Non-timber forest products and climate change adaptation among forest-dependent communities in Bamboko forest reserve, southwest region of Cameroon

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Abstract

Background: Forests are naturally endowed to combat climate change by protecting people and livelihoods as well as creating a base for sustainable economic and social development. But this natural mechanism is often hampered by anthropogenic activities. It is therefore imperative to take measures that are environmentally sustainable not only for mitigation but also for its adaptation. This study was carried out to assess the role of Non-timber forest products (NTFPs) as an adaptation strategy based on local perception to cope with the impacts of climate change among forest-dependent communities around the Bamkoko Forest Reserve in the South West Region of Cameroon.

Methods: Datasets were collected through household questionnaires (20% of the population in each village that constitute the study site was a sample), participatory rural appraisal techniques, transect walks in the 4 corners of the Bamboko Forest Reserve with a square sample of 25 m^2 x 25 m^2 to identified and record NTFPs in the reserve, and direct field observations.). Both qualitative and quantitative (statistics) methods were used to analyze the collected data.

Results: A total of 18 plant species were identified as being harvested as Non-Timber Forest Products by the residents around Bamkoko Forest Reserve. The majority of the respondents (88%) perceived that there has been a change in climate patterns due to increased temperatures and unpredictable rainfalls. Eru was the most affected NTFPs with a standard deviation of 1.66799 and crops was the most affected livelihood activity by climate change around Bamboko Forest Reserve with a standard deviation of 1.20459 and local population used more than one strategy to cope with these adverse effects

Conclusions: The study concluded that with the increasing climate change effects on crop production and other livelihoods, non-timber forest products still play a safety net role to assist communities. The need to ensure sustainable harvesting, improved processing, and access to non-timber forest products markets cannot be over-emphasized.

1. Background

The importance of forests to the well-being of a large number of poor people especially in tropical developing countries is indisputable and well recorded (Ruiz Pérez and Arnold 1996; Arnold and Ruiz-Perez 1998; Byron and Arnold1999; Tieguhong and Ndoye 2004; Sunderlin et al.,2005, Powell et al. 2011;).NTFPs contribute to the livelihoods of about 2 billion of the world's poorest people in urban and rural settlements and are among the most valuable plant resources for present and future food security. (FAO, 2001; Basu, 2009). Natural resources are inextricably linked to development processes such as peace, stability, livelihood security, human health, and economic growth (Wollenberg and Ingles, 1998; Cunningham, 2001; CBFP, 2005), which are also underlying factors for vulnerability to both climatic and non-climatic impacts (Brooks et al.,2005). Forests are considered safety nets"in that people draw on available natural resources to meet emergency shortfalls and to keep them from being worse off in times of need (Belcher, 2005) According to the report by World Bank (2008) the majority of communities living

adjacent to forest reserves; about 60 million around the globe are estimated to be almost wholly dependent on forests. Climate change is currently one of the greatest environmental challenges facing humankind (Totten et al., 2003). Africa was predicted to suffer the most from the impacts of climate change according to the 2001 Intergovernmental Panel on Climate Change (IPCC). All the projections of climate change zoom in on the vulnerability of Africa and its inability to respond to the scale of the problem (Stern, 2006; IPCC, 2007) especially concerning the poor majority whose livelihoods are directly linked to climate-driven sectors. The Congo Basin forests face similar climate challenges that put at risk future and previous developmental efforts in the region. Van Dijk (1999) in his study on changing accessibility to NTFPs resources in Cameroon through a survey of local communities noted that many NTFPs are more scarce nowadays than in the past for several reasons, ranging from climatic stresses, increased demand for NTFPs, population growth, increased logging and fuelwood harvesting activities, forest conversion to agricultural land, low or declining soil fertility, ecosystem degradation associated with intensified crop production, wildfires, and weak enabling government policies. It is argued that climate change presents additional challenges to a country such as Cameroon, owing to its agro-ecological diversity (Brown et al. 2010). Indeed, studies have identified different aspects of climate change vulnerability specific to individual agro-ecosystems in Cameroon (Brown et al. 2010, Yengoh et al. 2010a). While changes that warrant adaptation may occur in all agroecosystems in the country, these changes are not likely to be of the same intensity in the entire country (IPCC 2007). Many developing countries (Smith and Scherr 2003; World Bank 2004);(Nkem et al.2010).Over1.6 billion people living in extreme poverty. Forest preservation and conservation provide an essential mitigation measure towards addressing climate variability and change (Kremen et al. 2000; Thompson et al.2009). There is a limited understanding of the magnitude of the changes in local climatic scenarios in the landscape because of uncertainty, irregularity, and periodic changes. In a study in southern Cameroon, villagers describe this situation as a "climate accident" Chia et al., (2013).However, the inherent variations of climate from season to season and from year to year make variability a fundamental part of climate change (Hulme et al., 1999; Berz, 1999). In other forested areas in the region researchers have underscored the vulnerability to climate variability and change of sectors, such as food, energy, and water (Sonwa et al.,2012), and the livelihood strategies of forest-dependent communities (Bele et al.,2013a,2013b; Nkem et al.,2012; Chia et al. 2013) in other forest areas in the region. In this paper, the use of Non-Timber Forest Products (NTFPs) is preferred as an adaptation option to climate change. Non-Timber Products are defined as biological materials other than timber which are extracted from the forest for human use. There are suggestions, however, of three major pathways of climate change impacts on indigenous people and their livelihoods through an increase in environmental risks, reduction in livelihood opportunities, and consequent stressing of existing social and policy institutions Agrawal (2007). Forest livelihood strategies are influenced by forest type, which determines the availability and distribution of various livelihood assets described in the Department for International Development (1999) sustainable livelihood framework. This may be related to the differential sensitivity of forest types to climate impacts, as well as to the nature of the use of the asset by the community. These climate risks have been selected from the well-documented scientific analysis of climate change on tropical forests, particularly the Congo Basin forests (CBFP 2005; IPCC 2007; Locatelli et al. 2008; Somorin 2010).It is asserted that NTFPs if properly managed can provide

good sources of animal protein and income to the immediate communities as well as promote tourism. Climate change has been defined as a long-term change in the statistical distribution of weather patterns over periods ranging from decades to millions of years (Parmesan and Yohe, 2003; Robledo and Forner, 2005). According to USAID (2007), climate variability is defined as the inherent characteristic of climate which manifests itself in changes of climate with time. Examples of climate variability include extended droughts, floods, and conditions that result from periodic El Niño and La Niña events (Grimm et al*.,* 2000; Conway, 2008). Vulnerability to the impacts of climate change is a function of exposure to climate variables, sensitivity to those variables, and the adaptive capacity of the affected community (Fussel and Klein, 2006). Often, the poor are dependent on economic activities that are sensitive to the climate. For example, agricultural and forestry activities depend on local weather and climate conditions; a change in those conditions could directly impact productivity levels and diminish livelihoods (USAID, 2007).

Adaptation through reducing vulnerability is therefore one of the approaches considered likely to reduce the impacts of long-term climate changes. Importantly, it has been argued by Nkem et al.,(2010) that sustainable utilization of NTFPs could be among the effective climate change adaptation strategies in Africa. Several climate change-related policies and programs have focused on NTFPs. According to the UN (2009), NTFPs are one of the co-benefits of REDD+ (Reduced Emissions from Deforestation and Forest Degradation plus). Through its implementation, communities will gain more benefits from ecosystem services, especially through the creation of sustainable NTFPs based enterprises. The Fifth Assessment Report of the IPCC Smith et al.,(2014a) describes how older people are usually at greater risk from storms, floods, heatwaves, and other extreme events partly because they tend to be less mobile than younger adults, more likely live alone in some cultures and thus find more difficult to avoid hazardous situations. During such times of stress, the most important coping strategy for households involves gathering of NTFPs such as wild mushrooms, firewood, wild fruits, thatch grasses, medicinal plants, bush meat, building poles to mention a few. This reliance on forest resources is often greater considering that forests also support local industries that produce wood products Nkem et al., (2010). It is widely recognized that climate change has caused substantial impacts on forested ecosystems (Kirilenko and Sedjo, 2007). Climate change is expected to result, in many regions, in increased frequency and severity of extreme climate events such as heat stress, droughts, and flooding in the coming decades (Irland et al., (2001). In particular, it will modify the risks of fires and pest and pathogen outbreaks, with negative consequences for food, fiber, and forest production including NTFPs Easterling et al., (2007). In regions with large forest-dependent populations, particularly in Africa, expected decreases in rainfall, and increased severity and frequency of drought can be expected to exacerbate current exploitation pressures on forests and expansion of agriculture into forest lands (Arnold and Perez, 2001). In these regions, this can be expected to impose additional stresses on people who depend on fuelwood for their domestic energy needs and NTFPs for their livelihoods (Arnold and Perez, 2001). Also, climate change may result in to shift in forest boundaries. The change in weather may be higher compared to the adaptability capacity of plants and may result in the loss of some of tree species (Scholes and Linder, 1998). Undoubtedly, human influences have implications for the present role of agricultural lands and forests in global carbon cycles ain future carbon sequestration. In order to mitigate climate change, more carbon

Should be sequestered in forest ecosystems and strategies for an adapted forest management are sought Dixon et al. (1994). NTFPs are increasingly becoming important in terms of rural and urban livelihoods, as there is an established cause-and-effect relationship between poverty and forest degradation in the cause of deriving subsistence households' needs (Shackleton and Shackleton, 2004). The role of forests and trees in food security, contribution to water supply, provision of economic alternatives and support to other sectors has been recognized (Shackleton and Shackleton, 2004). There has been increased recognition of the value of non-timber forest products to people's livelihoods. For example, wild foods greatly improve nutrition and increase food security particularly for rural poor (Shackleton and Shackleton, 2004). NTFPs provide livelihood benefits by assisting households to cope with sudden changes in the economic, social or bio-physical environments in which households exist and function Shackleton, (2001).The majority of the forest dependent people have reduced opportunity to cope effectively with the adversities of climate change due to low capabilities, poverty, weak institutional mechanisms (Shackleton and Shackleton, 2004) and lack of access to resources (Brooks 2003; Brooks et al., 2005).several studies have been carried out on climate adaptation in the forest region of Cameroon using divergent methods but little is known about climate change impacts on NTFPS. The present study provides an understanding of the ability of forest dependent communities to respond to climate change impacts, using their local perception on temperature and rainfall patterns to reduce their vulnerability and enhance their adaptative capacity using potential NTFPs. Information generated from this study provides a timely scientific input to policy-makers during the current implementation of initiatives to combat climate change effects while assisting communities to cope/adapt and sustain their livelihoods. According to Regmi et al. (2010) climate change adaptation consists of initiatives and measures to reduce the vulnerability of natural and human systems to actual or expected climate change effects. However this study is a contribution to the growing literature on climate adaptation in the forested regions of Cameroon.

