change, as highlighted herein. Considering the threats faced by *Prunus africana*, park management should revisit the harvesting period. Preferably, the debarking period should be shifted from the dry to the rainy season, to reduce the number of dead trees and the borer effect. Thus, harvesting could start weeks before the rains begin, and this would enable the tree to store enough water needed for regeneration. Specific research is required on the identification and management of pests and diseases, such as the causes of borer and its economic cost to local and national economies.

The local population is aware that the environment is no longer the same as it was in years past. They see these changes and adapt to ameliorate their living conditions. NGOs and integrated conservation and development projects focus on income generation activities as a way out of poverty and to reduce forest pressure. Interestingly, the presence of NGOs and local groups in communities is an important social and capital asset vital to promoting livelihoods and environmental protection. However, many indigenous people in the study area do not see a clear relationship between conservation actions and climate change, or between livelihood activities and climate change. This might consequently affect the outcomes and attainment of conservation and development objectives, so environmental education programmes, conservation actions and livelihood activities should be climate-focused and specific.

Government institutions at the local level and involved in biodiversity conservation issues should work in close collaboration with indigenous groups, individuals and institutions on natural resource management issues. Traditional conservation techniques should be studied and integrated into contemporary ecological management approaches, in order to attain durable resource use, whilst people with specific knowledge, for instance traditional doctors, should be involved in research on medicinal plants.

The collaborative management approach is important in mainstreaming an indigenous population in biodiversity conservation and the achievement of conservation goals. The VFMC is aimed at empowering local communities in forest management, but unfortunately, the local population perceives it as “government interest-driven.” This institution ought to be people-friendly in order to bring conservation nearer to the people, and as such its role should be clearly defined and not conflictual with those of the traditional councils. More education and sensitisation should be afforded to the communities and members of such institutions, and the Cameroon 1994 Forestry Law should be summarised and taught to local community members. Since decisions concerning the lives of forest communities are made outside the local sphere, their fears, worries and expectations should be considered in the design and activities of community-based natural resource management institutions.

Government services and ministries cannot be everywhere and may not be able to take note of important changes happening within local communities. Indigenous people are live witnesses to environmental changes, since they live and interact with the natural environment. Understanding molecular changes could entail empowering and building the capabilities of community-based institutions to record events and happenings in their environment, especially those directly relating to their livelihoods. For example, the acidic rains which affected crops, water and natural resources in April 2018 in all communities was not officially recorded, but the population saw the impacts it created. Such information could be useful to development organisations and government institutions, and so government officials at the local level, or village resource persons, should be empowered to collect information on events relating to climate change.

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APPENDICES

Appendix 1: Research authorization from the MINFOF

REPUBLIQUE DU CAMEROUN
Paix - Travail - Patrie

MINISTERE DES FORETS
ET DE LA FAUNE

SECRETARIAT D'ETAT

SECRETARIAT GENERAL

DIRECTION DE LA FAUNE
ET DES AIRES PROTEGEES

BP 34430 Yaoundé
Tél: 222 23 92 28

REPUBLIC OF CAMEROON
Peace - Work - Fatherland

MINISTRY OF FORESTRY
AND WILDLIFE

SECRETARY OF STATE

SECRETARIAT GENERAL

DEPARTMENT OF WILDLIFE
AND PROTECTED AREAS

Yaoundé, le 07 JUIN 2018

N° 2557 /L/MINFOF/SETAT/SG/DFAP/SDCF/SBP/ESH

REF: Y/L OF 30 APRIL 2018

THE MINISTER

To

Ms. Viviane NTOKO
University of Augsburg
Alter Postweg 118
86159 Augsburg
Tel : +49(0)821598-2292
Email : ntoko_njole@yahoo.com

REGIONAL DELEGATION OF
FORESTRY AND WILDLIFE
SOUTH WEST - BUEA
RECEIVED
DATE 28 JUIN 2018

Buea 29.06.2018

<u>Objet</u>: *Application for Research Permit.*

Madam,

Following your letter dated April 30th, 2018, relating to the above subject matter,

I have the honor to inform you of my approval to enable you conduct your research during the period from April 27th to August 27th, 2018.

This letter will serve as a letter of introduction to the Conservator of the Mount Cameroon National Park, who will supervise your research.

