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# Exploring vulnerability and adaptation to climate change of communities in the forest zone of Cameroon

**Mekou Y. Bele · Anne M. Tiani · Olufunso A. Somorin · Denis J. Sonwa**

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**Abstract** Understanding vulnerability to the impacts of global environmental change and identifying adaptation measures to cope with these impacts require localized investigations that can help find actual and exact answers to the questions about who and what are vulnerable, to what are they vulnerable, how vulnerable are they, what are the causes of their vulnerability, and what responses can lessen their vulnerability. People living in forests are highly dependent on forest goods and services, and are vulnerable to forest changes both socially and economically. In the Congo basin, climate change effects on forest ecosystems are predicted to amplify the existing pressure on food security urging expansion of current agricultural lands at the expense of forest, biodiversity loss and socioeconomic stresses. The paper aimed at exploring vulnerability and adaptation needs to climate change of local communities in the humid forest zone of Cameroon. Field work was conducted in two forest communities in Lekié and in Yokadouma in the Center and Eastern Regions of Cameroon respectively. The assessment was done using a series of approaches including a preparatory phase, fieldwork proper, and validation of the results. Results show that: (a) the adverse effects of climate conditions to which these communities are exposed are already being felt and exerting considerable stress on most of their livelihoods resources; (b) drought, changing seasons, erratic rain patterns, heavy rainfall and strong winds are among the main climate-related disturbances perceived by populations in the project sites; (c) important social, ecological and economic processes over the past decades seemed to have shaped current vulnerability in the sites; (d) Some coping and adaptive strategies used so far are outdated; and specific adaptation needs are identified and suggestions for facilitating their long-term implementations provided.

M. Y. Bele (✉) · A. M. Tiani · D. J. Sonwa
Center for International Forestry Research (CIFOR), P.O. Box 2008, Messa, Yaounde, Cameroon
e-mail: b.youssoufa@cgiar.org

M. Y. Bele
e-mail: yoube_bele@yahoo.com

O. A. Somorin
African Development Bank, 15 Avenue du Ghana, 1002 Tunis Belvedere, Tunisia

O. A. Somorin
Forest and Nature Conservation Policy Group, Wageningen University and Research Centre (WUR), 6708 PB Wageningen, the Netherlands

## 1 Introduction

Climate change is in fact one of the most serious environmental, social and economic threats the world has ever faced affecting different sectors of life. It particularly has the potential to deepen poverty, food insecurity, poor livelihoods and unsustainable development especially in developing countries (FAO 2005; IPCC 2007). The poor countries in particular are the most vulnerable because of their high dependency on ecosystem goods and services and their limited capacity to adapt to a changing climate (e.g. MEA 2005; Stern Review 2006). For African countries, climate-related risks are expected to intensify existing problems and create new combinations of risks, given the existing widespread poverty and dependence on the natural environment (Brown et al. 2010; Somorin 2010; Bele et al. 2011; Somorin et al. 2011; Sonwa et al. 2012a, b). Areas of particular concern include communities with vulnerable livelihoods, food and environmental insecurity, health, gender inequalities, weak security and governance, the lack of infrastructure and education, and the lack of access to appropriate resources and capacities to deal with extreme events. So, anticipating or adapting to climate change impacts become a necessity in order to minimize their consequences on human well-being and on the environment (Locatelli et al. 2008; Sonwa et al. 2010). In the context of Central Africa, forests deserve to be at the forefront of any debate on adaptation to climate change and are essential from realizing major global targets like the millennium development goals. This is because not only do forests play a key role in national economy, but they also constitute a safety net for local communities for traversing periods of hunger (Nkem et al. 2007, 2010). According to Congo Basin Forest Partnership (CBFP 2008), forests contribute more than 10 % of the GDP of the countries of Central Africa. In addition, 150 million people including 60 million indigenous in this region depend directly or indirectly on forest ecosystems for their subsistence. Therefore, considering the vulnerability of forests to climate change and given their vital role in the household livelihood and food security in tropical developing countries especially in Sub Saharan Africa, climate change and climate variability measures have to be taken seriously and for adaptation strategies need to be integrated into all the sectors of development (Nkem et al. 2007; Locatelli et al. 2008).

### 1.1 Overview of the climate impacts in Cameroon

As elsewhere in Central Africa, Cameroon has not been spared from the severe impacts of climate change. The analysis of climate change impacts in Cameroon (UNEP 2000; NC1 2005), though not systematic due to inadequate resources both technical and capital, reveals that Cameroon has been impacted in almost all the sectors of development (Bele et al. 2011). Scientific understanding of climate change indicates that Cameroon has already experienced significant shifts in weather patterns over the period of a single generation, a trend that will likely continue for several centuries (Molua and Lambi 2007; Molua 2008). Statistics show that in Cameroon, rainfall has already decreased by over 2 % per decade since 1960 (Molua and Lambi 2007). Crop yields have been poor; in particular the cash crop has been affected by unsteady rains. The low lying coastal region is at risk from rising sea levels (Asangwe 2006). The impacts on humans are certain and in places drastic. People in some areas may benefit from climate change but the great majority will struggle to cope with its effects. Cameroon economy is predominantly agrarian and agriculture and the exploitation of natural resources especially forest resources remain the driving force of the country's economic development. The populations of Cameroon rely on forest goods and services for basic resources, income generation, and employment as well as buffer role in difficult periods. Forest sector contributes 6–10 % to gross domestic product (GDP) (CBFP 2008) and the

value of forest products (logs, sawnwood, plywood, veneers, parquets) run into millions of dollars annually. The sector alone employs up to 13,000 people (MINFOF 2008) and many more within the informal sector involved in domestic timber trade, charcoal, and even NTFPs. However, the adverse effect of climate conditions to which the country is exposed overtly affects these resources thereby significantly affecting the economic, social and environmental dimensions of the national sustainable development (Sonwa et al. 2012b).