The justification for study is that, revenue generated through market systems if well managed and appropriately used, can play important roles for adaptation. Like safety nets in forest goods and services, it can serve as a security bond for urgent use for adaptation actions or other forms of interventions .For this to occur, however, the needs to be clear definition of whether adaptation should be embedded in the public or private domain, or perhaps a combination of the two, and what regulations are needed to structure the activities. The objectives of this study were to: Identify different types of NTFP that so far, serve as safety nets sustaining the livelihoods of forest communities in the study area and amount earned per household per year in BFR, to examine the local perception of climate change vulnerability (rainfall patterns and temperatures around BFR) and its impacts on the availability of NTFPs as well as livelihoods of forest-dependent communities around BFR, to examine the coping/adaptation strategies at the community level under changing climate.

2. Materials And Methods

2.1 Study area description

Bamkoko Forest Reserve is located between latitude 4° 19’ 53” and 4°50’ 35” North and longitude 9° 10’ 45” and 9° 25’ 35” East of the prime meridian (World Resource Institute,2018). This study covers part of the Mbonge Sub Division in Meme Division and part of the Muyuka Sub Division in the Fako Division both in the South West Region of Cameroon. Most of the reserve is found in the Mbonge Subdivision where most of the activities are carried out. This study covered the following sampled villages; Munyenge, Lilale, Lykoko, Bova, and Kotto. Several criteria were used in choosing the sampled villages which among others included: villages located not more than three kilometers from the forest reserve, Villages whose inhabitants are actively involved in the collection and harvesting of non-timber forest products, Villages having a good number of active hunters. A least one village from all the four corners of the reserve. Site "A" was made up of Munyenge, Lilale, Lykoko, site "B" the principal village sampled was Bova, site "C" was the concerned with Efolofo village while site "D" was Kotto village (figure 1). A sample size of 20% of the population was selected following Mugenda and Mugenda (2003), who states that a sample of 10.0% to 20% of the total population for a large or small population is adequate and large enough to provide sufficient information concerning the population under study (Table 1). In each of the selected strata, all households head or their representative were interviewed. A village list of households was established in collaboration with the village leaders. A total of 750 households (number of male and femal were equal per village for example, 130 male and 130 female households heads Lilale village) in each village were selected for interview based on gender.

Table 1: Sample Frame

Strata	Population (HH)	Proportion (%)	Sample Size
Munyenge	760	20%	152
Lilale	800	20%	160
Lykoko	750	20%	150
Bova,	943	20%	188
Kotto	500	20%	100
Total	3753	100%	750

2.2 Methodology

a. Data collection

Datasets were collected using household questionnaires, participatory rural appraisal techniques, transect walks, and direct field observations .A reconnaissance survey was carried out before actual data collection to provide a general picture of the research area, including identifying and meeting various stakeholders around the BFR. Reconnaissance surveys enabled the authors to obtain basic information on population size, ethnicity, and socio-economic activities of the study area. Ecoguards and village officers were the main resource persons of the baseline information related to the study area. Tools used in data collection were; GPS, block notes, pens, pencils, measuring tape and flap sheets.

b. Participatory Rural Appraisal (PRA) techniques

PRA is an exploratory method that aims at having a dialogue with stakeholders and getting information from them through participatory communication and analytical method (Duangsa, 1996). The participatory tools and techniques for assessing climate change impacts and exploring adaptation options by Regmi et al., (2010) were modified and adapted for use during the exercise. The tools used in the study were resource mapping to map local climatic hazards; free listing of NTFPs; matrix scoring; climatic hazard trend analysis to gain insight into past hazards; climatic hazard ranking to compare and contrast the impact of major climatic hazards on the social group; vulnerability assessment; coping and adaptation strategies to assess the effectiveness of the current coping strategies

c. Transect walk

Transect walks were conducted to verify the identification of NTFPs in the BFR. In each corner, one transects of 3km each from the edge of the forest towards the center were carried out. The distance from one transect to the next was 2 km. The first plot was established randomly followed by systematic sampling where the distance from one plot to another was 500m. The square sample plots of 25 m^2 x 25 m^2 were adopted because they are easy to layout with a total of two plots per transect. The square plot design is also recommended in the guideline for the baseline study of Community Forests in Cameroon (ICRAF, 2016), Sustainable Financing of Community Forest Enterprises in Cameroon (DRYAD) project. A total of 4 sample plots were established and existing NTFPs assessed and recorded (Figure 1). People with long experience in the utilization of particular NTFPs were asked to identify plant species and provide information on the use and quantity which can be harvested from each plant. The identification of plant species was in vernacular names and later was translated into botanical names. Secondary data involved the collection of information from different sources like reviewing relevant documents like publications, journals, reports, and books.

a. Data analysis

The following data were collected: prices of products, products traded and socioeconomic characteristics of the people involved in the NTFP trade (Ndoye et al., 2007). Both qualitative and quantitative (statistics) methods were used to analyze the collected data.from group discussions, scoring exercise and household interviews The cross table analysis tool was used to evaluate the percentage of household income earned from each NTFP and the contribution of NTFPs to the total household incomes. Details of the calculations of the-cash income obtained from NTFPs are presented in table 3.

3. Results And Discussions

3.1 Frequencies of NTFPs captured per transect

The frequency assessment by NTFPs showed that there is no single dominant NTFPs in the forest reserve with the maximum single frequency of 60. Considering the diversity of NTFPs recorded, there a low rate of dominance by a single NTFPs, it is possible to conclude that the BFR is reach in NTFPs.

3.2 Major NTFPs in and around BFR (Table 2)

NTFPs Scientific name	Local name
Garcinia cola	Bitter kola
Irvingia Gabonensis	Bush mango
Piper nigrum	Black Pepper
miswak	Chewing stick
Gnetum africanum.	Eru
Cola nitida	Kola nuts
Cola lepidota	Monkey kola
Ricinodendron	Njansang
Prunus Africana	Pygeum
Calamus rotang	Rattan cane
Gastropoda	Snail
Acacia Seyal delile	Fuelwood
Aframomum melegueta	Alligator Pepper
Santalum lanceolatum	Bush Plum
Marantaceae	Ngongo
Cyperus bulbosus	Bush Onion
Anacardium occidentale	Cashew nuts

Source: Fieldwork, 2018

Forest resources in the form of NTFPs serve as safety nets, sustaining the livelihoods of some forest communities in BFR. They play a vital role in income generation and household food security (Nkem et al., 2010). The results of this study indicate that the collection and sale of NTFPs is a major livelihood activity and a source of income for households especially in Munyenge, Lilale, Lykoko, Bova, and Kotto and the access to NTFPs is open to the people in both forest reserve settings. They collect NTFPs known as shown in (table 2) . Local people extracted NTFPs primarily for meeting household needs, as well as for earning additional income to support or supplement their livelihoods. NTFPs harvested from the BFR have been classified according to the benefits identified by the respondents including direct and indirect benefits. Direct benefits included human food, animal feed, medicinal plants, and poles, and wood fuel. Indirect benefits include environmental conservation and watershed protection (ecosystem services).

3.4 Amount of NTFPs used and sold per household per year in the BFR

Table 3 shows the amount of NTFPs used and sold per household per year in the BFR. Bitter kola,eru, bush mango,njansang, kola nuts, snails were the most traded NTFPs in the area. It was learned that the demand for these resources was higher compared to the supply. It was estimated that a household can generate up to 1990000 FCFA per year from the selling of NTFPs. The amount of revenue was low because the forest is protected by the village, government, and the entry to the forest and the harvest of NTFPs was through the permit and they also have their limit were they can collect NTFPs. About 53%, 24%, and 23% of the respondents agreed that eru, bush mango njansang, bitter kola, and snails, respectively could be used to assist households to cope with climate change.

Table 3: NTFPs used and sold per household per year

Products	Amount used per household per year	Average amount sold per year	The average amount earned per year (EURO)
Bitter kola (buckets)	2	15	542.02
Bush mango (buckets)	4	30	813.04
Black pepper (buckets)	2	10	36.13
Chewing stick (bundles)	1	20	18.07
Eru (kg)	50	50	542.02
Kola nuts (buckets)	5	22	451.69
Monkey kola (buckets)	1	5	36.13
Njansang (buckets)	7	16	722.70
The rattan cane (Bundles)	5	15	162.61
Snail (buckets)	10	30	271.01
Fuelwood (bundles)	17	50	-
Bush Plum (buckets)	2	5	-
Total			3,595.42

Source: fieldwork, 2018

3.5 Local perception on climate change variability and impact on livelihoods and NTFPs

As indicated by respondents, they agreed that the most affected livelihood activity by climate change and variability was agriculture with a mean of 3.2402 and a std=1.20549 that crop productivity was ranked number one being affected by climate change and variability, Also, results summarized that crop production was mostly influenced by unpredicted rainfall in the BFR. Climate change and variability has been reported to affect agriculture, biodiversity and health in (Munyenge, Lilale, Lykoko) About 42.5% of the interviewed households indicated that crop production especially maize was on a decline trend in Bova and Kotto areas. Similar response was also reported by Senbeta (2009) in West-Arsi Zone, Ethiopia. High sensitivity of agricultural crops to climate change and variability make it vulnerable whenever change occurs. This is caused by unpredicted rainfall mainly short rainy seasons and sometimes rainfall not coming at the expected time compared to previous years. It was revealed that decline in crop yields was also associated with non climatic factors such as increased in , pest with a means of 3.3193 and a std deviation =1.24827.