Kindly accept, Madam, the expression of my sincere regards. /-

<u>Copie</u> :
- DRFOF/Sud-Ouest
- Conservator/Mount Cameroon NP

Jules Doret NDONGO

Appendix 2: Letter of introduction to the Chiefs

REPUBLIC OF CAMEROON
Peace-Work-Fatherland

MINISTRY OF FORESTRY
AND WILDLIFE

REGIONAL DELEGATION
FOR THE SOUTH WEST

Mt Cameroon National Park

TEL: (+237)243654434

REPUBLIQUE DU CAMEROUN
Paix-Travail-Patrie

MINISTERE DES FORETS
ET DE LA FAUNE

DELEGATION REGIONALE
DU SUD-OUEST

Parc National du Mont Cameroun

Buea, the 28 MAY 2018

No 99 /L/MINFOF/RDFOF-SW/MCNP/CMU/ 135

The Conservator

Le Conservateur

TO

The Chief of

Subject: **LETTER OF INTRODUCTION**

Dear Chief

This is to attest that Mme **NTOKO VIVIAN NJOLE** a PhD student from the University of Augsburg-Germany, is currently carrying out a study on **'CLIMATE CHANGE IN MCNP: LOCAL PERCEPTIONS, NATURAL RESOURCES AND ADAPTATION'**. She will be conducting interviews and administer questionnaires with selected members and focus groups in your community. This activity will take place from 27th April to 27th August 2018.

We shall be grateful for your support as well as that of other selected members of your communities for the success of this study.

While we anticipate your support, accept my sincere thanks.

The Conservator

Besong Simon B.
Ingénieur des Eaux et Forêts
Msc, Forest Res Management

CC:

-File

-Concerned

Appendix 3: Letter of introduction to VFMC Presidents

REPUBLIC OF CAMEROON
Peace-Work-Fatherland

MINISTRY OF FORESTRY
AND WILDLIFE

REGIONAL DELEGATION
FOR THE SOUTH WEST

Mt Cameroon National Park

TEL: (+237)243654434

REPUBLIQUE DU CAMEROUN
Paix-Travail-Patrie

MINISTERE DES FORETS
ET DE LA FAUNE

DELEGATION REGIONALE
DU SUD-OUEST

Parc National du Mont Cameroun

Buea, the 2 8 MAY 2018

No 29/L/MINFOF/RDFOF-SW/MCNP/CMU/ 135

The Conservator

Le Conservateur

TO

The VFMC of

Subject: **LETTER OF INTRODUCTION**

Dear Sir/Madam

This is to attest that **Mme NTOKO VIVIAN NJOLE** a PhD student from the University of Augsburg Germany, is currently carrying out a study on '**CLIMATE CHANGE IN MCNP: LOCAL PERCEPTIONS, NATURAL RESOURCES AND ADAPTATION**'. She will be conducting interviews and administer questionnaires with selected members and focus groups in your community. This activity will take place from 27th April to 27th August 2018.
We shall be grateful for your support as well as that of other selected members of your communities for the success of this study.

While we anticipate your support, accept my sincere thanks.

The Conservator

Besong Simon B.
Ingénieur des Eaux et Forêts
Msc, Forest Res Management

CC:

-File

-Concerned

Appendix 4: Sample of attendance during village meetings

ATTENDANCE SHEET DURING DATA COLLECTION IN THE VILLAGES

Date	5/6/18
Name of village	[illegible] Bokwaongo
Name and type of group	Womens group

Details of participants

No.	Names	Village	Contact	Signature
1	Hannah Ngale	Bokwaongo		
2	Hannah Wotani	"		
3	Olivia manga	"		
4	Lydia Njuma	"		
5	Lydia Lyonga	"		
6	[illegible] Debuk	"		
7	Malouba Mustar	"		
8	Rose Vefonge	"		
9	Regina Itali	"		
10	Cecilia Kotti	"		
11	Matina Nyoki	"		
12	Emma Lifonga	"		
13	Clara Ngumbeh	"		
14	Christy Jimbolor	"		
15	Christy Teke	"		
16	Mojoko Nyie	"		
17	Sophie Nyie	"		
18	Martha Nyoki	"		
19	Lilia Ngale	"		
20	Ester Mafany	"		

Appendix 5: Attendance presentation of research to MCNP staff and collaborators

AND WILDLIFE		ET DE LA FAUNE
REGIONAL DELEGATION		DÉLÉGATION REGIONALE
FOR THE SOUTH WEST		DU SUD-OUEST
Mt Cameroon National Park		Parc National du Mont Cameroun
Tel: 243.65.44.34	Attendance List	Date 14/05/2018

