Adverse Impact of Climate Change on Mambioko Community Dependent Forest and Local Perception on Vulnerabilities and Responses-Centre Region of Cameroon

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Abstract

This study was undertaken to identify and assess climate change vulnerabilities and impacts on the livelihoods of forest dependent communities in Mambioko community forest in the Centre Region of Cameroon. Primary data was collected from 120 households; key informants, focus group discussions and was supplemented with secondary data from desk review of relevant literature. Forest resources were generally perceived by forest dependent communities as declining. Climate Change was observed to have impacted on their major livelihood's activities/resources of forest dependent communities by way of prolonged drought, erratic rainfall pattern, and variability in rainfall intensity. These trends have consequently led to drying of rivers and streams, shift in cropping season, reduced yield, frequent and extreme warm conditions among others. Use of irrigation, crop diversification, household income diversification through alternative livelihood activities and increase in size of cultivated farms are among the different measures being adopted by communities to cope up with the effects of climate change. Using socio-economic indicators, the bimodal agro ecological zone is vulnerable to climate change impact. The zone has relatively higher dependency on climate sensitive livelihood activities/resources, limited diversified income sources and moderate access to climate change information. In an attempt to help forest dependent communities cope up with climate change impacts, fundamental issues such as non-climate dependent alternative livelihood activities, access to climate, sustainable agricultural practices and sustainable forest resources management are key areas for various multidisciplinary intervention.

Background

Forest ecosystems have important environmental and ecological dimensions which provide livelihoods to Millions of people globally. Forest provides services that are directly link to micro and macro climate, water and soil resources, plants and animals' diversity, food production and food securities and energy resources. Nevertheless, the dynamic nature of ecological systems is continuously influence by climate variabilities. Climate change has the multifaceted potentials to affect the geographical location of ecological systems the species they contain and ability to offer a wide range of benefits on which society depend on for their sustained livelihood generations Climate change is often considered a key threat to the survival of species and the reliability on the forest ecosystems world-wide. It is believed that the effects of climate change on forests will continue to alter forest in many ways, resulting to change of many services that forest ecosystem provide. In the forest zone of Cameroon recent studies indicated that climate change is already having adverse impact on the livelihood strategies of rural people (Bele et al., 2013). Drought, changing seasons, erratic rainfall patterns, heavy rainfall and strong winds are among the main climate- related disturbances perceived by local people. Although some individuals have developed coping strategies, there is a limit of broader community resilience that can be fostered through such individual's efforts (Bele et al., 2013). It is important to understand and know the impact of climate change on the livelihoods of the forest dependent communities and the respond of these communities within the context of their adaptation strategies which in future will reduce their vulnerability and enhance

their livelihoods activities. The roles play by forest-dependent communities through incentives, motivation and participation in design and the implementation of adaptation strategies. This research aims at contributing to the growing literature on climate change vulnerability and the adaptation strategies in forests dependent communities in Cameroon.

1.2 Conceptual Frameworks

Vulnerability is a word that is familiar to most of the people and is commonly used to refer to something that is at risk of being harmed. Many specific technical definitions of vulnerability have been developed to meet the needs of different social and ecological fields of investigation. This research uses the technical definition of vulnerability given by the Intergovernmental Panel on Climate Change (the IPCC), where vulnerability is described as:

The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. (IPCC, 2014)

Resilience, a concept related to vulnerability, is also considered when projecting how systems may respond to climate change. The IPCC (2014) defines resilience as:

The capacity of social, economic, and environmental systems to cope-up with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.”

Vulnerability and resilience are, therefore, related aspects of how systems are affected by climate change vulnerability reflects the harm that may be caused to a system by climate change, while resilience reflects the ability of a system to “carry on” despite being exposed to climate change (Brugère and De Young, 2015). Although they are closely linked concepts, vulnerability and resilience are not opposing concepts, since a system can be both vulnerable to climate change and resilient, if it has the capacity to recover from and adapt to damage caused by climate change (Buckle et al., 2001, Gallopin, 2006). Vulnerability and resilience can be analyzed by considering the impacts on a system caused by climate or extreme weather. Climate change impacts are often characterized using three factors: the exposure to potentially damaging climate or weather; the sensitivity of the system to that exposure, and the ability of the system to adapt once the exposure has happened. These three factors, exposure, sensitivity and adaptive capacity, are core elements of many approaches to assessing the vulnerability and resilience of systems to climate change (Fritzsche et al., 2014). The IPCC (2014) defines exposure, sensitivity, impacts and adaptive capacity as follows:

- Exposure is the presence of people, ecosystems, infrastructure, or a species, in an area expected to be exposed to changes in climate or to extreme weather, either under present conditions or in future.
- Sensitivity is the magnitude of the direct or indirect effects of climate or extreme weather, either adversely or beneficially, relative to the climatic event.