Climate change is believed to exacerbate human and livestock diseases by changing environmental factors that lead to the growth and development of insects transmitting diseases in the BFR. It was learnt

that about 36.4% of the respondents agreed there has been an increase in human diseases including malaria, measles and cholera. Results summarized from temperatures results show that increase in temperature resulted in an increase in animal and human diseases which were not previously pandemic in the area with a std deviation= of 1.19068 and 1.30641 (Table 4) respectively. For example, increase in mosquito results in an increase in malaria incidences compared to the previous years.

Table 4: The Means and std deviation of climate change impacts on livelihoods

Means

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
NTFPs * Livelihoods	750	100.0%	0	0.0%	750	100.0%

Report

NTFPs

Livelihoods	Mean	N	Std. Deviation
Decreased in Agricultural crops	3.2402	179	1.20549
Increased in human diseases	3.2652	132	1.19068
Increased in animal diseases	3.1838	136	1.30641
Increased in pests	3.3193	119	1.24827
Deceased in the quantities of fish cought	3.1980	101	1.40014
Deceased in the number of animal hunts	3.1084	83	1.35261
Total	3.2267	750	1.26969

Forest resources in the form of NTFPs serve as safety nets, sustaining the livelihoods of some forest communities in BFR. They play a vital role in income generation and household food security Nkem et al., (2010). The results of this study indicate that the collection and sale of NTFPs is a major livelihood activity and a source of income for households especially in Munyenge and the access to NTFPs is open to the peoples in both forest reserve settings. They collect NTFPs known like eru (*Gnetum africanum.),* sails (*Gastropoda),* bush mango (*Irvingia Gabonensis),* bitter cola (*Garcinia cola)*.In this study, majority of the households agreed that heavy rainfall prevented the collections of NTFPs especially fuelwood which is used by the entire households in BFR with a means of 2.9618 and std deviation =1.58067. Most of the households eat unready prepare food because the fuelwood collected is wet and produces mostly smoke instead of flames when it is burnt. Households involve in the collection of NTFPs as the main livelihood activity especially the Kotto households communicated that the harvesting of fruits from the

different tree species is at times poor as a result of poor flowering and fruiting of the tree species, Also heavy rainfall is affecting the collection of NTFPs especially the harvesting of certain fruits in some trees species according to some households in Bova is very poor due pests and diseases that affect the flowering of this fruits based on their local knowledge While some households (75%) communicated that there has been the decrease in eru which they attributed it to climate change and variability. Besides, an average of 3.0048 of the households agreed that drought one of the climate impacts on climate-sensitive resources in these communities. Drought has caused a serious problem in collections of some NTFPs species especially Njansang which have become very difficult for back to decompose and cracking to remove the nuts and decrease in the number of snails of households pointed out that it was due climate change and variability which record a means of 3.3173 and std deviation =1.67369 (Table 5)

Table 5: the Means and STD deviation of impacts of climate change on NTFPs

Means

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Livelihoods * NTFPs	750	100.0%	0	0.0%	750	100.0%

Report

Livelihoods NTFPs	Mean	N	Std. Deviation
Drying of water sources	3.4190	105	1.68009
Drought	3.0084	119	1.78267
Heavy rainfall	2.9618	131	1.58067
Decreased in Eru	3.0241	291	1.66799
Decreased in Snails	3.3173	104	1.67369
Total	3.1067	750	1.67821

3.7 Changes in temperature around the BFR

The majority of the respondents agreed that there have been changes in the temperature in the area. About 71% of them reported that there has been an increase in temperature for more than 20 years ago around the BFR (Figure 2). However, about 12% of the respondents noticed the contrary, a decrease in temperature. While only 5% believed that there has been no change in the temperature for the last 20 years. Trend analysis of the annual temperature around BFR shows an increase in the temperature for the past 30 years (Figure 2). The climatic data records were in line with the people's perceptions

3.8 Rainfall changes around BFR

The majority of the respondents (88%) agreed that there have been changes in the rainfall patterns over 20 years. They noticed a change not only in the total amount of rainfall but also in the timing of the rains; with rains coming either earlier or later than expected. But only 10% of the respondents believed that there were no changes in rainfall patterns from the last 30 years. Figure 3 indicates that 54% of respondents noticed an increase in the amount of rainfall or a shorter heavy rainy season (unpredicted rainfall). It was further revealed that 21% of the respondents felt that there has been a decrease in the amount of rainfall including dry season starting early and was also longer than usual in the area. However, only 9% believed that there has been no change in annual rainfall for the last 20 years. The trend analysis of the annual rainfall from 1960 to 2015 shows fluctuations with increased annual rainfall (Figure 3). The people's perceptions were in line with the climatic data records

3.8 The Availability of NTFPs

Eru was identified as key and rare NTFPs in the study area. The majority of the respondents (90%) admitted to harvest and consumes eru during the wet season. A total of 25 bags harvested from the forest were listed during PRA (Table 4). This implies the BFR is rich in wild eru and people were knowledgeable on edible eru found in the forest. It was reported by respondents that fuelwood is available during the dry season as the rainy season has been too rainier in the past years while the collection of snails is during the rainy season especially during August to September which is considered as the peak season for snails collection as identified by respondents.

Table 4: NTFPs and their availability

NTFPs Scientific Name	Local Name	Availability
Garcinia cola	Bitter kola	Rainy season
Irvingia Gabonensis	Bush mango	Rainy season
Piper quinensis	Bush pepper	Dry season
Acacia Seyal delile	Fuelwood	Dry season
Gnetum Africana	Eru	Rainy season
Cola nitidia	Kola nuts	Dry season
Cola lepidota	Monkey kola	Rainy season
Helix aspersa	Snail	Rainy season
Gnetum Africana	Eru	Rainy season

4. Adaptation Strategies To Cope With Climate Change And Variability

The need for a multi-disciplinary approach in climate change mitigation and adaptation research is dictated by the multi-disciplinary nature of problems related to climate change. At the center of this communication and collaboration. In this study, 4.2% of the households used fertilizers in their farms to

increase yields. The local agriculture system depends on natural temperature, sunshine, and rainfall. This implies adjusting and improving (technically, financially, and materially) agriculture activities which will reduce the vulnerability and increase the adaptive capacity of households. The planting of trees to protect winds 5.9% of the household have planted trees especially around their houses to protect strong winds during torrential rainfall which is accompanied by strong winds in the study site which use to up roof their houses and most households used their traditional methods to protect winds by tying red pieces of cloth around their farms land. An additional 7.6% of the household have adopted irrigation systems of farming during the prolonged dry seasons and drought; they moved to swamps areas and opened new farms where water is available throughout the year the local farmers used watering cane to send water into their farms. Furthermore, 32.8% of household have diversified their crops, sustaining the diversity of crops it is an appropriate adaptation option for food security and livelihood in these communities. Household in the study area has expressed their willingness to integrate other livelihood activities like food crops and livestock rearing (sheep) have increased their source of income especially small farmers in the study area. This is similar to the findings of Yengoh et al. (2010). This study also shows that diversification as an adaptation option at the local levels, cuts across different sectors (environment, forest and wildlife, livestock and fisheries, agriculture and rural development, scientific research, finance, and commerce), thus it requires the development of inter-sectoral coordination. In this result, 69.7% of households have diversified their occupation to reduce their vulnerability to local climate and uncertainty. Engaging in non-climate dependent alternative jobs such as driving, masonry works, sale of assorted goods "provision store", shoe repairing, painting, sewing, or dressmaking was ranked the second-highest among the coping measures described by respondents. Although the dominant occupation is farming and therefore it is expected that most people will give priority to any coping measures that will help sustain their dominant livelihood activity, household members especially the young migrating to urban centers in search of jobs resulting in rural exodus in the study site.

Also, 78.2% of respondents have increased their farm sizes. According to the household, they increase their farm sizes every beginning of farming seasons as an adaptation option to local climate variability and uncertainty. The expansion of agricultural land is a coping and adaptation strategy for these forest-dependent communities. This supports other findings in the same area by Bele et al.,(2013). Increasing the agriculture land to compensate for losses has put more pressure on other natural resources on which the communities depend, resulting in a perverse cycle that could increase their vulnerability even more. Increase climate variability and uncertainty seems to be one of the main disturbances shaping current vulnerability in these communities. It was revealed that 85.2% of respondents consume and sell NTFPs from the forest as a climate change variability coping strategy. They use NTFPs like bush mango, fuelwood; bush blum, snails, bitter kola, kola nut to be sold in Mbonge, and Munyuka markets. Finally, 52.3% of respondents sell timber trees from their farm as coping strategies to climate change and variability.