MCNP PRESENTATION BY RESEARCH STUDENT ON CLIMATE CHANGE

No	Name	INSTITUTION	FUNCTION	Telephone/email	Signature
1.	Besong Simon	MINFOF	Conservator	675332871	
2.	Valentine B. EBUA	GIZ	Head of Antenna	675.375.276	
3.	Yves Nathan Mpkembom	MINFOF	RCSPT-SW	675528281	
4.	Tchinda Leguy	PSMNR build	NFE	699579820	
5.	Dfundem Tatow	MCNP	CDO	677138581	
6.	Akemfua A.N. Alice	MCNP	EDU	675171706	
7.	Ntoko Vivian	Pugstund Researcher	Research Student	651749957	
8.	Dr. Ettagbor Hans	MINFOF/MCNP	Support staff	685568588	
9.	Efuetlancha T. Alem	GIZ/PSMNR	TA TNP	675433207	
10.	Iyassa Mosua	GIZ	TA	677575668	

Appendix 6: Questionnaire design

QUESTIONNAIRE FOR HOUSEHOLD INTERVIEWS

GENERAL INFORMATION

INTERVIEW DATA

Section to be filled by the researcher

Interview date		
Name of village/cluster		
Participant code		Interviewers' initials and 3-digit serial No. (e.g. NV001)

SECTION A: BIODATA

Name and Surname (Optional)	
Gender	Male ☐ (1) Female ☐ (2)
Age	(1) 20-35yrs ☐ (2) 36-45 ☐ (3) 46-60 ☐ (4) 61-above ☐
Marital status	(1) Married ☐ (2) Single ☐ 3) Divorced ☐ 4) Widow ☐
Education	(1)No formal education ☐ (2) Primary ☐ (3) Secondary ☐ (4) High school ☐ (5) Higher education ☐

SECTION B: NATURAL RESOURCE UTILISATION AND AVAILABILITY

1. **How important would you rate the forest to your livelihoods?**
High ☐ Medium ☐ Low ☐ No ☐

2. **Why do you go to the forest? (Can tick more than one response)**

1	Food	☐
2	Bush meat	☐
3	Construction materials	☐
4	Cultural practices	☐
5	Tourism	☐
6	Medicinal plants	☐
7	Firewood collection (Fuel)	☐
8	Wrapping material	☐
9	Household equipment & farming tools	☐
10	Water resources	☐
11	Timber	☐
12	Others	☐

3. **NTFPs DESCRIPTION: (Parts**: bark, leaves, stem, roots, branches, seed, ripe fruits, tender shoot, and resin. **Purpose**: Vegetables, pickles, medicine, edible/food, spice, gum, cash income, culture, religion, social networks, pollination, and environmental conservation)

3.1. Which NTFPs do you collect from the forests, where, which parts do you use and for what purposes?

Scientific name (s)	Local name (s)	Where collected				Parts used	Purpose/Use
		Protected area	Secondary forest	Fallow land	Farm land		

3.2. Which changes in NTFPs availability have you experienced?

3.3. What are the reasons for changes in NTFPs availability?

3.4. According to you which changes in NTFPs availability are as a result of climate change?

3.5. Which changes in NTFPs utilisation have you experienced?

3.6. What are the reasons for changes in NTFPs utilisation?

3.7. According to you which changes in NTFPs utilisation are as a result of climate change?

3.8. Are there years that some NTFPs were not available at all or available but in a reduced quantity?
A) Yes ☐ B) No ☐ yes which year (s) and why?

3.9. Have some NTFPs species disappeared for the past 20 years?

A) Yes B) No If yes which year and why?

4. WILDLIFE

4.1. Which wild animals do you collect from the forests, which parts do you use and for what purposes?

Scientific name (s)	Local name (s)	Where collected				Parts used	Purpose/Use
		Protected area	Secondary forest	Fallow land	Farm land		

4.2. Which changes in wildlife availability have you experienced?

4.3. What are the reasons for changes in wildlife availability?

4.4. Which changes in wildlife availability are as a result of climate change?

4.5. Which changes in wildlife utilisation have you experienced?

4.6. What are the reasons for changes in wildlife utilisation?

4.7. According to you which changes in wildlife utilisation are as a result of climate change?

4.8. Are there years that some wildlife species were not available at all or available but in a reduced quantity?
A) Yes ☐ B) No ☐ If yes which year (s) and why?