- Impacts are the observed effects of climate and extreme weather.

Adaptive capacity is the ability of a system or a species to respond to climate change or a climatic event in a way that reduces harmful impacts. The relationships of vulnerability and resilience to exposure, sensitivity and adaptive capacity are shown diagrammatically in Figure 1. The damage caused to the system which reflects the system's vulnerability is the outcome of the exposure, sensitivity and adaptive capacity. The ability of the system to retain its function – the system's resilience – reflects how well the system can recover from the exposure to climate change. Among the components, exposure and sensitivity is determined by the intrinsic attributes of the system. Exposure and sensitivity can increase or decrease according to the perturbation of external environments. Adaptive capacity of a system concludes how much a system is vulnerable or resilient to the perturbation.

- **Environmental Degradation in Mambioko Community Forest**

The principal cause of environmental degradation as reported by the local communities during the focused group discussions and field survey were bush fire with an estimated 50 ha forest being cleared every year as dry season has been come to prolong resulting to drought and flooding of some food crops farms as the rainy season has been too rainier.

2.0 Literature Review

In the forest zone of Cameroon recent studies indicated that climate change is already having adverse impact on the livelihood strategies of rural people (Bele et al., 2013). Drought, changing seasons, erratic rainfall patterns, heavy rainfall and strong winds are among the main climate- related disturbances perceived by local people. Although some individuals have developed coping strategies, there is a limit of broader community resilience that can be fostered through such individual's efforts (Bele et al., 2013). It is important to understand and know the impact of climate change on the livelihoods of the forest dependent communities and the respond of these communities within the context of their adaptation strategies which in future will reduce their vulnerability and enhance their livelihoods activities

Adaptation to climate change targets the impacts of climate change by reducing vulnerability and/or enhancing resilience. Changes in the earth climate system have introduced new dynamics and uncertainties on agriculture systems, with increasing unevenness in inter-annual and seasonal climate patterns (Crane, Roncoli, & Hoogenboom, 2011). In this light, the adaptation of agricultural systems is necessary to reduce vulnerability and enhance adaptive capacities (Smit & Skinner, 2002). The adaptation of agricultural systems to climate change is a function of the type of climatic stimuli, location, farming characteristics, political, economic and institutional contexts in which policies are designed and implemented (Bryant et al., 2000).

In Cameroon, the agriculture sector and other forest-related sectors (water, energy-fuel wood, and food-NTFPs) are vulnerable to climate variability and vulnerability is further exacerbated by land degradation,

fragmentation and overexploitation of natural resources (MINEPDED, 2015; Sonwa, Somorin, Jum, Bele, & Nkem, 2012)

3.0 Study objectives

The objectives of this study are:

- To identify major climate sensitive livelihood resources at the household level.
- Examine the level of dependency on climate sensitive livelihoods resources and their perception of climate change impacts on their livelihoods.

To examine the socio-economic vulnerability and the available coping and adaptation strategies.

Materials And Methods

4.1 Study area Description and Methodology

The site selected for this study (Mambioko) is about 40km away from the chief town of Ngambe-Tikar sub division. It was selected based on the accessibility, number of villages, and dependency of the community on climate sensitive livelihood resources. The study site is covered by a community forests (Mambioko community forest) and it fall in the bi-modal humid forest agro-ecological zone with an annual rainfall range of 1,500–3,000mm and mean temperature of 23°C and covered a surface area of 4684 hectares with a population of about 800 inhabitants and a population density of about 7 people per km². They are found in the transition zone between Northwestern Congolian lowland forests and Northern Congolian forest-savanna mosaic. The local economy is based on the exploitation of natural resources including timber agriculture, hunting, fishing and the exploitation of non-timber forest products (NTFPs). The area is characterized by an equatorial climate, made up of two dry seasons (November –

