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Local vulnerability, Forest communities and Forest-carbon conservation: case of southern Cameroon

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The mechanism for reducing carbon emissions through forest conservation is dominating climate policy processes in many tropical forests countries. However, there are concerns about the implications of these activities on forest-dependent communities, who are vulnerable to climatic stresses. Reconciling local vulnerability, adaptive capacity and forests carbon conservation initiatives is necessary but challenging. This paper examines this option in two community forests carbon conservation projects in Nomedjoh and Nkolenyeng in southern Cameroon. Base on community perception, the study reveals firstly, that communities are vulnerable to local climate variability and the carbon conservation projects might further exacerbate community vulnerability. Secondly, local adaptation needs and options encompass improvement in livelihood diversification, strengthening the viability of local economic activities, knowledge and capacity building in local agriculture systems and alternative livelihood options. Thirdly, the motivation, incentives and willingness of forest communities to participate in forests conservation activities are somehow influenced by factors linked to their adaptation needs, in addition to the perception of tenure security. Furthermore, the carbon project objectives and activities have prospects to enhance the adaptive capacity of forest communities if well implemented. This study concludes that assessing the vulnerability of livelihood options of communities to both climatic and non climatic stresses is a point of departure to minimise risk on forests carbon conservation schemes.

Key words: Adaptation, mitigation, local livelihoods, conservation, rainforest, Cameroon.

INTRODUCTION

Two opportunities to tackle the present and future impacts of climate change include; mitigation of climate change by reducing greenhouse gas (GHGs) emissions particularly carbon dioxide and methaneother green-house gases (GHGs); and adaptation by adjusting social and ecological systems to climate change impacts (Klein et al., 2005; IPCC, 2007). In the forest sector, mitigation on the one hand is presently dominated by the reduced emissions from deforestation and forest degradation (REDD+) mechanism; with the 'plus' denoting carbon sequestration and carbon stock enhancement (Murdiyarso et al., 2005). On the other hand, forest ecosystems

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and forest dependent-communities are vulnerable to the impacts of climate change requiring two approaches for adaptation (Locatelli et al., 2008). First, 'adaptation for forest', which necessitates the ecological system of the forest to adapt to climate change and secondly 'forest for adaptation' necessitating forests to provide goods and services to cushion forests dependent-communities against climate change impacts (Locatelli et al., 2008).

Research has underscored the potentials of linking adaptation and mitigation strategies and activities in the forest sector (Guariguata et al., 2008; Locatelli et al., 2010; Ravindranath, 2007). Integrating mitigation and adaptation provides a bundle of socio-economic, biodiversity conservation and other environmental benefits (Dang et al., 2003; Klein et al., 2005; Ravindranath, 2007; Ayers and Huq, 2009). Furthermore, with financial resources being directed towards mitigation than adaptation, it is essential to define mitigation policies and projects that contribute to the adaptation of forest communities (Ayers and Huq, 2009). However, climate policy response sets which include both options – adaptation and mitigation – are still receiving less attention in the climate change response processes, especially in the developing countries. This could be due to the limited knowledge on the commonalities between adaptation and mitigation (Dang et al., 2003).

The southern rainforest of Cameroon is part of the trans-boundary Congo basin forest ecosystem. The region is second to the Amazon in terms of biodiversity and it contains about 25-30 million tonnes of carbon which is threatened by anthropogenic carbon emission activities such as slash-and-burn agriculture, plantation agriculture, logging and fuel wood extraction etc (Haore, 2007; Nkem et al., 2010; CBFP, 2006; Robiglio et al., 2010). These aspects have drawn so much attention for the region regarding its potentials for the REDD+ mechanism. The millions of people inhabiting the southern rainforests of Cameroon and the Congo basin region in general depend directly and indirectly on ecosystem goods and services for food, fibre, energy, water, medicine etc (Nkem et al., 2010). Recent findings indicate that forests and forest related sectors for example food, energy, and water are vulnerable to climate change and variability in the region (Sonwa et al., 2012) and the forests provides opportunities for forest dependent communities to adapt to climate change and variability (Haore, 2007; Justice et al., 2001, Nkem et al., 2010, 2013).

Given that, adaptation and mitigation strategies are both relevant for the Congo basin region. However, climate change policy analysis in the region indicates that mitigation is dominating the process compared to adaptation and the integrated - adaptation and mitigation option. Political interests are strong for mitigation due to the available financial and investment flows, scientific uncertainty, and lack of knowledge and information related to the other options (Somorin et al., 2012; Martens et al., 2009). In Cameroon, designing and implementing adaptation and mitigation in synergy will minimise duplication of activities; financial, technical and material costs (Somorin et al., 2012). Nevertheless, bottom-up opportunities and challenges in linking adaptation and mitigation is relevant to support the design of 'win-win' strategies at the national level.