4.9. Have some wildlife species disappeared for the past 20 years?

A) Yes ☐ B) No ☐ If yes which year and why?

5. MEDICINAL PLANTS

5.1. Which medicinal plants do you collect from the forests, which parts do you use and for what purposes?

Scientific name (s)	Local name (s)	Where collected				Parts used	Purpose/Use
		Protected area	Secondary forest	Fallow land	Farm land		

5.2. Which changes in medicinal plants availability have you experienced?

5.3. What are the reasons for changes in availability of medicinal plants?

5.4. According to you which changes in medicinal plants availability are as a result of climate change?

5.5. Which changes in medicinal plants utilisation have you experienced?

5.6. What are the reasons for changes in utilisation of medicinal plants?

5.7. According to you which changes in utilisation are as a result of climate change?

5.8. Are there years that some medicinal plants were not available at all or available but in a reduced quantity?
A) Yes ☐ B) No ☐ If yes which year (s) and why?

5.9. Have some medicinal plant species disappeared for the past 20 years?

A) Yes ☐ B) No ☐ If yes which year and why?

SECTION C: CLIMATE VARIABILITY AND CHANGE, AND PERCEPTION

6. PERCEPTION OF VARIATIONS IN SEASONS

6.1. What is your knowledge (perception) of rainfall (precipitation) trend over the past 20 years?

1) Decreasing ☐ 2) Increasing ☐ 3) Altered ☐ 4) No change ☐ 5) Don’t know ☐

6.2. What is your knowledge (perception) of temperature trend over the past 20 years?

1) Hotter ☐ 2) Cooler ☐ 3) No change ☐ 4) Altered ☐ 5) Don't know ☐

7. How do you explain climate change? (Give your answer for each option)

1	Long dry season	Yes ☐	No ☐
2	Short rainy season/reduced rainfall	Yes ☐	No ☐
3	Hot temperatures/High temperatures	Yes ☐	No ☐
4	Intensity of rainfall events/strong winds	Yes ☐	No ☐
5	Length of dry period in rainy season	Yes ☐	No ☐
6	Floods in fields and villages	Yes ☐	No ☐
7	Dry valleys	Yes ☐	No ☐
8	Don't know	Yes ☐	No ☐
9	Others, please mention:		

8. What are the perceived reasons of climate change? (Give your answer for each option)

1	Modernisation/civilisation	Yes ☐	No ☐
2	Population increase	Yes ☐	No ☐
3	Politics	Yes ☐	No ☐
4	Man's sins	Yes ☐	No ☐
5	God's work	Yes ☐	No ☐
6	Deforestation	Yes ☐	No ☐
7	Rich countries (Europeans)	Yes ☐	No ☐
8	Economy	Yes ☐	No ☐
9	Don't know	Yes ☐	No ☐
10.	Others, please mention:		

9. What are local parameters of climate change? (Give your answer for each option)

1	Bird behaviours	Yes ☐	No ☐
2	Migration of birds and bees	Yes ☐	No ☐
3	Spread of obnoxious/invasive weeds	Yes ☐	No ☐
4	Water level in streams and rivers	Yes ☐	No ☐
5	Fruiting and flowering of trees	Yes ☐	No ☐
6	Incidence of insects	Yes ☐	No ☐
7	Temperatures	Yes ☐	No ☐
8	Sea level	Yes ☐	No ☐
9	Dry valleys	Yes ☐	No ☐
	Others, please mention:		

10. How do you know that the climate has changed (indicators)? (Give your answer for each option)

1	Drying of water courses and swamps	Yes ☐	No ☐
2	Strong winds	Yes ☐	No ☐
3	Changes in seasons	Yes ☐	No ☐
4	Scarcity in certain animal species	Yes ☐	No ☐
5	Low rainfall	Yes ☐	No ☐
6	Scarcity in some plant/NTFPs species	Yes ☐	No ☐
7	Changes in vegetation cover	Yes ☐	No ☐
8	Increase in temperature	Yes ☐	No ☐
9	Decrease in river level	Yes ☐	No ☐
10	Increase in sea level	Yes ☐	No ☐
11	Don't know	Yes ☐	No ☐

11. What are the present observed factors of climate exposure in your environment? (Choose one response)

1) Changes in precipitation trends ☐ 2) Floods ☐ 3) Strong winds/storms ☐ 4) Changes in temperatures ☐