February and July – mid-September), and two rainy seasons (March to June and mid-September late October. Annual rainfall is between 1,600 mm and 1,700 mm and average temperature range from 19°C to 29 °C

Figure 2: layout map of the study site

4.1.2 Methodology

1. Data collection

Secondary data was obtained through desk review of related literature from published and unpublished sources. A survey and primary data collection was collected within five months from February 2018 to July 2018 in villages that constitutes the study area. Primary data was collected through structured questionnaire for conducting interview at household level. In each village, the households were selected

based on their availability of individuals, their willingness to participate in the interviews and their estimated numbers as given by the village head and the age chosen that was from 27 years and above was based on their longevity in the study site; experienced in local climatic variability and climatic changes. Additional information was collected from key informants through focus group discussions or village meetings. Tools used include; brainstorming, historical trend analysis diagnosis, visioning, process documentation. Tools which were used include; brainstorming, historical trend analysis diagnosis, visioning, process documentation.

1. Data Analysis

Data were analyzed descriptively using excel spread sheet. Statistics were carried out where necessary to test for the level of significance among variables. Analysis were made at the level of the agro-ecological zone

Results And Discussion

5.1 Major climate sensitive livelihood resources.

According to some households during survey, fishing was identified as major climate sensitive livelihood activity and ranked the lowest climate sensitive livelihood activity (1.75%) of the respondents their major livelihood activity was fishing. Hunting was identified as another major climate sensitive livelihood activity (1.7%) of the respondent their major climate sensitive livelihoods activity was hunting, which ranked the second lowest. Others livelihood activities were (non dependent on climate sensitive livelihood activities like business and white collar job).The collection of NTFPs was also another major climate sensitive livelihood activity/resources (61.3%) of the respondents do carried out the collections of NTFP as their major livelihood activity and was ranked the second highest major livelihood activity and agriculture ranked the highest major livelihood activity (100%) of the respondents carried out agriculture as their major livelihood activity. From this study it was observed that, the entire households do carry out different agricultural activities but to some households it is not their major livelihood activities (Figure.3)

5.2 Level of dependency on climate sensitive livelihoods resources

In the study area, respondents ranked their level of dependency on climate sensitive livelihood activities/resources based on the significant contribution climate sensitive livelihood activities/resources (tree products, plant materials and forest product for food and agricultural activities like farming) make to household's income and other household needs (Figure.4). The three-level ranking was used based on the significant role these resources play in livelihoods sustainability. (High dependency = Home consumption and frequent sale of surplus on the local market; Moderate Dependency = Home consumption and occasional sale on the local market; Less dependency = Home consumption only) Generally, (46.7%) of

the total respondents were ranked as high level of dependency on forest resources. In this category, respondents described the contribution of climate sensitive livelihood activities/ resources to household's income as very significant. The study showed that level of dependency on fishing was(11.8%) following the field survey which ranked the third lowest dependency, follow by hunting which recorded a percentage of (6.8%) which ranked the second lowest dependency while others activities recorded (3.4%) level of dependency which ranked the lowest dependency while the collections of NTFPs recorded (39.8%) of dependency which ranked the second highest dependency and finally agriculture recorded the (99.2%) level of dependency and was ranked the first highest level of dependency following the survey.(Figure.4)

5.3 Perception on climate change impacts on major livelihoods resources (agriculture and its indicators)

Agriculture is still highly dependent on climate; temperature, light, and water are the main drivers of crop growth. The perception of climate change impact on agriculture was based on the following indicators like pest and diseases, drought, erratic rainfall, prolong, rainfall, low production, changing seasons and strong winds. In this study (74.6%) of the respondents agreed that pest and diseases have been affecting their agricultural activities in the past 10 years especially cocoa. This finding is like the study of (INS,2009b). Low production (83.2%) of the respondents agreed that this have been the principal climatic threat to their agricultural activities leading to food insecurity in these communities. Erratic rainfall as one the indicator, (81.5%) of the respondents believed the climatic stress they are facing on their agricultural activities is erratic rainfall which have change their traditional farming which they use to have in the past. This finding is like another study carry out (Bele et al.,2013). According to the survey (54.2%) of respondents agreed that prolong rainy seasons was affecting their agricultural activities which result to post harvest problem and food insecurity. This finding is similar to the study carried out by ((Yengoh et al., 2010a). In addition, (97.5%) of respondents said strong winds is one of the climatic stress affecting their livelihood activity (agriculture). This finding is like the study carried out by (Bele et al.2013). Following the household survey, (94.1%) of respondents agreed that the increase in climatic events like drought have increase food insecurity in this communities which their livelihoods depend on agriculture. (Figure.5). According this communities, changing seasons (100%) of the respondents is affecting the production calendar which at first was clearly defined but now farmers needs to adapt to unpredicted rainfall and dry season patterns. This finding was revealed by (Chia et al.2011).