It is against this backdrop that the paper seeks to explore the links between adaptation and mitigation at the project level by examining local vulnerability and adaptation needs of forest-dependent communities in relation to climatic and non- climatic changes and their possible implication for forests carbon conservation activities in two community forests (Nomedjoh and Nkolenyeng respectively) Payments for Ecosystem Services (PES) projects in the Southern rainforest of Cameroon. Drawing from the perception of communities the paper focuses on identifying the incentives, motivations and willingness for communities to participate and adhere to forest carbon conservation conditions.

MATERIALS AND METHODS

Theoretical background for linking adaptation and mitigation

At the project level, adaptation opportunities exists in mitigation activities, while on the other hand, adaptation activities can promote forest conservation, biodiversity and enhance the conservation of carbon sinks (IPCC, 2007; Ravindranath, 2007). Some factors and principles have been identified to verify and guide the extent to which synergy and trade-offs exist between adaptation and mitigation activities.

First, identifying the individuals or communities participating in the response options is crucial. It is important to determine the extent to which the communities targeted for adaptation and mitigation activities overlap. The communities to be involved in adaptation activities are identified by vulnerability assessments and the vulnerability of such communities to climate change may be determined by food security, skills and capacity, level of development and primary economic activities. Subsistence agricultural communities with high food insecurity and with little livelihood diversification have less opportunities to respond to climate change. The willingness and capacity of the population to participate in mitigation strategies can also be determined by the socio-economic situation of the communities (Murdiyarso et al., 2005). However, these are relationships that require empirical investigation. Murdayarso et al. (2005) further highlights that the vulnerable groups in most communities are the poor and food insecure people who depend on agriculture and other natural resources for their subsistence. Conversely, their efforts and incentives to participate in response activities may be influenced by access and use of resources, land tenure arrangements etc. It is therefore important to question whether addressing the constraints arising from the vulnerability of communities can provide a basis to design policies that offer better opportunities for adaptation and mitigation activities.

Second, the location of the project is very critical in determining the need for adaptation and the effectiveness of mitigation. Climate change impacts and vulnerability of communities are spatially distributed. Communities in vulnerable agro-ecological areas require more efforts in terms of adaptation. Mitigation potentials are also spatially distributed. Characteristics of soils, topography, land-cover use and climate patterns drive the potential productivity of