Table 5: Responses on various adaptations as coping strategies to climate change

Adaptation strategies	% Response
Used of fertilizers	4.2
Planting of trees	5.9
Irrigation	7.6
Diversification of crops	32.8
Diversification of occupation	69.7
Increase in farm sizes	78.2
Used of NTFPs	85.2
Timber selling from own farm	34.3

5. Conclusion

The coping and adaptation strategies of the communities to the changing climate were as follows. Improving cocoa production using suitable measures and the introduction and enhancing agroforestry production systems are also crucial for household food security and income generation. Secondly, planting trees to protect strong winds and using irrigation systems to improve alternative livelihood and income activities constituted important coping strategies for communities. Activities such as beekeeping, growing livestock, and the sustainable collection and marketing of NTFPs are envisaged activities other than agriculture can greatly enable households to gain additional income and ensure food security among communities adjoining the BFR .Crop diversification is also of importance to the communities within the umbrella of livelihood diversification. The organization of local markets for commodities will improve and stabilize prices to ensure higher incomes. Furthermore, local communities need greater access to information about climate change issues and knowledge sharing as well as capacity building on the different new farming techniques and the processing of the various NTFPs and crops. In this direction material support that cut across different sectors (agriculture and rural development, forest and wildlife, environment, livestock) for enhancing adaptive and capacities need to be promoted. The design and implementation of such strategies require that actors within these sectors and other stakeholders located at different governance levels have specific roles to play in the design and implementation of such strategies. These roles cannot be carried out independently, but will requires a combinations of efforts based on efficient communication, collaboration, networking, knowledge management, and information sharing among all stakeholders (policymakers, local communities, civil society, scientists/researchers, etc). In this policy process, policymakers need to mainstream the adaptation from international policies into national policies and scientists/researchers need to communicate results and facilitate understanding among all stakeholder groups.

6. Recommendations

a. The implementation of adaptation strategies requires capacity development of the local communities which INGOs and NGOs can play this role by implementing adaptation through community capacity building or projects.
b. Alternatives livelihoods generation intervention (non dependent on climate) in this communities should be of prime important
c. Setting up mitigation plans in this communities based on local reality will contributes in reducing the vulnerability of the local population
d. The Government should enforce laws governing harvest and utilization of NTFPs by providing sufficient budget to carry out forest patrols and support livelihood alternative to local communities around the BFR

Abbreviations

BFR: Bamboko Forest Reserve; DRYAD: Latin word meaning Tree; NTFPs: Non –Timber Forest Products; IPCC: Intergovernmental Panel on Climate Change; ICRAF: World Agroforestry Centre; PRA: Participatory Rural Appraisal; REDD+: Reduced Emission from Deforestation and forest Degradation and Plus

Declarations

Authors Contributions:

All authors were involved in analyzing and editing the paper. All authors read and approved the final manuscript.

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Competing interests

The authors declared that they have no competing interests.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon request.

Ethics approval and consent to participate

This article does not contain any studies with participants performed by any of the authors.

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Informed consent

Informed consent was obtained from individual participant included in the Study.