5.4 Respondents perception of climate change impact on fishing and its indicators

Fishing is another activity and a source of income to some households in the study area. According to responses during the survey, (9.8%) of the household agreed that, the drying of water courses due to unreliable rainfall have reduced fishing ground in this communities leading to reduction in the quantities of fish which is caught, for the past 10 years for commercial and for subsistence. In addition, drought (93.2%) of the households agreed that, the principal climatic threat to fishing activity was drought especially during the short rainy seasons reducing food compliments of the households. (Figure.6).

Furthermore, household responses (69.5%) agreed that heavy rainfall is the climatic disturbance affecting fishing in this communities especially as the rainy seasons have been come rainier in the past years.

5.5 The perception of respondents on the impact of climate change on NTFPs

Forest resources in the form of NTFPs serve as safety nets, sustaining the livelihoods of some forest communities in Mambioko. 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 Ngoume and the access to NTFPs is open to the peoples in both community forest settings. They collect NTFPs known as Mbalaka, Maobi (*Baillonellatoxisperma*), Nguimba, Bush mango (*Irvingagabonensis*), Njansang (*RicinodendronHeudelotti subsp. Africanum*). NTFPs collection is very strategic in the Mambioko CF, it constitutes about (39.9%) of main livelihood activity and source of income. In this study 91.8% of the household agreed that heavy rainfall prevented the collections of NTFPs especially fuel wood which by is used all the household in Mambioko CF. Households involved in the collection of NTFPs as a main livelihood activity especially in Bidi the 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. In addition, (94.3%) of the household agreed that drought as one of the climate impacts on climate sensitive activities/resources in these communities. Drought have caused serious problem in collection of some NTFPs species especially njansang which have become very difficult for back to decompose and cracking to remove the nuts. Furthermore (98.1%) of the household indicates that changing seasons is currently affecting the collections of NTFPs due to unpredictable pronounce seasonality like the occurrence of dry Months which have become drier, occurrence less precipitation has reduced the resilience of some plants species due to prolong dry season. Also (84.9%) of the household agreed that erratic rainfall is affecting the collection of NTFPs especially the harvesting of certain fruits in some tree species according some household in Ngoume is very poor due pests and diseases that affect the flowering of this fruits base on their local knowledge.

5.6 Socio-economic vulnerability of respondents in the study site base on six selected indicators

The socio-economic vulnerability in the study site was estimated using six socio-economic indicators. In the estimation, the following assumptions were made:

5.6.1 Household size (HH): Higher household size is associated with higher vulnerability

5.6.2 Level (LE): Lower education level is associated with higher vulnerability

5.6.3 Level of Awareness of Climate change issues (Access to Climate Change information (ACI): Lower access to climate change information is associated with high vulnerability

5.6.4 Dependence on climate sensitive activities/resources (DCO): Higher dependence on climate sensitive occupation is associated with higher vulnerability

5.6.5 Low income (High income is associated with lower vulnerability and lower income is associated with high vulnerability)

5.6.6 Poverty is associated with high vulnerability

5.7 Coping and adaptation strategies.

The enabling framework for gaining access to both this knowledge and the resources with which it can be translated into concrete actions that promote adaptation, however, must be provided by governmental and non-governmental institutions at the local, national and international level (Yengoh et al. 2009). The importance of indigenous people as an indispensable asset of knowledge on environmental issues and problems in their communities is well-known (Johnston et al. (2009). At the centre of this communication and collaboration, Vignola et al. (2009) advocate an ecosystem-based framework in which addressing the problems of ecosystem degradation and the conservation of natural capital are the main focus. In this study, (4.2%) of the household used fertilizers in their farms in order 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 off roof their houses and most households used their traditional methods to protect winds by tying red pieces of cloths round their farms land. Additional (7.6%) of the household have adopted irrigation system of farming during the prolong dry seasons and drought, they moved to swamps areas and opened their new farms where water is available throughout the year the local farmer used watering cane to send water into the farms. They described this irrigation system as “climatic push factor”.