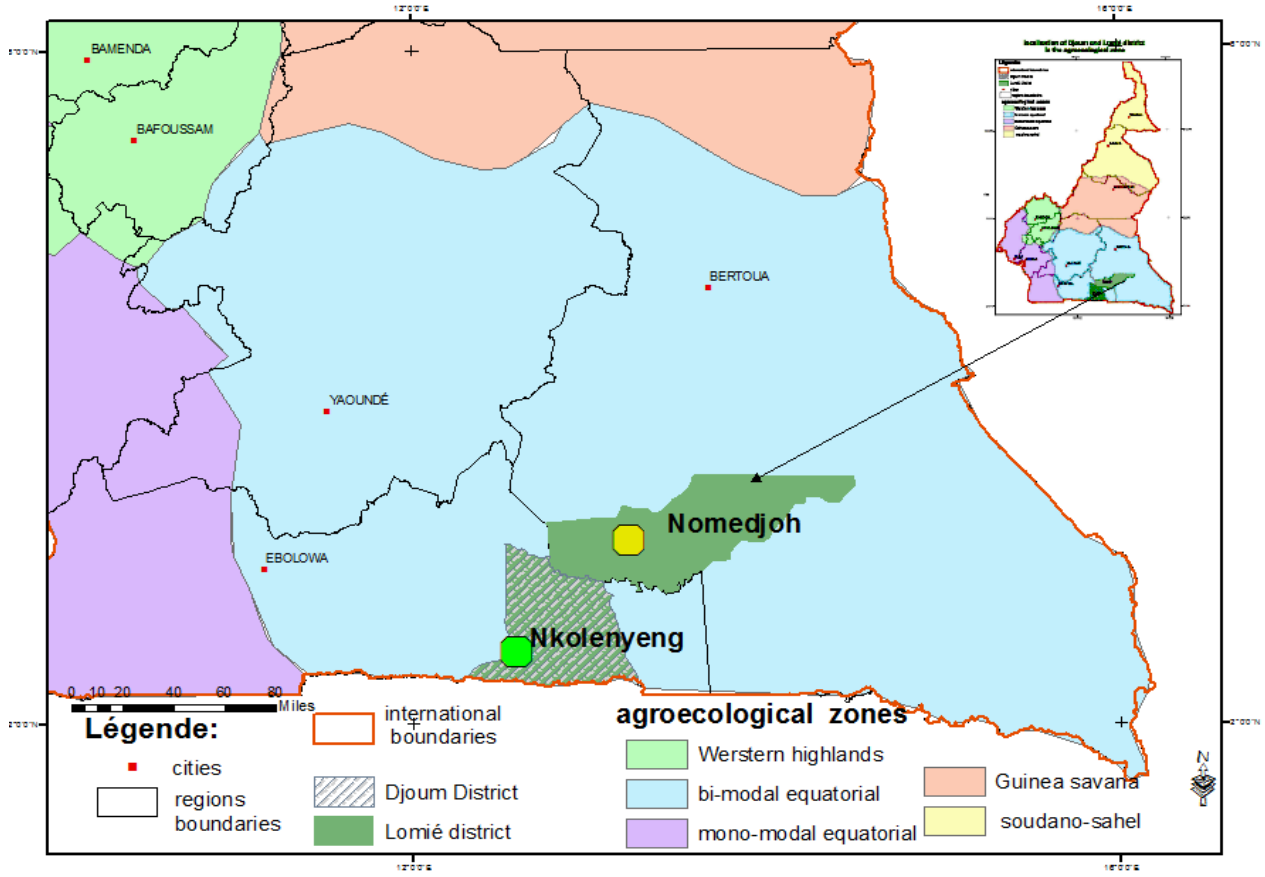

Figure 1. Map of Cameroon showing the location of the two community forest areas.

sequestration as well as alternative land uses, which ultimately will determine the incentives and feasibility to participate in sequestration programs (Murdiyarso et al., 2005).

Third, it is also important to know whether a particular activity on the adaptation or mitigation side increases or reduces vulnerability. Market instability can be a major source of risk to vulnerable populations, and interventions aimed at organizing markets, can provide an effective way to reduce vulnerability of forest commu-nities to climate change and may increase willingness or incentives to participate in climate change response options (Nkem et al., 2010). Mitigation strategies can reduce the vulnerability of vulnera-ble populations through income diversification. Income can be generated from mitigation services like carbon markets and through the diversification of agricultural activities like agro-forestry and exploitation of non-timber products and energy products (Murdiyarso et al., 2005).

Study approach and methods

Study area

The two selected community forests, Nomedjoh and Nkolenyeng, are located in the rainforest of southern Cameroon, and they fall in the bi-modal humid forest agro- ecological zone with an annual rainfall of 1,500-3,000 mm and a temperature of 23°C (Bele et al., 2013).

Community forests management in Cameroon emerged after the 1994 Forestry law. The law gave rights to communities to manage a forest area not exceeding 5000 hectares, after a management agreement between village community and state forests administration, for a period of 25 years renewable after every 5 years (GoC, 1995).

The Nkolenyeng community forest is located in Djoum subdivision in the Dja and Lobo division in the South region of Cameroon (Figure 1). It was created in 2005 with a surface area of about 1,042 hectares (BRD, 2010). Nomedjoh is located in Lomie sub-division in the Upper Nyong division in the East region of Cameroon (Figure 1). The village is situated along a 2 km distance on the Abong-bang - Lomie road and the area of the community forest extends over 1942 hectares. The characteristics of the two study sites are presented in Table 1.

The PES projects are part of the Congo Basin Forest Fund (CBFF) initiative with the objective of assisting forest communities in the Congo basin to conserve tropical forest by finding ways to integrate PES and community forest management. The projects have commitments to provide payments to communities for halting or slowing down deforestation. The projects are implemented by the Centre for Environment and Development (CED) with support from Bioclimate Research and Development, Econometrica and Rainforest Foundation of the United Kingdom.

Data collection

Data was collected from the Nomedjoh and Nkolenyeng commu-forest areas respectively using a combination of different methods. Focus group discussions were used during data collection with one focus group for each study area. Groups comprised of men and

Table 1. Summary of relevant information about the study areas.