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Figures

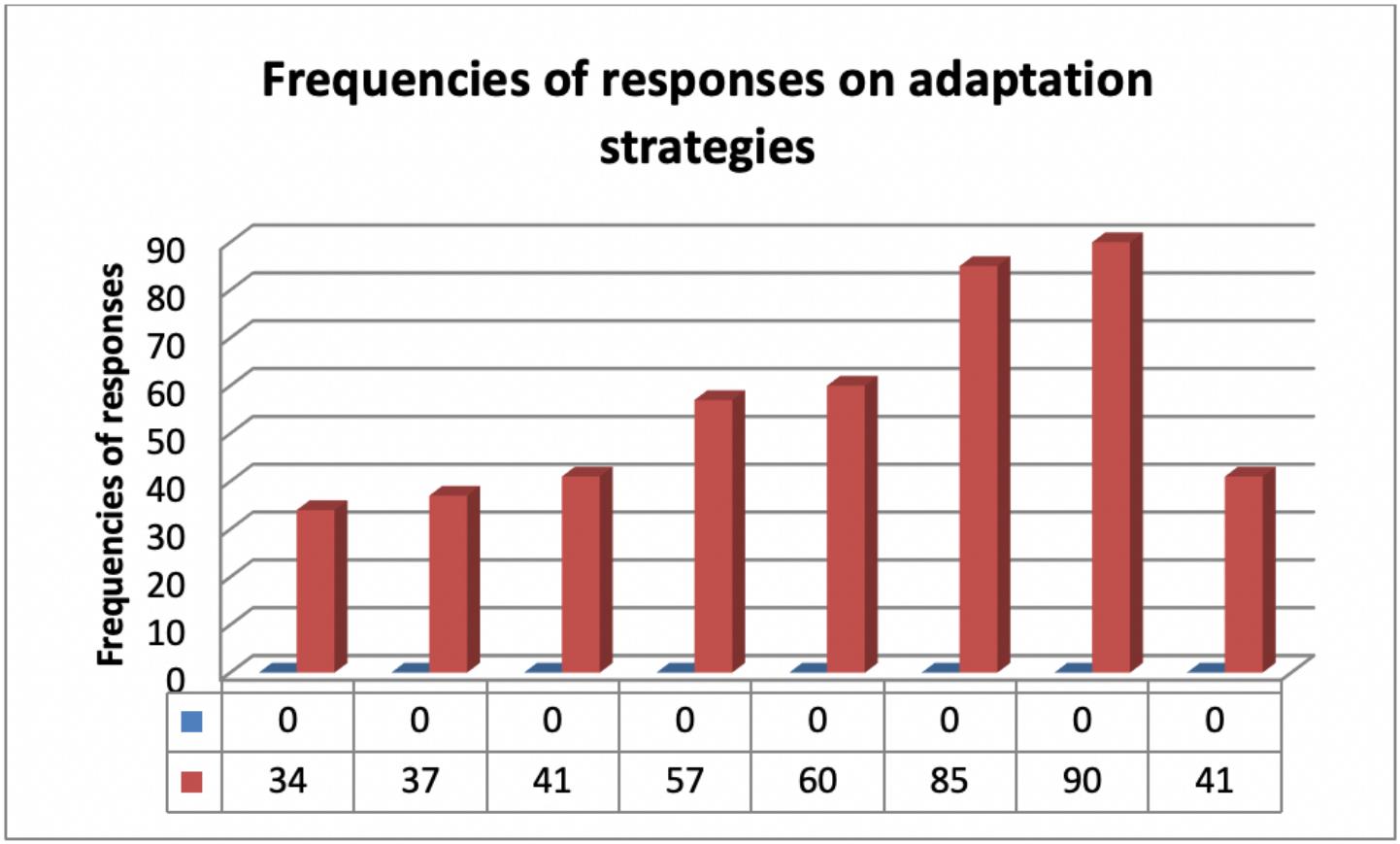

Figure 1

Frequencies of respondents on coping and adaptation strategies

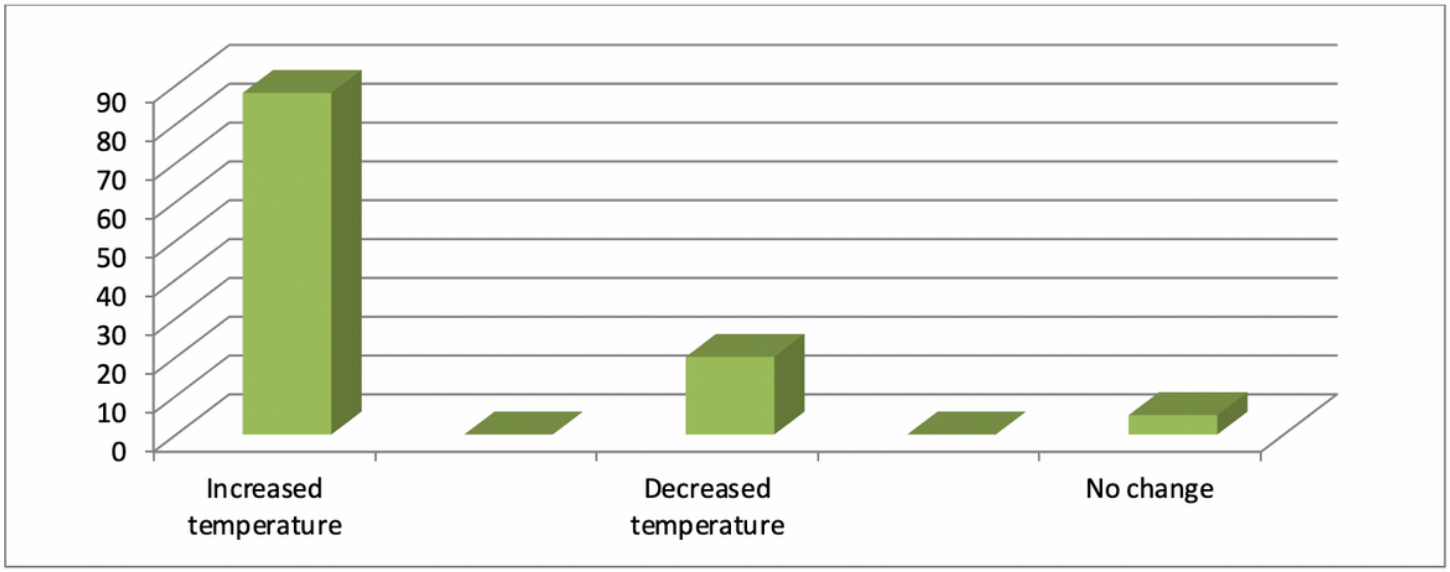

Figure 1

local perceptions on changes in temperature around the BFR

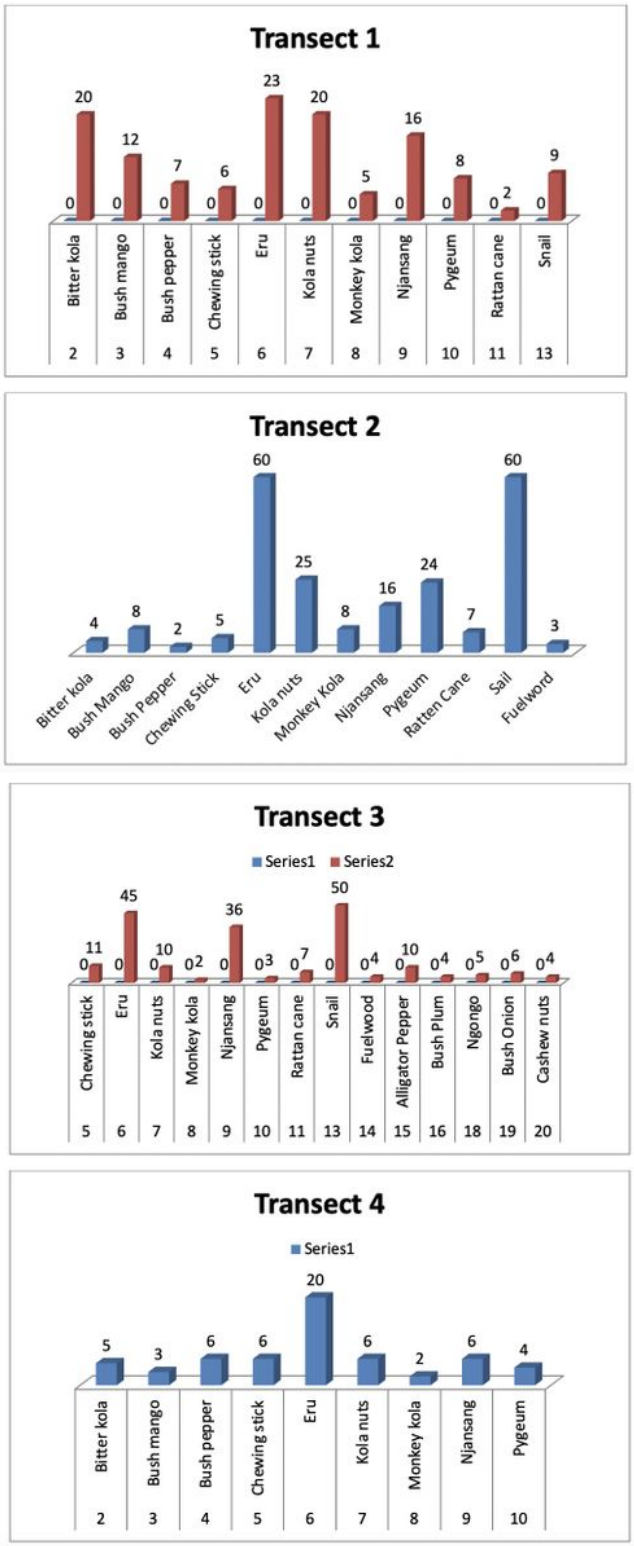

Figure 1

Frequencies of NTFPs captured per Transect

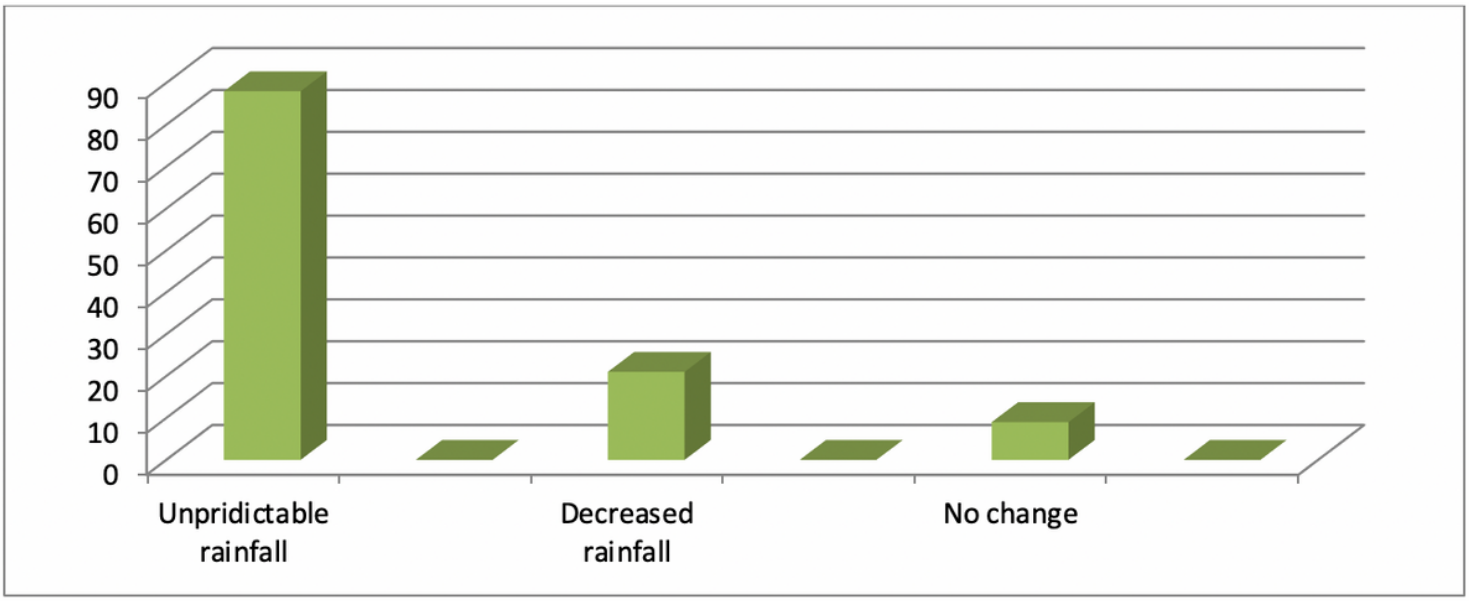

Figure 1

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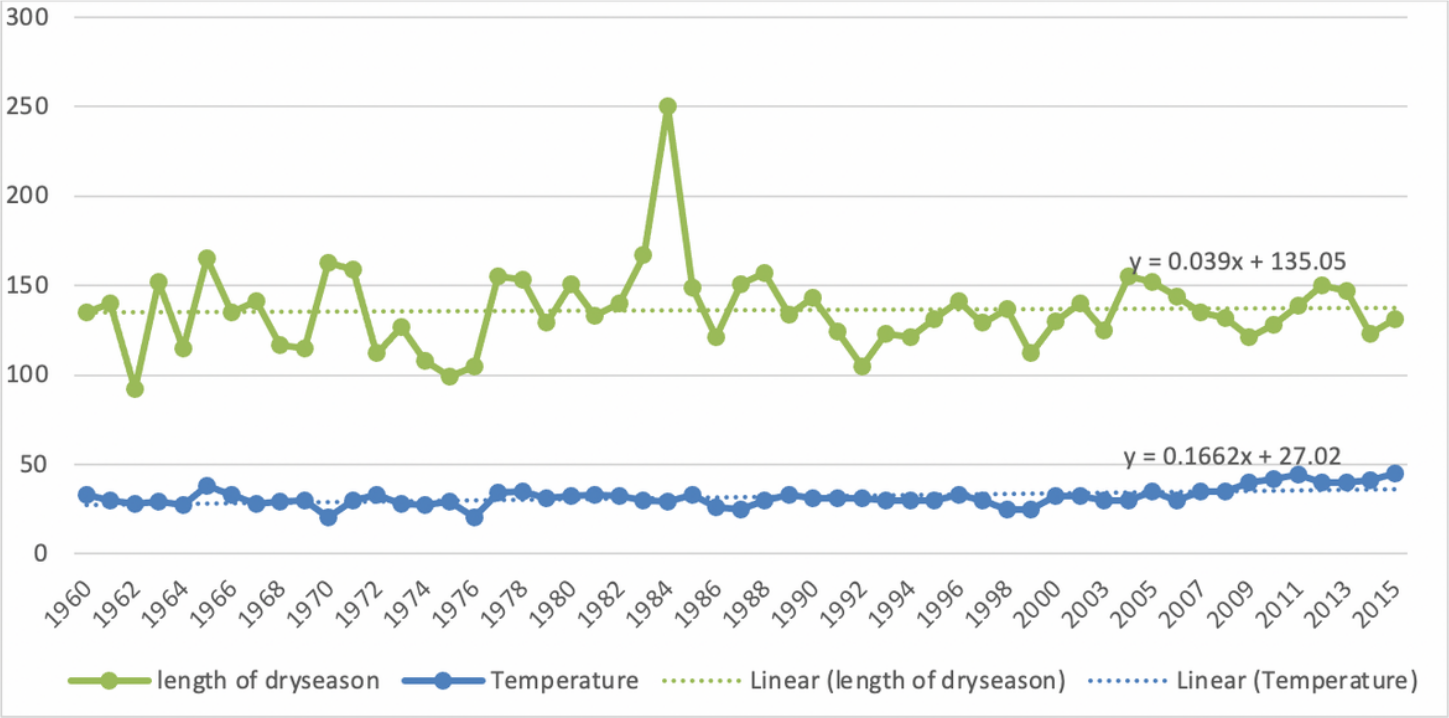
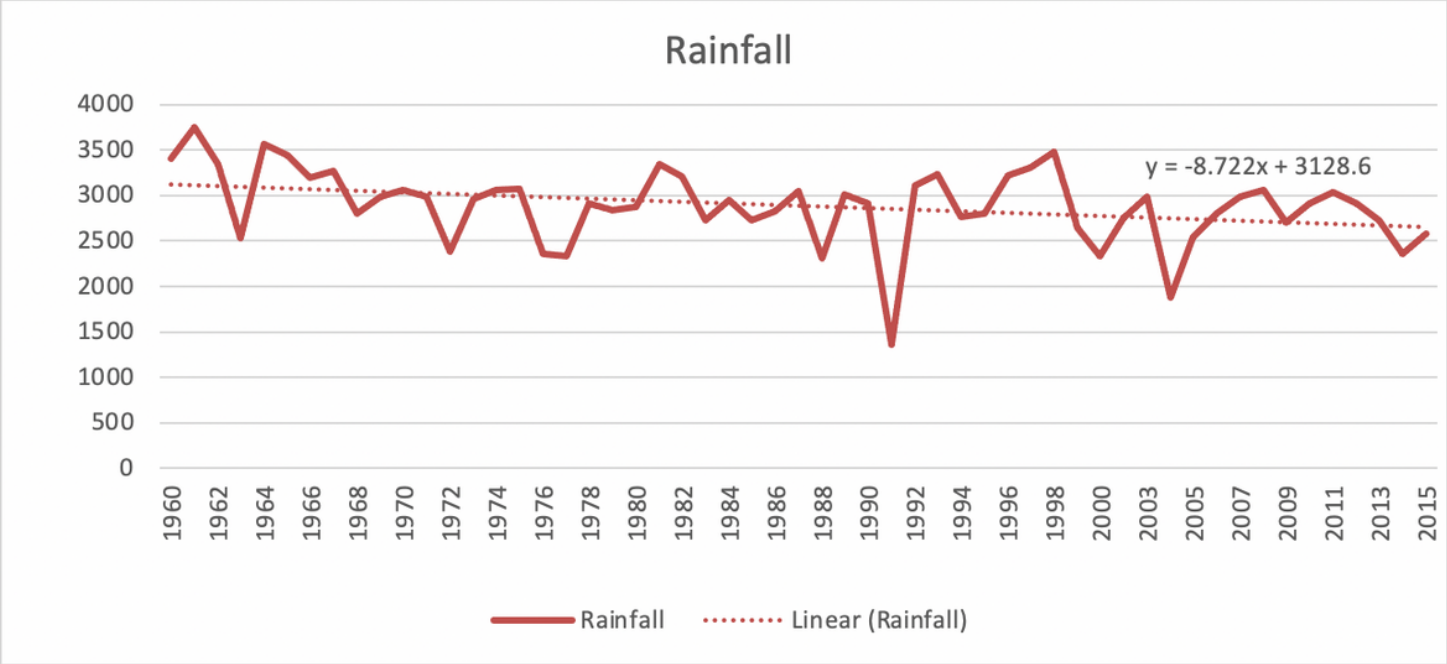