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 this communities. This finding is like other studies carried out by (IDRC, 2009). Household in the study area has expressed their willingness to integrate other livelihood activities like food crops and livestock rearing (sheep) have increase their source of income especially small farmers in the study area. This is similar to the findings of (Yengoh et al. 2010). The head master of the Mambioko primary school have initiated beekeeping farming in the Mambioko village though he faced a lot of challenges(financial and technical) This study also show that diversification as an adaptation option at the local levels, cuts across different sectors (environment, forest and wild life, livestock and fisheries, agriculture and rural development, scientific research, finance and commerce), thus it requires the development of inter-sectoral coordination. This finding is supported by that of Yengoh et al (2010), which draw attention to the fact that coordination and collaboration is required between sectors that build the capacity of rural livelihoods.

In this result (69.7%) of household have diversified their occupation in order 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 dress making

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 centres in search for jobs resulting to rural exodus in the study site. Finally, (78.2%) of respondent have increased their farms sizes. According to the household, they increase their farms sizes every beginning of farming season 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 (Figure.8). This supported the findings carried around the same area (Bele et al., 2013a, 2013b and Chia 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. Increased climate variability and uncertainty seems to be one of the main disturbances shaping current vulnerability in these communities.

Conclusions

This study has investigated the adverse impacts of climate change effect at the household level of forest dependent communities in the case of Mambioko CF in the Centre region of Cameroon. It has also assessed the different coping and adaptation measures being adopted by these communities in the wake of a changing climate. Socio-economic vulnerability levels of this ecological zone have also been determined. Generally, the adverse effects of climate change on key livelihoods activities/ resources and its impacts on livelihoods over the years are already evident. Community perceptions indicate that they are vulnerable to the variation in local climatic conditions and the seasonal calendar, with noted variations in temperature and sunshine, rainfall, and other climate sensitive schedules such as sowing periods and harvesting periods. The secondly vulnerability fear is related to the high level of dependency on climate sensitive livelihoods activities/resources and to some extent the lack of knowledge; widespread poverty and capacity relating to coping strategies.

The communities ranked as highly vulnerable based on the socio-economic vulnerability indicators used. Generally, the high dependency on climate sensitive sectors tends to increase vulnerability to climate change especially, rural communities whose livelihood predominately depends on rain-fed agriculture and forest resources. In the light of this study, addressing the effect of climate change impact at the household level requires reducing the socio-economic vulnerability.

Critical issues such as options of alternative livelihood activities, access to climate, sustainable agricultural practices and agro forestry practices and sustainable forest resource management are key areas to focus. Significant contributions from civil society groups and relevant governmental institutions can play a key role in minimizing the exposure of forest dependent communities to the impact of climate change. This can be done through creating awareness and helping communities to cope and adapt to a changing climate by building on existing coping and adaptation measures whiles a more scientific approach to ensure sustainable livelihood are being developed.

Recommendations

Based in literature and results of this study, the following recommendations could be considered in enhancing the adaptive capacity of the Mambioko local communities:

1. Community resilience building plans should be work out as it will enhance their adaptive capacity there by reducing their vulnerabilities
2. The role of national and local government in further analyzing vulnerabilities livelihoods resources of the this communities in order develop adaptive capacity of local communities which cut across different sectors(intersectorial)
3. 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.
4. Setting up mitigation plans in this communities based on local reality will contributes in reducing the vulnerability of the local population
5. Alternatives livelihoods generation intervention (non dependent on climate) in this communities should be of prime important
6. Further research is encouraged in the wake of changing cropping patterns in this area.