12. What are the expected (future) perceived factors of climate exposure in your environment?

1) Changes in precipitation trends ☐ 2) Floods ☐ 3) Strong winds/storms ☐ 4) Changes in temperatures ☐

13. **Which extreme climatic events have you experienced over the past 20 years (1987-2017) and what are the effects?**

Year (s)	Event	Consequence (s) on livelihoods/natural resources

SECTION D: CLIMATE CHANGE & VARIABILITY IMPACT ON NATURAL RESOURCES

14. How do you rate the effect of climate change on NTFPs? (Choose one response only)

1	Strongly positive impact	☐	**Please explain why ?**
2	Medium positive impact	☐	
3	Small positive impact	☐	
4	No impact	☐	
5	Strongly negative impact	☐	
6	Medium negative impact	☐	
7	Small negative impact	☐	
8	Don't know	☐	

15. How does climate change impact NTFPs? (Tick more than one option if necessary)

1	Low productivity to sustain humans/animal needs	☐
2	Changes in quality	☐
3	Changes in growth	☐
4	Loss of species	☐
5	Changes in area diversity/reduced area	☐
6	Shifts in seasonality	☐
7	No impact	☐
8	Don't know	☐

16. How do you rate the effect of climate change on wildlife? (Choose one response only)

1	Strongly positive impact	☐	**Please explain why ?**
2	Medium positive impact	☐	
3	Small positive impact	☐	
4	No impact	☐	
5	Strongly negative impact	☐	
6	Medium negative impact	☐	
7	Small negative impact	☐	
8	Don't know	☐	

17. How does climate change impact wildlife? (You can choose more than one response if necessary)

1	Changes in abundance	☐
2	Changes in timing	☐
3	Loss of species	☐
4	Changes in area diversity	☐
5	Changes in availability	☐

6	No impact	☐
7	Don't know	☐

18. How do you rate the effect of climate change on medicinal plants (Choose one response only)

			Please explain why ?
1	Strongly positive impact	☐	
2	Medium positive impact	☐	
3	Small positive impact	☐	
4	No impact	☐	
5	Strongly negative impact	☐	
6	Medium negative impact	☐	
7	Small negative impact	☐	
8	Don't know	3	

19. How does climate change impact medicinal plants (You can choose more than one response if necessary)

1	Low productivity	☐
2	Changes in quality	☐
3	Changes in growth	☐
4	Loss of species	☐
5	Changes in area diversity	☐
6	Changes in availability /timing	☐
7	No impact	☐
8	Don't know	☐

SECTION E: POWER RELATIONS CONCERNING NATURAL RESOURCES

20. NTFPS ACCESS

20.1. Have your access to certain NTFPs changed due to climate change? Please choose only one access option for each resource

Local name/Specie (s)	No change	Restricted access	No access	Who made the rules	Do you abide to rules		Reasons (Yes or No)
					Yes	No	
Have you experienced any problems due to non-respect of rules (e.g. restricted and no access):							

20.2. What are the effects of changes in access to your livelihoods?

21. Wildlife access

21.1. Have your access to certain wildlife species (Animals) changed due to climate change effects?

Local name/Specie (s)	No change	Restricted access	No access	Who made the rules	Do you abide to rules		Reasons (Yes or no)
					Yes	No	
Have you experienced any problems due to non-respect of rules (e.g. restricted and no access)							

21.2. What are the effects of changes in access to your livelihoods?

22. Medicinal plants access

22.1. Have your access to certain medicinal plants changed due to climate change effects?

Local name/Specie (s)	No change	Restricted access	No access	Who made the rules	Do you abide to rules		Reasons (Yes or no)
					Yes	No	
Have you experienced any problems due to non-respect of rules (e.g. restricted and no access):							

22.2. What are the effects of changes in access to your livelihoods?

SECTION F: ADAPTATION MEASURES/PRACTICES TO CLIMATE CHANGE TAKEN TO MAINTAIN NATURAL RESOURCES

23. Which natural resources/conservation measure (s) do you implement and why?

	Reason (s) for adoption (can choose more than one reason)					
Strategy/activity	Increase household income	Increase food availability	Reduce forest dependence	Fight against climate change	No idea	Explanations