Parameter	Nomedjoh community forest	Nkolenyeng Community forest
Region	South region of Cameroon	East region of Cameroon
Ethnicity	100% Baka indigenous community	92% Bantu, 8% Baka
Population	About 896	About 555
Size of community forest area	1942 ha	1042 ha
Main livelihood activities	- Traditional hunter-gatherer community -Collection and sale of Non timber Forest Products (NTFPs): Mbalaka, Nguimba, Maobi, Bush-mango, wild honey, raffia tree grubs -Hunting: monkeys, chimpanzees, porcupines, snakes, birds, and rats -Fishing : crabs, shrimps, silure and carpe -Some income from agriculture work in neighbouring	-Agrarian community -Agriculture: Cocoa, cassava, groundnuts, plantain , maize, coco-yams, sweet-potatoes -Hunting: monkeys, porcupines, rats, birds -Livestock: pigs and sheep
Type of agriculture activity	Subsistence: cassava, groundnuts, plantain , maize, coco-yams, sweet-potatoes	Subsistence and commercial agriculture
Major drivers of deforestation	Slash and burn shifting cultivation agriculture to establish mix agriculture fields	Slash and burn shifting cultivation agriculture to establish mixed agriculture fields for subsistence, expansion of plantation agriculture, illegal logging, energy (firewood)
Land acquisition/ownership processes	Inheritance, cleared forest	Inheritance, cleared forest

women with at least 30 years of age capable of providing data and information on observations on climate change and livelihoods relationships for the past 10 years. Brainstorming was the dominant tool used during the focus group discussions, including historical trend observations.

The focus group discussion was complemented by household surveys using semi-structured questionnaires. Simple stratified random sampling was used to identify households in Nkolenyeng, in which the community was divided into quarters (Eko-ze, Mone nlam, Mintom and Oding a Baka neighbourhood, and households selected from these quarters randomly. We made sure that respondents had a permanent stay in the area for at least 8-10 years. In Nomedjoh, one after every two households was sampled from the start of the village to the end, as the village is located along a 2 km road stretch. Questionnaires were administered to households independently, with each interview lasting between 45-54 minutes, with an average 65 household interviewed in Nomedjoh and 45 households in Nkolenyeng.

Informal interviews and discussions were held with the village chiefs, elders and other villagers involved in various village committees related to socio-economic issues and the management of the community forest institution. Community resource persons of the PES projects were also involved in the informal interviews and discussions. They provided information on the development and implementation of the PES project including practical challenges.

Field observation was employed focusing on farm sizes, distance of farms from households, farming methods, type of crops, respect of PES conditions, activities of the PES project such as experimental farms, cocoa and tree nurseries and bee-keeping activities.

SPSS package was used to analyse the data collected. Frequency and proportions were analysed in percentages to identify dominant responses between households.

RESULTS AND DISCUSSION

Perception of vulnerability to climatic variability in project areas

The vulnerability of human-environmental systems is determined by exposure, sensitivity and the adaptive capacity of social-ecological systems. Exposure relates to the potential impacts as a result of changes and variation in temperature, changes in rainfall, changes in seasonal patterns and changes in climate sensitive and related resources and activities (Ionescu et al., 2009; Locatelli et al., 2008; Yengoh et al., 2010). Climate change is expected to exacerbate the vulnerability of communities with adverse impacts on livelihood options (Somorin, 2010).

Results from focus group discussions in both communities expressed observable variations in temperature and sunshine, variation in rainfall, variation in water sources, variation in appropriate sowing period and variation in appropriate harvesting period. Survey results confirmed focus group results across the two areas with respondents having observed variations in the order of temperature and sunshine (96%), rainfall (99%), diseases

and pest (5%), variation in sowing period (82%), variation in water resources (8%) and variation in harvesting period (78%). The magnitude of the changes was difficult to observe; observations centred on uncertainty, irregularity, and periodic changes. “Rain comes unexpectedly during periods observe as dry season and delay to come during periods when rain is expected following the local seasonal calendar” a villager said. This is same with temperature and sunshine. A distortion in the local seasonal calendar was expressed in the focus group discussions which considered are linked to major climate sensitive schedules such as sowing/planting and harvesting periods. Local people described the present situation as *“accident climatique”, (“climatic accident”)*. Some authors assert that inherent variation of climate from year to year and from season to season, makes variability an integral part of climate change (Berz, 1999; Hulme et al., 1999).