Figure 1

Average annual temperature around BFR from 1971 to 2015 Source: Manfe Weather Station, 2018



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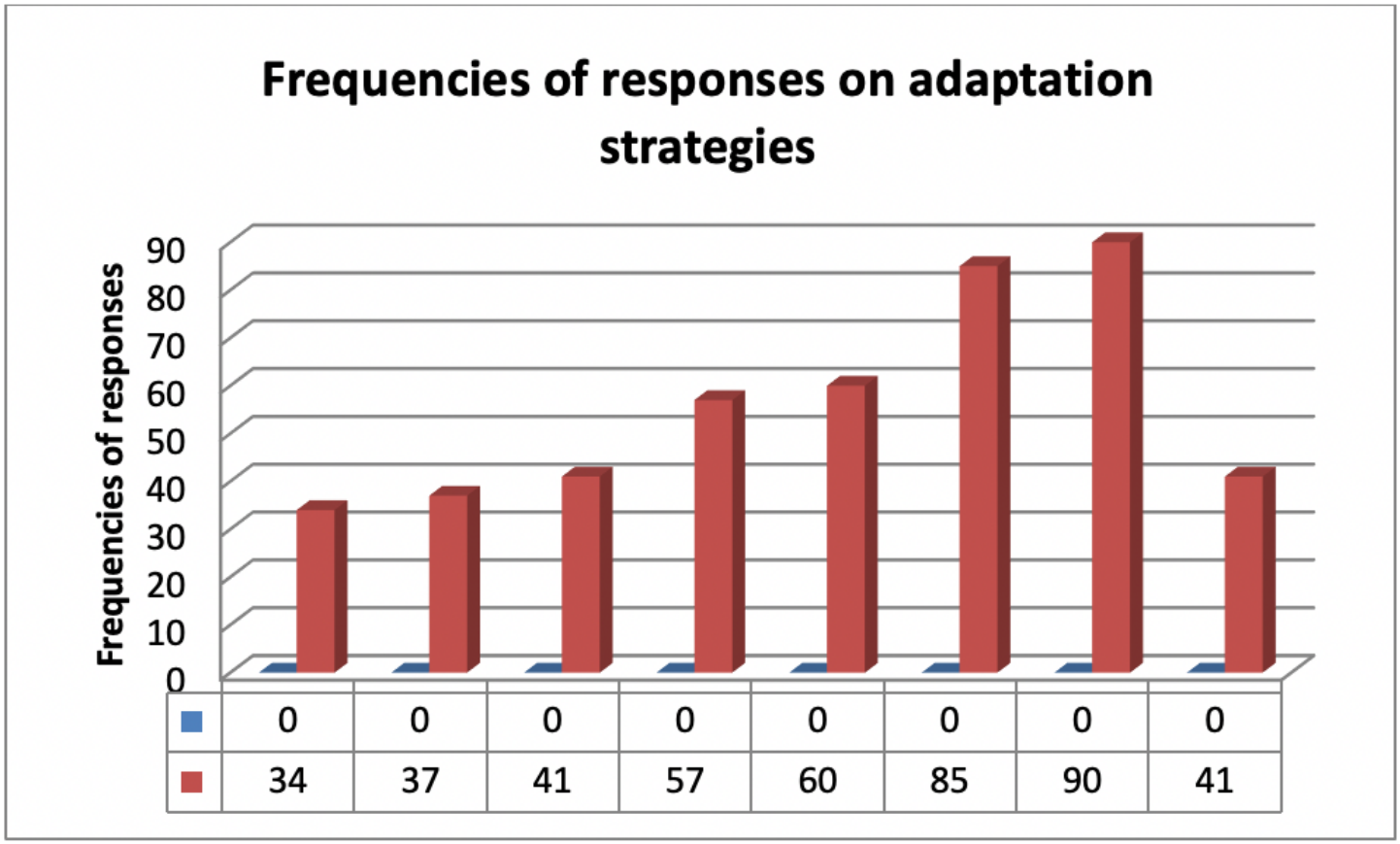
Average annual rainfall around BFR from 1960 to 2015 Source: Manfe Weather Station, 2017



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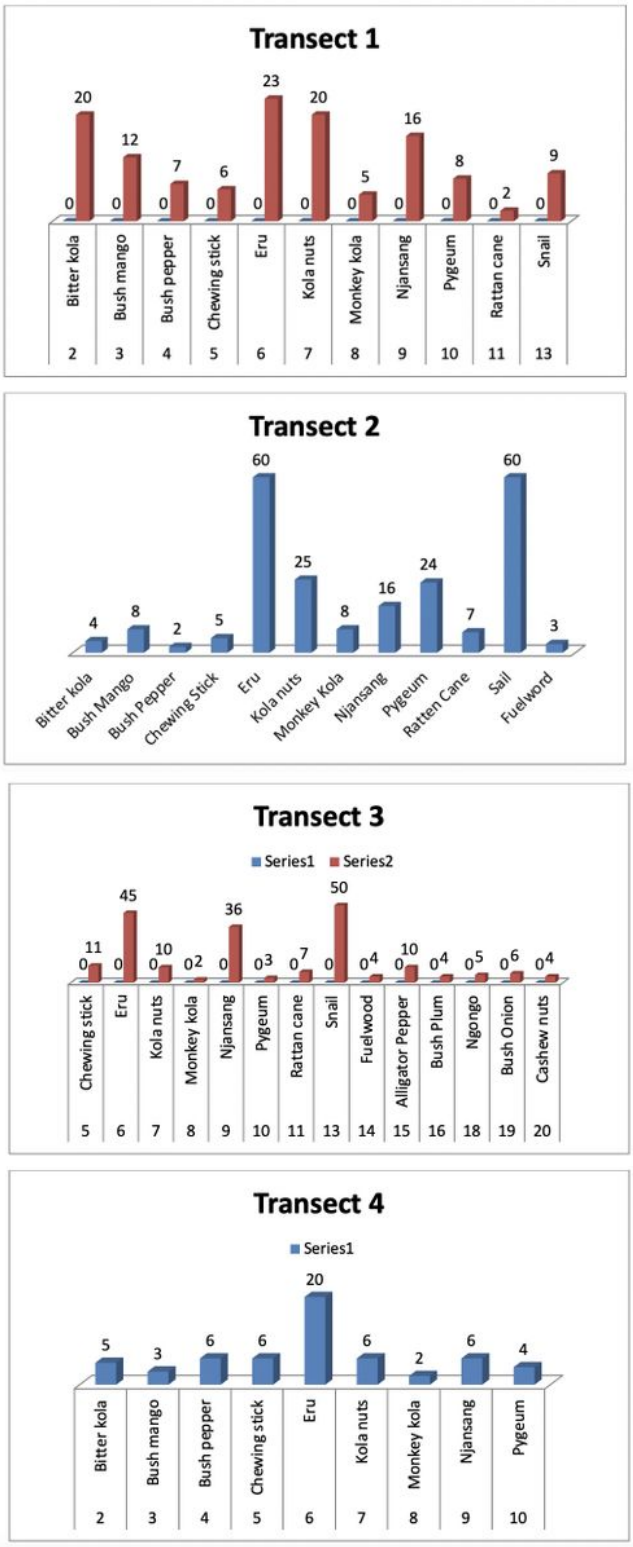