Closing remarks: Thank you very much

Appendix 7: Planning for village meetings

Village	Name of Group	Interview Period	Meeting Venue	Dates
Mapanja	Traditional Council	Evening	Chief's palace	15/06/2018
	Mount Cameroon Prunus Association	Morning	Member's off licence	16/06/2018
	Village Forest Management Committee	Evening	Researchers residence	13/06/2018
	Hands on the ground women's group	Morning	Members home	13/06/2018
Likombe	Traditional council	Afternoon	Chief's palace	22/06/2018
	Village Forest Management Committee	Afternoon	Presidents home	22/06/2018
	Hunters	Evening	Villagers home	22/06/2018
Bova	Traditional Councils (2)	Afternoon	Chief's palaces	24/06/2018 & 16/06/2018
	Hunters	Morning		11/06/2018
	VFMC	Evening	President's home	26/06/2018
	Ecotourism	Morning	Villagers home	16/06/2018
	Solidarity women	Evening	President's home	18/06/2018
	WEWULEY- Community Based Forest & Environment Management	Afternoon	Meeting venue	11/07/2018
Bokwaongo	Traditional Council	Afternoon	Chief's palace	06/06/2018
	Mount Cameroon Prunus Association	Evening	Chief's palace	7/06/2018
	Ecotourism	Afternoon	Chief's palace	31/05/2018
	VFMC	Afternoon	Chief's palace	11/06/2018
	Hunters	Evening	Chief's palace	11/06/2018
	IFOSE women's group	Evening	President's home	7/6/2018
	Emmaculate ladies	Evening	President's home	5/06/2018
Buea	Collaborative Management co-ordinator	Afternoon	MCNP meeting room	27/07/2018
	Ecotourism co-ordinator	Morning	MCNP meeting room	27/07/2018
	Protection and Surveillance co-ordinator	Afternoon	MCNP meeting room	25/07/2018
	Sustainable Financing co-ordinator	Morning	MCNP meeting room	25/07/2018
	Regional Delegate MINEPDED	Morning	Delegates office	1/08/2018

Appendix 8: Sample interview guide

INTERVIEW GUIDE: FOCUS GROUP DISCUSSIONS

Section A: Personal information

Date	
Name of group	
Type of group	
Number of participant (s)	

Section B: Building trust and setting the scene for discussion

1. Introduction of the research (topic, objectives and importance) and acknowledging participants time.
2. Could you please share your work on ecotourism in the Mount Cameroon region?
3. When did ecotourism start on Mount Cameroon and what are its activities?

Section C: Natural resource utilisation

1. In which areas of the park do you carry out ecotourism activities and why?
2. Ecotourism in the park is dependent on which natural resources?
3. How do you use the natural resources for ecotourism?
4. Have you realized any changes in availability of these natural resources and how (e.g. shifts in range and abundance, extinction, timing)?
5. In your opinion why the changes?
6. Which changes do you attribute to climate change and why?
7. What are the effects of climate related changes on the ecotourism industry and your livelihoods?

Climate variability and change

1. Which months are suitable for ecotourism activities and why?
2. How has unstable seasons affected ecotourism activities?

Section D: Natural resource management

1. Which laws and practices do you use to maintain natural resources for ecotourism?
2. How do you sanction non respect of laws and practices?
3. How do you manage the Mount Cameroon landscape for ecotourism?
4. Which socio-economic data and observations have influenced ecotourism activities and how?
5. Which climate related socio-economic data and observations have influenced ecotourism activities and how?
6. How do you manage the diverse Mount Cameroon landscape to cope with climate variability and change?
7. How has the impacts of climate variability and change affected ecotourism management?

Section E: Adaptation practices and measures to protect natural resources

1. Which adaptation practices/measures do you implement for ecotourism?
2. Which measures/practices are short and long term?
3. Which practices/measures are climate related and how?
4. Which climate related measures/practices are for different seasons?
5. How do adaptation strategies/practices enhance livelihoods and natural resources?

Closing remarks: Thank you very much

Appendix 9: Sample of transcribed interview

Section A: General Information

Date: 16/06/2018
Name of village: Mapanja
Name of group: Mount Cameroon Prunus Management Group
Number of participants: 05
Type of group: Association

Section B: MOCAP

Why MOCAP?
Mbanda: In the past Plantecam was controlled by the French. It was located in Mutengene and brought people from Bafoussam and other areas to harvest prunus. The villages in reaction harvested prunus at night illegally by felling down entire prunus trees. To ensure sustainable harvesting the Mount Cameroon project created two unions Mapanja and Bokwaongo for prunus harvesting. There was conflict between Plantecam workers and the Mapanja/Bokwaongo unions on prunus harvesting areas. Mapanja and Bokwaongo were licensed under Plantecam. Because of conflict between Plantecam and the two unions Mount Cameroon Project created the umbrella MOCAP.