Climatic conditions such as rainfall, temperature vary significantly over short periods of time that is from season to season and from year to year, and at relatively smaller spatial scales and may bring surprises to an otherwise unsuspecting population as noted by other researchers (Yengoh et al., 2010). Exposure to isolated surprises, either man made or natural, is a threat to the adaptive capacity of agriculture dependent communities. In addition, it reduces the potentials of these communities to attain the objective of food sufficiency and better nutrition. Locally specific climate stressors with low predictability are mostly likely to negatively affect small-holder and subsistence farmers (Morton, 2007). About 82 and 85% of respondents for Nkolenyeng and Nomedjoh respectively indicated that a considerable percentage of households have experienced and also predicted the impacts of unexpected variation of local climatic conditions on their livelihood activities. Farmers complained of a distortion in the different stages of crop production such as farm preparation, planting or sowing, farm maintenance and harvesting. Abortive germination of crops was a major complain from farmers, as a result of over and unexpected sunshine and temperature during periods initially observed for rainfall. Cocoa farmers also complain of poor harvest attributing it to prolonged rainy season observed in the area. These findings are in accordance with similar studies carried in the same humid forests zone of southern Cameroon on community vulnerability and coping strategies in Yokadouma and Nkol-evodo (Bele et al., 2013).

Despite the lack of clarity on the drivers and magnitude of change observed, changes observed relate to more or less the observations and predictions of the IPCC (2007) for variations in temperature, precipitation and a distortion in the seasonal calendar in general. The perception of a decline in agriculture production in community areas is in accordance with the IPCC predictions for Africa, which indicates that agriculture production will decline with ensuing impacts on food security and income (IPCC, 2007).

Furthermore, traditional post harvesting techniques have been greatly affected by prolonged rainy seasons. The method consists of leaving part of the produce in the fields for preservation, but rainfall uncertainty and the lack of alternative preservation techniques and preparedness drive farmers into difficult situations. This affects income generation from crop production as indicated by other studies (Yengoh et al., 2010).

Households involve in the collection of NTFPs as a main livelihood activity especially the Baka households in Nomedjoh 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. Base on local knowledge, communities attributed the poor flowering to the ‘accident’ in the climatic system. A 54 year old focus group participant in Nomedjoh said: “*I am sure the present accident in the climate will also affect our fruit trees in the future”.* Ndangalasi et al. (2007) affirms that climatic and other edaphic factors influence NTFPs productivity, density and distribution. In this circumstance of uncertainty related to future NTFPs collection, households in Nomedjoh are predicting possible decline in income from NTFPs.

Vulnerability to non-climatic stresses in Nomedjoh and Nkolenyeng

The vulnerability of human-environmental systems is also defined as a function of adaptive capacity. Adaptive capacity of local communities is also defined as a function of access to resources, income, food security, knowledge, information and technology (Brooks and Adger, 2005). Communities deficient in any of the factors mentioned have lesser capacity to adapt, thus are more vulnerable to climate variability and change (Romero, 2005; Yohe, 2001). The conservation conditions put in place by the carbon conservation projects is seen to have implication for the main livelihood activity and the source of income according to respondents in Nkolenyeng (88%) and Nomedjoh (22%). The differences is due to the fact that many households (91%) are engaged in agriculture as their main source of income in Nkolenyeng, as compared to Nomedjoh (15%) (Table 2) and the conditions put in place by the PES project has direct repercussion on traditional agriculture practices. First, the conservation project has forbidden slash-and burn method of farming in the community forest areas, a farming method communities describe as productive and less labour intensive. A 62 year old farmer in Nkolenyeng complains: “*At my age I have little energy to prepare my fields without burning, so for now with the project conditions I will prepare only a small portion”*. In this situation farm sizes will not be increased due to much work involved in preparing fields for planting. A decline in farm sizes indicates a decline in crop production and a subsequent threat to food security and a potential decline in income from agriculture.

Table 2. Socio-economic features of study areas captured in the sample.

Attributes	Nomedjoh (N=65) %	Nkolenyeng (N=45) %
Main livelihood activities		
Agriculture	15	91
NTFPs collection	66	0
Hunting	22	2
Fishing	3	0
Others	0	7
Scale of agriculture activity		
Subsistence	95	96
Small-scale	8	13.3
Plantation	0	76

Second, the yearly opening of new agriculture fields in the virgin forest which is a routine and a necessity for farmers in the forest communities both for subsistence and commercial purposes is unacceptable under this PES regime. Agriculture has been limited only to existing fallows in the community forest areas. According to household (96%) in both communities, the opening of new fields is a yearly routine. Newly open fields in the virgin forest are more fertile, with high agriculture productivity. In this regard a decline in future agriculture productivity with subsequent impact on food security and income has been predicted by farmers especially in the Nkolenyeng community forest area where agriculture is the main livelihood activity.