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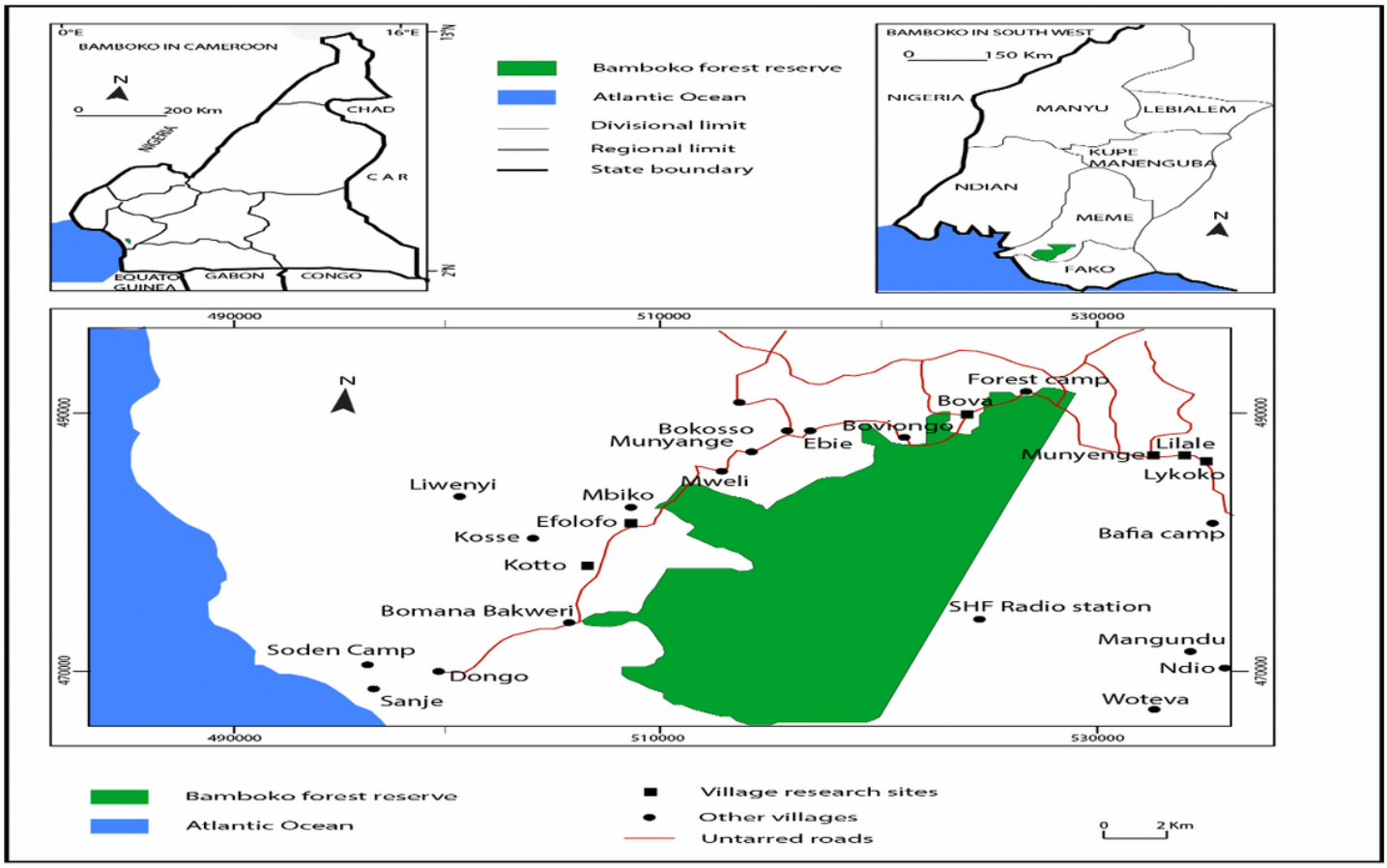
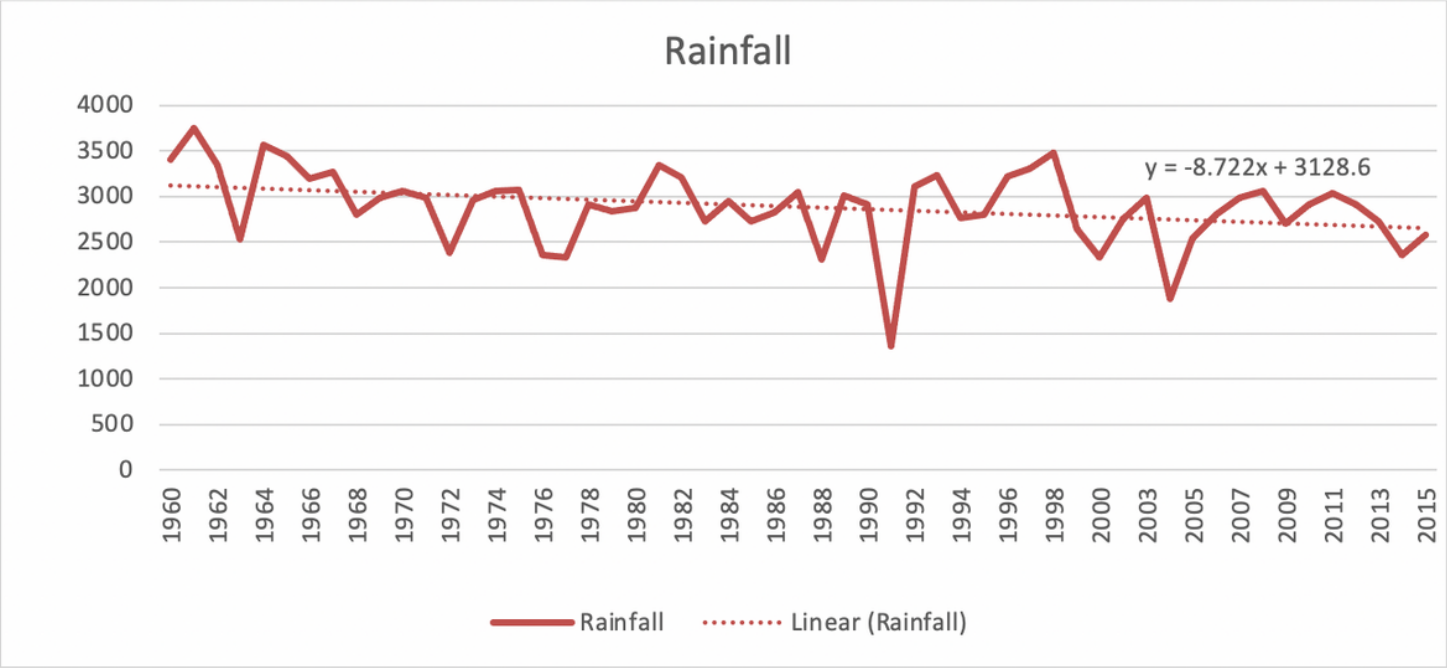