MOCAP started with Mapanja and Bokwaongo who lateron sensitized others. MOCAP know has 14 villages registered with it and benefits are shared to these fourteen villages

Section C: Natural resources utilisation/availability

Q: Which sections of the forest do you collect *prunus*?
Mbanda: Before the Mt Cameroon National Park, we harvested prunus from the entire forest (communal land, farmland, national park). Presently exploitation is divided into three harvesting zones: a) farm land: individually planted and natural b) Community forest Etinde made up of nine villages, with benefits shared between them c) national park: 41 villages

Q: Which changes in availability have you observed and why?
Mbanda: Prunus has decreased due to illegal exploitation, unsustainable harvesting in the past due to tree felling.
Mambo: Now there is no unsustainable harvesting because we have supervisors who control harvesting.
Mbanda: Sticks are tagged and the supervisor verifies/registers which tagged tree/stick is harvested, and who has harvested which stick. He ensures that harvesters have left the forest to ensure nobody stays behind to do illegal harvesting
Jonas: Before the decision of having a supervisor harvesting was not controlled, but now harvesting is controlled.

Q: Which changes in availability are as a result of climate variability and change and why?
Jonas: During the long dry season even if the stick is harvested sustainably and with the lack of rainfall the stick dies. We have observed few prunus dead and prunus in the forest dies faster than that in the farmland.
Paul: A disease called borer affects prunus from the roots and the tree starts producing dust. Borer affects all trees especially those in the forest because the forest has more prunus. Generally after discussion they group concluded that prunus in the farms is more affected than that in the forest

Q: What are the effects of changes in availability on our livelihoods?
Paul: No market for prunus , thus the young men in the villages cannot buy motor bikes, build houses, marry and educate their children

Q: Which changes in *prunus* utilisation have you observed and why?
Paul: In the past prunus was used for medicines, fuelwood. Now prunus in addition is sold. There is increase in the sale of prunus unlike in the past.

Q: Which changes in utilisation are as a result of climate variability and change and why?
Paul: The quantity for sale has reduced. Prunus harvesting is dependent on availability of buyers.
Dry season is the best harvesting time for prunus. During rainy season the sticks are slippery. During dry season the harvested stick takes long to recover, with the impact been reduced productivity, difficult recovery, death risk.

Q: How have these changes affected different groups of people in your community?
Paul: Generally in the village when prunus buyers were available business flourished in the village. Life had a balance scale for the business people and harvesters.

Young boys since they are no buyers suffer from poverty and even business people in the villages are poor because they do not have money to buy.

Section D: Natural resources management (Institutions, practices, laws)

Q: Who is responsible for controlling the collection of *prunus*?
Mokie: Before the MCNP there was no harvesting control. We did not even know the commercial benefits of prunus, thus it was used for traditional medicines and fuel wood.
Now prunus is controlled by MOCAP under the authority of MINFOF. MOCAP controls harvesting and selling
Jonas: The government through MINFOF controls MOCAP

Q: How was *prunus* controlled and collected?
William: MINFOF staff is sent to the field to see if harvesting is done sustainably. Before harvesting there is a joint inventory between MINFOF and MOCAP. The mountain is divided into blocks, after inventory there is an estimated quota from each block. Thus government controls sustainable harvesting
In the forest harvesters loo for a small stick to be used as ladder tied around the prunus to be harvested. We tie many small sticks to form a ladder for climbing. The prunus is divided into four parts, with two parts harvested and two parts left.
Prunus which belongs to individuals and who are unable to harvest pay harvesters about 18000 fr (30 kg x 600 frs), the harvester is paid 8000 frs and the owner gets 10 000 frs. This all depends on a negotiation between the harvester and owner
Jonas: The owners of individual farms gain because the benefit are all received by him. For prunus from the community forest and national park out of 600 frs per kilo, 200 frs goes to the harvester and 400 frs to MINFOF. Out of the 400 frs 6% enters MOCAP coffers. The % to MOCAP is not standard. It depends on the market price.