On the other hand, the collection of NTFPs and hunting constitute the main livelihood options for the Baka ethnic group in Nomedjoh (66% for collection of NTFPs and 22 % for hunting) (Table 2), and the PES project has no major limitations on hunting and gathering activities. Any constraint on their subsistence agriculture activities which is mostly an alternative livelihood option will be supported by NTFPs collection and hunting activities. This implies that the PES carbon project might reduce the adaptive capacity and exacerbate vulnerability of communities by limiting access to agriculture land with subsequent impacts on food security and local economic viability. This is in line with the findings of Yohe (2001) and Romero (2005).

Adaptation to local climate variability and forest-carbon conservation conditions

Local communities need strategies to reduce their vulnerability to climate variability as a result of exposure and sensitivity of their livelihood activities. Furthermore, communities need to enhance their adaptive capacity which has been influenced by the changes in land use activities enforced by the forest-carbon conservation projects.

Local adaptation needs of rural communities are linked to income and food security, alternative income sources and livelihood diversification, information, knowledge and capacity building (Sonwa et al., 2012). In a situation of unpredictability and unevenness of rainfall and temperature, and the presence of the carbon project, farmers stressed the need to intensify their local agriculture enterprises in other to sustain income and food security. This implies adjusting and improving (technically, financially and materially) agriculture activities to reduce the vulnerability and increase the adaptive capacity of households. However, the various agriculture strategies envisaged should be capable of adapting to the local agriculture landscapes in the study areas, taking into consideration local climate variability and uncertainty. Before the carbon conservation projects, the expansion of cultivation areas into the virgin forests was a coping strategy employed especially in Nkolyenyeng and to a lesser extend in Nomedjoh. Increasing the sizes of agricultural fields is a coping strategy employed by forests communities to adjust to climatic changes (Bele et al., 2013).

In relation to crop production, farmers in both community forests areas expressed the possibilities of engaging into more mixed cropping, multi-level cropping and in the planting of improved and new crop varieties. A farmer in Nkolenyeng said: "*It might be helpful if we plant seeds that can resist in the soil and wait for the rain; however it is not a guarantee because the weather really behaves funny nowadays".*

Garden farming appeared to be of major interest to households in Nomedjoh, in which with limited rainfall, crops can be supplied with water using watering cans. In addition soil fertility of gardens can be improved by using organic manure. This aspect can enable year round production of certain crops. Capacity building through the strengthening of local agriculture systems, empowering of local agriculture knowledge and innovations and information sharing are relevant adaptation strategies (Somorin, 2010).

Cocoa production, a major agriculture activity in Nkolenyeng can also be improved through pruning of diseased and dead branches, burying of diseased cocoa pods, planting new rootstock, grafting new higher yielding

or more resistant varieties, more effective crop spraying and improved drying and management techniques. Meanwhile, in Nomedjoh, introducing a cash crop like cocoa will reduce their dependency on NTFPs as the major source of income. However, if not well monitored it might lead to deforestation.

Improving agro-forestry through fruit trees was also highlighted during the discussion; households saw the planting of fruit trees as a means of supporting household food consumption and the source of income through marketing of fruits, nuts, and edible oils. Agro-forestry is a major climate change adaptation strategy for forest communities (Somorin, 2010; Verchot et al., 2006).

Initiating other income generating activities within the confines of local resources is of great importance, and the benefits are relevant for forest communities adjust to climate variability and uncertainty. Activities such as bee-keeping, improved collection and marketing of the differ-ent forest fruits, fish farming, and mushroom growing will enable households in the study areas to earn income from activities other than agriculture. This option is of great importance to the Nkolenyeng community forests area with a high dependence on agriculture.

Enhancing livelihood diversity is seen as an appropriate adaptation option to guarantee food security and lively-hoods in the face of climate extremes and uncertainty (IDRC, 2009; Paavola, 2008). Integrating livestock pro-duction and food production provide income, food production and security for small-scale farmers in deve-loping countries (Yengoh et al., 2010). Households in the study areas have expressed interest to engage in activities other than agriculture. Livestock was mentioned as a key activity, including beekeeping, mushroom far-ming, and fish farming discussions across the two com-munities. Livelihood and income diversification has improved the coping capacities of rural communities to climate change and variability (Robledo et al., 2012).

However, improving alternative livelihood options de-pends on financial, technical and institutional support (Robledo et al., 2012).

Furthermore, communities are still struggling to under-stand and master the *"climate accident"*, they need know-ledge and information support in this particular aspect. The need of forest communities to enhance their adaptive capacity involve a variety of research domains, which requires a multi-disciplinary information and knowledge sharing approach to minimise challenges arising from the implementation, a position shared by Howden et al., (2007).