Declarations

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Authors contributions:

Tieminie Robinson Nghogekeh: He generates the primary idea of this study and the write up of the paper

Chia Loh Eugene: He structured the manuscript and evaluates the quality of the manuscript

Piabuo Serge Madiefe: He did the data entries and analysis

Nghobuoche Frankline Mayiadieh: Contributed in data collections and final reviewed of the paper

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Appendix

This questionnaire is to elicit information on assessing the perception, climate change vulnerability and the response. Feel free to express your ideas because your opinion may go a long way to providing solutions that meet future needs for environmental friendly and sustainable rural livelihoods.

Section I: Biodata of respondents (socio-demographic)

Country.....village name.....

1) Name.....2) sex.....3) Number of children.....4) Age.....

5) Ethnic group.....6) Education a) formal b) Non formal.....7) Marital status.....

8) Number of wives.....9) Total number of dependent.....10) occupation a) climate dependent occupation b) non climate dependent occupation

Section II: Climate sensitive livelihoods activities/resource

1. Which is your main livelihood activities/resources do you carried out?

Livelihood Activities/resources

Agriculture
Fishing
Hunting
Collection of NTFP
others

1. What is your level of dependency on climate sensitive livelihood activities?

Major livelihood activities/resources and level of dependency

Agriculture	HD	MD	LD	Less D
Fishing				
Hunting				
Collection of NTFP				
Others				
Section III: Perception and level of awareness about Climate change				

1. What is your level of awareness about climate change?

High level
Moderate level
Low level
No level
No idea

1. Do you have access to information about climate change? a) Yes bs) No. If yes where do you get your information

Government institutions
NGOS/research centers
Social network (TV, Radio,)
Family and friends

1. Livelihood activities/resources and the perception of climate change impacts on the activities

2. Agriculture and its indicators

Changing seasons	Agreed	Don't know	Disagreed
Drought	Agreed	Don't know	Disagreed
Strong winds	Agreed	Don't know	Disagreed
Prolong rainfall	Agreed	Don't know	Disagreed
Erratic rainfall	Agreed	Don't know	Disagreed
Low production	Agreed	Don't know	Disagreed
Pests and diseases	Agreed	Don't know	Disagreed

1. Fishing and its indicators

Heavy rainfall	Agreed	Don't know	Disagreed
Drought	Agreed	Don't know	Disagreed
Drying of water courses	Agreed	Don't know	Disagreed

1. NTFP and its indicators

Heavy rainfall	Agreed	Don't know	Disagreed
Drought	Agreed	Don't know	Disagreed
Changing seasons	Agreed	Don't know	Disagreed
Erratic rainfall	Agreed	Don't know	Disagreed
Bush fire	Agreed	Don't know	Disagreed
Pests and diseases	Agreed	Don't know	Disagreed

1. Hunting and its indicator

Changing seasons	Agreed	Don't know	Disagreed
Heavy rainfall	Agreed	Don't know	Disagreed
Drought	Agreed	Don't know	Disagreed
Bush fire	Agreed	Don't know	Disagreed
SIV: socio-economic vulnerability and its determinants			
4According to you, your vulnerability to climate change impacts is due to which of the following socio economic indicators?			
Socio-economic vulnerability of these communities and its indicators/determinants			

Household size
Level of education
Access to climate change information
poverty
Level of income
Dependency on climate sensitive livelihood activities/resources
Section IV: Coping and adaptation strategies

1. Face with this climate change vulnerability and impacts on your livelihood activities/resources what measures have you taken in order to cope /adapt to this impacts?

Coping and adaptation strategies and its determinants

irrigation
Diversification of crops
Planting of trees to protect winds
Increase fertilizers
Diversification of occupation
Increase in cultivation of farms sizes

Figures

Figure 1

A model of factors that can be used to assess the vulnerability and resilience of ecosystems

Source: Based on Fossel and Klein,2006, and Gauthier,2014

Figure 1

A model of factors that can be used to assess the vulnerability and resilience of ecosystems.

Figure 2

layout map of the study site.

Figure 3

Major climate sensitive livelihoods Resources.

Figure 4

Level of dependent on Major climate sensitive livelihoods Resources.

Figure 5

Perception of climate change impacts on agriculture and its indicators.

Figure 6

Perception of climate change impacts on fishing and its indicators.

Figure 7

Climate change impact on NTFPs and its indicators.

Figure 8

Socio-economic vulnerabilities and its indicators.

Figure 9

Coping and adaptation strategies and its indicators.

Supplementary Files

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