Q: Who is responsible for solving conflicts and sanctions in case of misbehaviour?
William: MOCAP and MINFOF resolves conflicts and misbehaviour

Q: How are conflicts and behaviours sanctioned?
William: 1) Conflicts from unsustainable harvesting 2) Stealing of prunus from farms, park prunus or already harvested prunus 3) During weighing exercise by MOCAP, harvesters are annoyed if there is delayance in harvesting. When weighed immediately after harvest the prunus has more weight but the weight reduces with time 4) When the supervisor tells you to harvest in a particular area but you harvest in another, you will be sanctioned by forgoing/forfeiting on bundle of prunus whose kilo varies depending on the strength of the person 5) **William:** MOCAP executive sends names of unsustainable harvesters to MINFOF, who suspends the said harvester for a period of about six months from harvesting prunus in a particular block. 6) When some harvesters are sent to a block far from the their villages, some go to nearby blocks to illegal expliotation for fear of distance

Q: Which changes in conflicts and sanctions have you experienced and why?
Mbanda: Same conflicts and sanctions. Conflicts mostly arise during exploitation

Q: Which changes in conflicts and sanctions are due to the impacts of weather variability?
Mbanda: All trees need water. The destruction of prunus due to long dry season reduces quantity available for harvesting and pushes people not to respect harvesting rules in search for more income

Q: Which management actions are you implementing to reduce *prunus* vulnerability to climate variability?
William: -Sustainable harvesting – Prohibition to fell trees and branches
Mbanda: -Harvesting period shifted from 5-8 years because the section/portion of the tree harvested did not fully recover after five years, thus extended to 8 years
Jonas: the extension from 5 to 8 years was because of climate change, long dry season and prunus needs a lot of water for regrowth
William: In the future if the dry season continues to prolong more prunus will die and the harvesting period risk to be extended to about 10 years. The impact is that we have to wait for longer periods to have prunus, thus affecting families, business people, childrens education and young boys.

Q: How do you manage the diverse Mount Cameroon landscape to cope with vulnerability of *prunus* to climate variability and change?

William: MINFOF has divided the park into exploitation units and blocks. The mountain has about 5 exploitation blocks. Mapanja and Bokwaongo fall under block four. Prunus harvesting is done in one block before going to another block

Section E: Power relations concerning natural resources

Q: Who has access to *prunus*?
William: - harvester have access to prunus – access is for all; 1) user rights 2 individual owners 3) government 4) harvesters

Q: How has access to *prunus* changed and why?
William: Changes in access because harvesting is limited to trained harvesters and MOCAP which controls the selling

Q: Which changes in access are due to climate variability and change?
Mbanda: Yes climate change has affected access. Prunus does well from an altitude of about 800. With the long dry season prunus at altitude 800 are more affected by the borer, thus harvesters go up to about 1000 altitude to find non infected prunus. Below altitude 800 prunus is heavily affected. Thus in the future prunus will only be available in higher altitudes

Q: Which members of the community are most affected by changes in access and why?
William: Future ---- Only stronger harvesters will be able to harvest at higher altitudes. Consequently there will be a direst reduction in harvesters, quantity of prunus harvested and increase in harvesting costs.
In the future prunus might not be financially viable to communities due to reduced availability, reduced number of harvesters and unstable markets

Q: Which problems have you encountered due to changes in access?
Lifongo: Unstable income for families

Q: What do you know about forest legislation on prunus?
Lifongo: Prunus is endangered specie, thus must be harvested sustainably for it not to be extinct

Section F: Adaptation

Q: Which practices/measures do you implement to protect *prunus*?
Mbanda: -Encouragement of individual regeneration – rotation harvesting – prohibition from tree cutting/branches during harvesting – control of unsustainable harvesting

Q: Do these activities vary with seasons and how?
Jonas: Activities do not vary with seasons but carried out following harvesting norms

Q: Which of the mentioned activities/measures are short and long term strategies?
Mbanda: Long term (regeneration, rotation) short term (sustainable harvesting, stop the cutting of trees and branches

Q: Which of these practices and measures are as a result of climate variability and how?
Mbanda: All prunus activities/measures especially regeneration fight climate change.

Q: How do activities /practices enhance livelihoods and *prunus*?
Jonas: Money from sustainable harvesting of prunus to buy television, marry, building of houses, they have "prunus marriages". Young girls are attracted to come to the village because of prunus money. They know prunus will pay for bike riders to go fetch water