The commercialisation of agriculture commodities and NTFPs constitute the main economic activity in the study areas. Marketing is done within the community (23%) or with traders from outside called 'buyam and sellam' (78%) or through common initiative groups (22%) for the case of cocoa. The household survey reveals that some 38% of households are not satisfied with the market prices. They attribute low prices to poor road infrastruc-ture linking their communities with major towns. However, there is difference in perception between households in the Nomedjoh and Nkolenyeng, regarding market prices. The difference is due to the fact that the Baka community in Nomedjoh is still getting acquainted with monetary value and the worth of products and market price fluctuations. On the other hand, the Nkolenyeng com-munity is a long time cash crop community with much knowledge about the value of money, market value of goods and price fluctuation. In addition to the market experience the difference in commodities marketed between the two communities may also influence percep-tion on market prices. Better market prices and road networks, will increase household benefits and improve household income. This will improve the adaptive capa-city of households against climatic uncertainty and expo-sure. This finding confirms that of Nkem et al. (2010) which emphasize that better returns and benefits from commodities may improve the role of forest goods and services as safety nets for adaptation to climate change by forest dependent communities.

The adaptation needs highlighted by research partici-pants are related to coping strategies reported in Yokadouma and Nkol-evodo, including agriculture im-provement through resistant crop varieties, better timing of planting and harvesting periods, better after harvest food storage, livelihood diversification and knowledge generation and training (Bele et al., 2013).

Research has shown that the Bantu and Baka popula-tions have contrasting lifestyles which has implications on their vulnerability and adaptation needs (Nkem et al., 2013). However, lifestyles of the Baka and Bantu popula-tions in the study areas appear similar, indicating similarity in vulnerability and adaptation needs.

The Baka population in Nomedjoh and Nkolenyeng are presently practicing sedentary Bantu lifestyles as oppose to their traditional nomadic hunting-gathering dependent way of life. The Baka's are gradually getting interested in livelihood activities that demand permanent involvement and monitoring such as agriculture for subsistence and commercial purpose.

Forest carbon conservation projects and adaptation opportunities

Murdiyarso et al. (2005) assert that some mitigation stra-tegies such as income diversification, income from mitigation services, agriculture intensification and agro-forestry have the potentials of reducing the vulnerability of vulnerable populations. Furthermore, Somorin (2010) highlights that conservation and restorations of degraded forests are also vital for community adaptation to climate change. The objectives and activities of the conservation project provide opportunities to benefit communities in relation to their adaptation needs. The carbon projects have material, technical, financial and institutional sup-port initiatives relevant for enhancing the adaptive capa-

city of communities.

The forest protection and regeneration activity put in place has marked boundaries and created forest reserve zones. This activity might protect tree species relevant for NTFPs harvesting in the future, especially in Nomedjoh where NTFPs collection is a major activity.

The projects have initiated sustainable forest use and management. The project is increasing tree cover, by planting new trees in new fallows, old fallows and in cocoa farms. Tree nurseries have been established with native tree species e.g. Maobi (Baillonella toxisperma), Bush mango (Irvinga gabonensis). Promova et al. (2012) confirms that forests and trees can support adaptation by providing goods to communities facing climatic threats.

Sustainable agriculture activities have been initiated in the different project sites. Agro-forestry in addition to improve seed varieties and mixed cropping have been introduced in project areas. Agro-forestry can potentially improve soil fertility and provide households with fuel wood. Cocoa agro-forestry has been introduced in Nomedjoh, as an alternative income source to NTFPs. Agro-forestry is a relevant strategy for forest carbon conservation and adaptation to climate change (Ravindranath, 2007; Smith and Scherr, 2001). Agro-forestry systems are important for carbon sequestration and at the same time they provide biophysical and social support for vulnerable communities to adapt to the negative consequences of climate change (Verchot et al., 2006).

Significant emphasis was made on creating and ameliorating alternative income generating activities such as beekeeping, mushroom farming, livestock and fishing. The collection of NTFPs is an activity which is being encouraged in Nkolenyeng, however many of the NTFPs tree species found in Nomedjoh are not found in Nkolenyeng. The project is introducing some of the tree species in Nkolenyeng, though it is a long term and uncertain activity. Firstly, the local climate in Nkolenyeng may pose a challenge, and secondly some of the tree species need about a century to attain the fruit producing age. "*I am really disturbed, if after all these changes and things don't work, what will be our fate?*"; a participant said.