Figure 1

Layout map of the Study area Source: World Resource Institute, 2018



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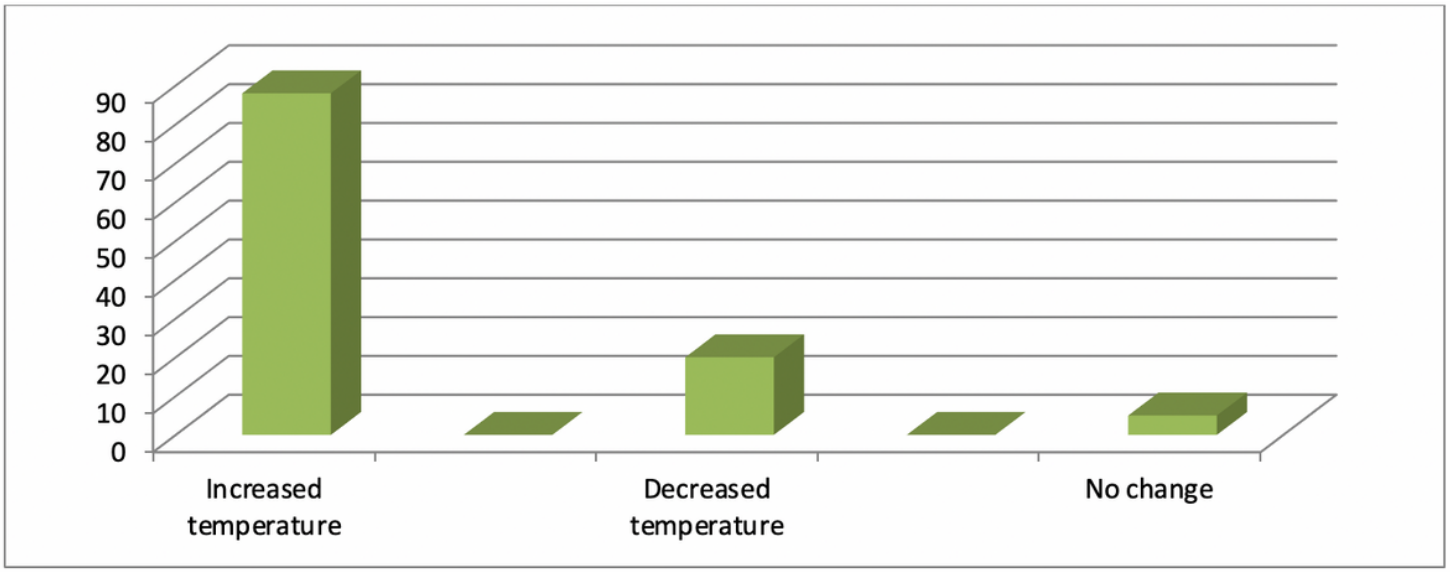
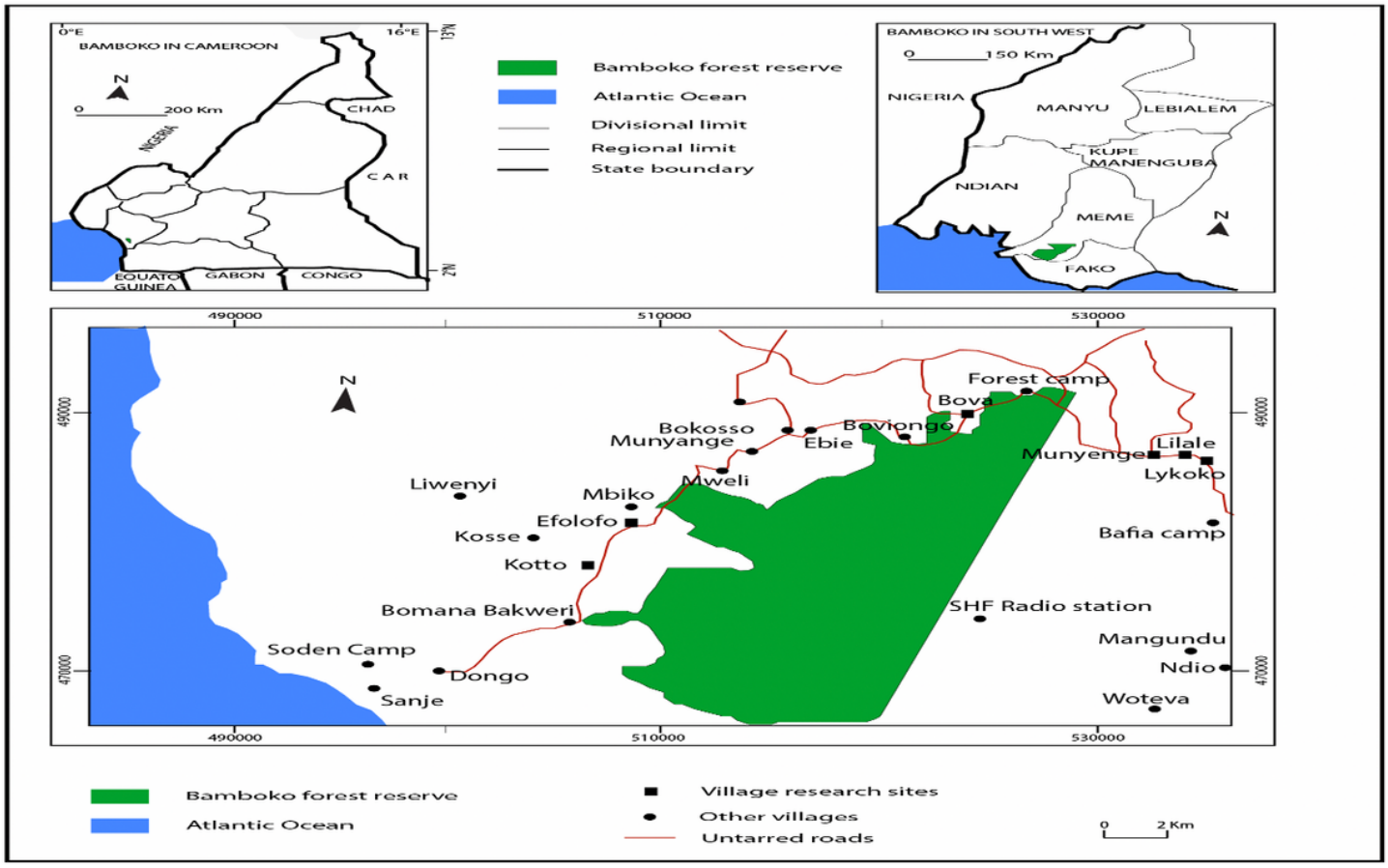


Figure 1

local perceptions on changes in temperature around the BFR



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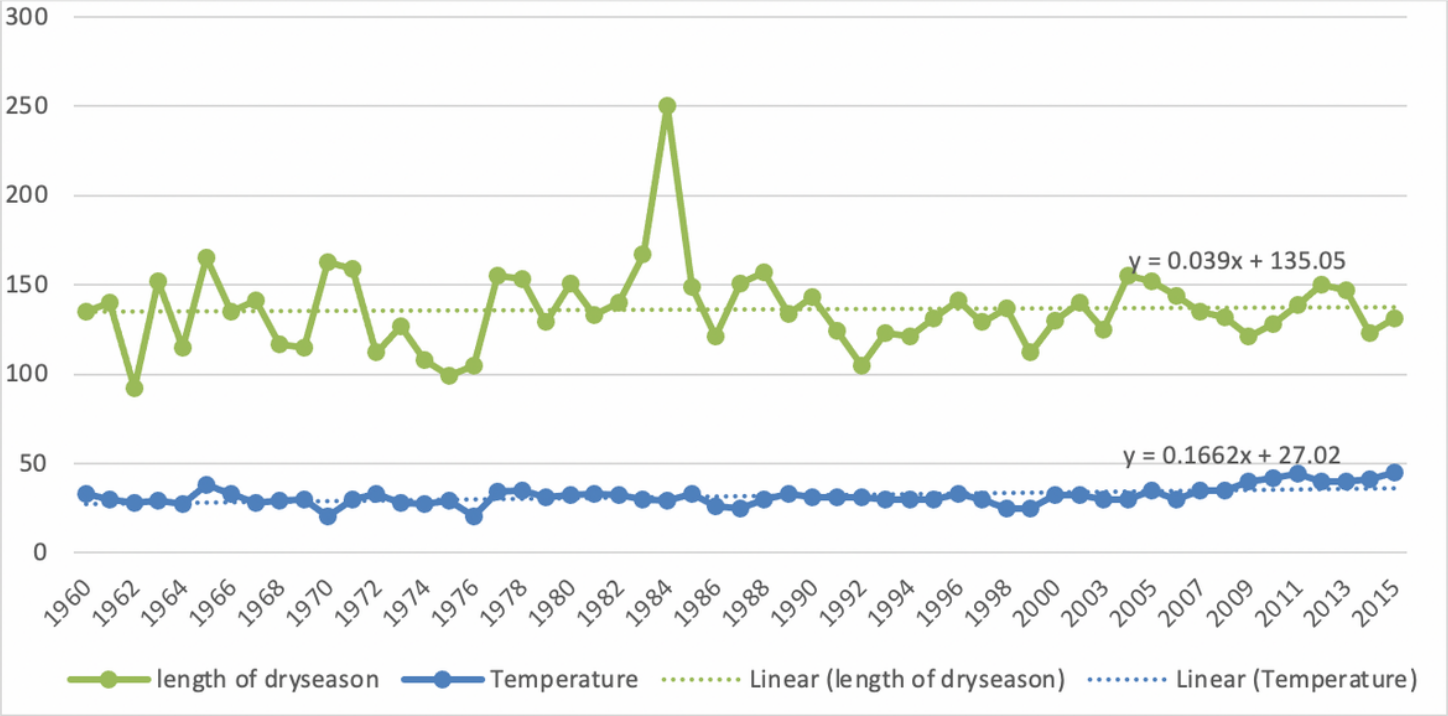

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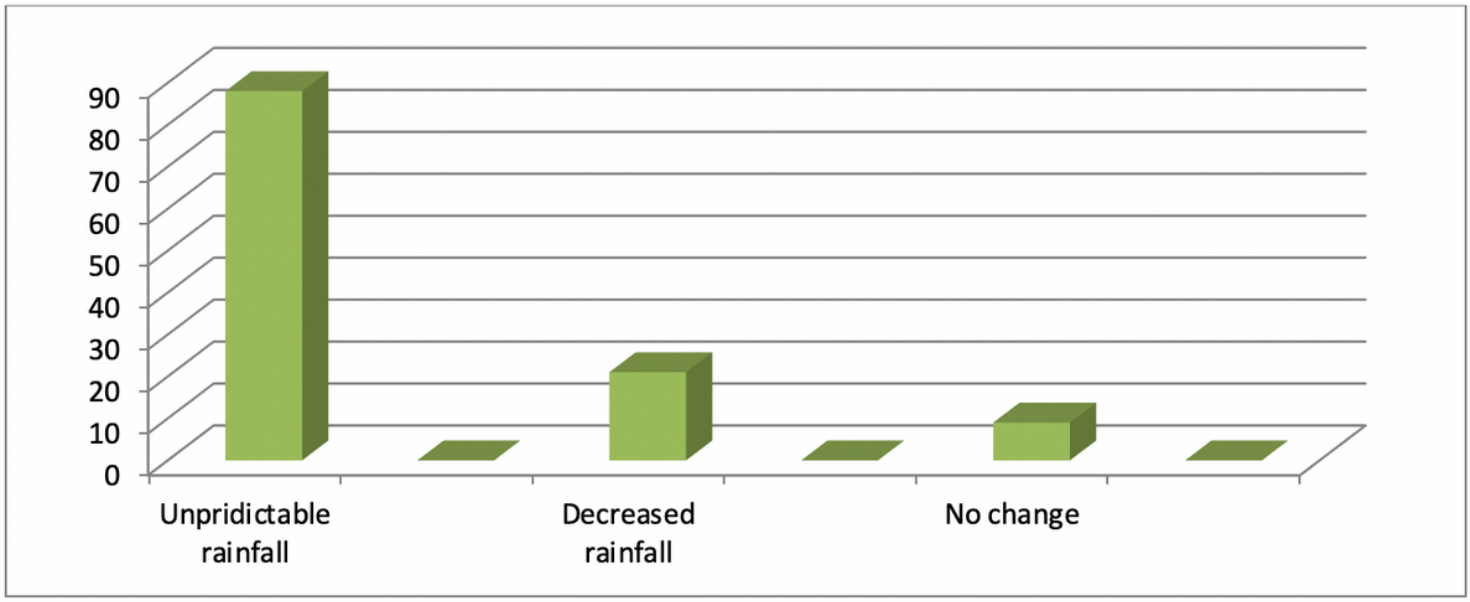

Figure 1

local perceptions on changes in rainfall patterns around the BFR