Capacity building in communities in general is being strengthened. Access to information, knowledge and capacity are very important in climate change response actions (Challinor et al., 2007; Howden et al., 2007). Capacity building of households regarding new farming techniques, alternative livelihoods and income strategies has been initiated. The carbon projects initiated capacity building in beekeeping, plantain propagation, nursery management, mixed cropping, and the planting and management of new crop varieties. About 82% of the households in both communities have participated and benefitted from at least one training activity related to agriculture intensification, agro-forestry, apiculture and silviculture. Material support has been provided in the form of seeds, nurseries and bee hives.

Making the commodities produced by household's worth their value in the market is one major priority of the PES project, because with better income from commodities, households will limit pressure on forest. However, better prices can also mean more incentives to exploit and destroy forest.

Lastly, financial flows from carbon sales will provide compensation to lost livelihood opportunities and enhance the different community initiatives and activities relevant for local adaptation (Wollenberg and Springate-Baginski, 2009).

Communities' willingness to participate and adhere to forest carbon conservation conditions

Identifying the underlying drivers of deforestation as a starting point of action is essential for policies aimed at halting deforestation to be effective (Agrawal, 2009). Most of the changes in forest cover in the study areas are the consequences of land use practices. The willingness to participate which translates to the positive outcome of the forest conservation activities depends on how communities are incentivized and the level of motivation of communities regarding the off-setting of poor land use practices. The capacity of the communities to participate and adhere to the PES project conditions is indicated by a range of underlying perceptions related to community adaptation needs; strengthening the viability of local economic activities, knowledge and capacity building in local agriculture systems and alternative livelihood options. This is a major incentive and motivation for communities (Wollenberg and Springate-Baginski, 2009; Salafsky and Wollenberg, 2000).

In addition to adaptation needs, perceptions regarding the effectiveness of local governance processes such as equity and participation in decision making are also crucial in increasing communities' participation. Wollenberg and Springate-Baginski (2009) and Dkamela et al. (2009), acknowledged that conservation initiatives such as REDD+ are more likely to succeed if they build on the interest of forest communities and indigenous communities.

The findings from the study areas indicate that the PES project was welcome and supported due to the perception of the tenure situation which favours communities as far as forest benefits are concern. In both communities, the notion of management rights for community forests and ownership rights is being misunderstood. They are aware that they own the forest and any benefit stream from the forest goes directly to the community, with limited or no conflict with the state. Households communicated that the respect they have for the present forest conservation rules will not be the same if forest was under state management. They consider forest resource management under state control as unfair, and beneficial to industrial forestry companies. The affirmative view about ownership and management of their forest is a motivating factor for the households to get involved in the

PES project activities. Wollenberg and Springate-Baginski (2009) affirms that clear tenure rights, resource rights and participation are major incentives for communities to engage in conservation initiatives.

Equitable distribution of resources and forest benefits is a condition that incentivizes and motivates forest communities; this can facilitate the positive outcome of carbon conservation projects (Dkamela et al., 2009). Encouraging perception about equality in benefit sharing in Nomedjoh (93% of respondents) is an indication that households will adhere to project conditions as compared with households in Nkolenyeng. Households (87%) in Nkolenyeng attribute their frustration to mismanagement and embezzlement of revenue that accrued from earlier forest exploitation deals. As a result suspicion and doubt loams around the present carbon project in Nkolenyeng and this atmosphere has implications on their willingness to participate and adhere to project conditions. Dkamela et al., (2009) highlights that inequitable distribution of forest revenues is a threat to community participation in REDD+ schemes. Despite these situations, households still argue that they are satisfied with the management of their community forest. Though, they stressed that management of the initial benefit flow from the PES project will be a test for their local governance structures and processes and this will determine the future and sustainability of the PES projects.

Conclusion

The findings of this study accentuate the importance of understanding the vulnerability of the livelihood strategies of forest-dependent communities to climatic and non climatic changes. On the other hand, households are the main agents of deforestation through their livelihood strategies in their respective forest areas and any action aim at halting deforestation will marginalised livelihood opportunities of forest communities. Strategies to reduce community vulnerability include livelihood diversification, strengthening the viability of local economic activities, knowledge and capacity building in local agriculture systems and alternative livelihood options for food security and income. These are also incentives that make the land management changes as a result of the conservation initiatives attractive to land users. The positive outcome of the conservation activities depends on the willingness and motivation of communities to engage and participate in the different mitigation activities, which can also be influenced by tenure rights. In this regard, there are commonalities between the adaptation needs of forest communities and the incentives and motivation of communities to participate and respect forest conservation initiatives. And strategies for a double response to climate change can be better designed by using the knowledge on vulnerability as a point of departure. However, further research is needed to analyse gender and vulnerable group differentiation regarding vulnerability, adaptation and forests carbon conservation.

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