## 2 About the paper

The objective of this paper was to assess local people's vulnerability to climate change in the humid forest zone of Cameroon in order to understand how they are affected and respond and to identify their specific needs for adaptation. The findings from this research will serve as the basis for further analysis to build adaptive capacity in the study sites and in similar areas in Cameroon and beyond. Using participatory action research, local community members discussed together climate perturbations they face and exchange on the particularities of past and recent climate related events. They also discussed their coping and adaptive strategies used so far. According to German et al. (2010), coping strategy is the means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster. Adaptive strategy is the ability to adjust to change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences First, the literature on risks and vulnerability to climate change in Cameroon with focus on impacts on local communities is reviewed. Then conceptual framework on vulnerability assessment is developed. The research methods are further described and the results are discussed with focus on: perception on climate change, main indicators of climate change, climate risks and responses, examples of coping and adaptive strategies and their limits, and identification of new adaptation strategies. The paper ends with a discussion and a conclusion of the challenge of addressing climate change adaptation in Cameroon and makes suggestions for longer-term adaptation processes to include more integrated programming that links with national development processes.

## 3 Vulnerability analysis conceptual framework

Vulnerability has been conceptualized in different ways by scholars from different knowledge domains and diverse communities of practice. Kasperson et al. (2005) reviewed different definitions of vulnerability and concluded that there is no single conceptualization of vulnerability that would fit all assessment contexts and purposes. The choice of definition may depend on its suitability for a particular vulnerability and its interpretation for policy or action (Downing et al. 2005). In the climate change field, the existence of diverse conceptualizations of vulnerability has become particularly problematic because of a close collaboration between scholars from many different disciplines and communities of practice (Füssel 2007). One common use of the word 'vulnerability' in the climate change field refers to the capacity of a system to be affected by a hazard (Turner et al. 2003). IPCC (2007) elaborates it further and defines "climate vulnerability" as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes". Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity"

(McCarthy et al. 2001). It is understood as a function of: $V = f(E, S, AC)$, where, E = exposure (the character, magnitude and rate of climate change and variation to which a system is exposed); S = sensitivity (structural factors that either heighten or lessen the impact of exposure, such as land tenure); and AC = adaptive capacity [the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantages of opportunities or to cope with the consequences]. Therefore, this definition helped assess the impacts of climate change on forest living populations and their responses.

## 4 Methods

### 4.1 Study sites

Two sites selected for this study are about 700 km away from each other (Nkol-evodo and Yokadouma) (Fig. 1). They were selected based on accessibility, existence of community forests, number of villages in the community forest, dependency of the community on forest resources, and ecological and social diversity. The Forestry Law of 1994 defines a "community forest" as 'a forest of the non-permanent forest estate, subject to a management agreement between a village community and the Administration in charge of forests. The management of this forest is entrusted to the village community concerned, with the technical support of the Administration' (RoC 1995). A community forest is a non-planted forest that can be set up only in an area over which the village community concerned has customary rights.

The two study sites fall in the bi-modal humid forest agro-ecological zone with an annual rainfall range of 1,500–3,000 mm and mean temperature of 23 °C. These sites are situated roughly between 2°N and 4°N and for the most part below an altitude of 800 m (UNEP 2008). They both have a four-season climate, with rainfall over 1,500 mm and a maximum of two dry months.

Nkol-evodo is located in the Lekié Division of the Center Region of Cameroon. It has a community forest (*Coopérative des Paysans de la Lekié – COPAL*) of 4,800 ha and comprises ten villages with a population of more than 5,000 inhabitants. It is found in the transition zone between Northwestern Congolian lowland forests and Northern Congolian forest-savanna mosaic (Olson et al. 2001). Key vegetation types include: primary and secondary forests, swampy forest along Sanaga and Afamba rivers, savanna, fresh water ecosystems, rocky areas with a mighty rock of more than a kilometer, agricultural plantations dominated by cocoa, as well as cash crop farms and fallows (Akoa 2007). Key treats to this forest are bush fire, slash and burned agriculture, long dry seasons, etc. In Nkol-evodo, agriculture remains the principal activity of most households. This agriculture is made up of cash crops farmland and perennial plantations (mostly cocoa). It is also the main source of revenues and for food for most households. On the other hand, *Yokadouma* is in the Eastern Region of Cameroon, in the Boumba and Ngoko Division. It is located in the transition between Northwestern Congolian lowland forests (Olson et al. 2001). Here, three community forests were part of this study: ASMIMI, ESSAYONS VOIR and MORIKOUA-LIYE. All together, these forests represent more than 13,000 ha. Population is estimated around 9,000 inhabitants (Betti 2004). The vegetation is made up of mixed semi-deciduous forests more or less degraded by anthropic activities such as forest exploitation and agriculture. In this site, key threats to forest include poaching and trade of protected species, forest exploitation and tree felling, bush fire, prolonged dry seasons and slash and burn agriculture (Betti 2004). Agriculture also remains the principal activity of most of the households. Other activities include collection of NTFPs, hunting, livestock rearing, and fishing.

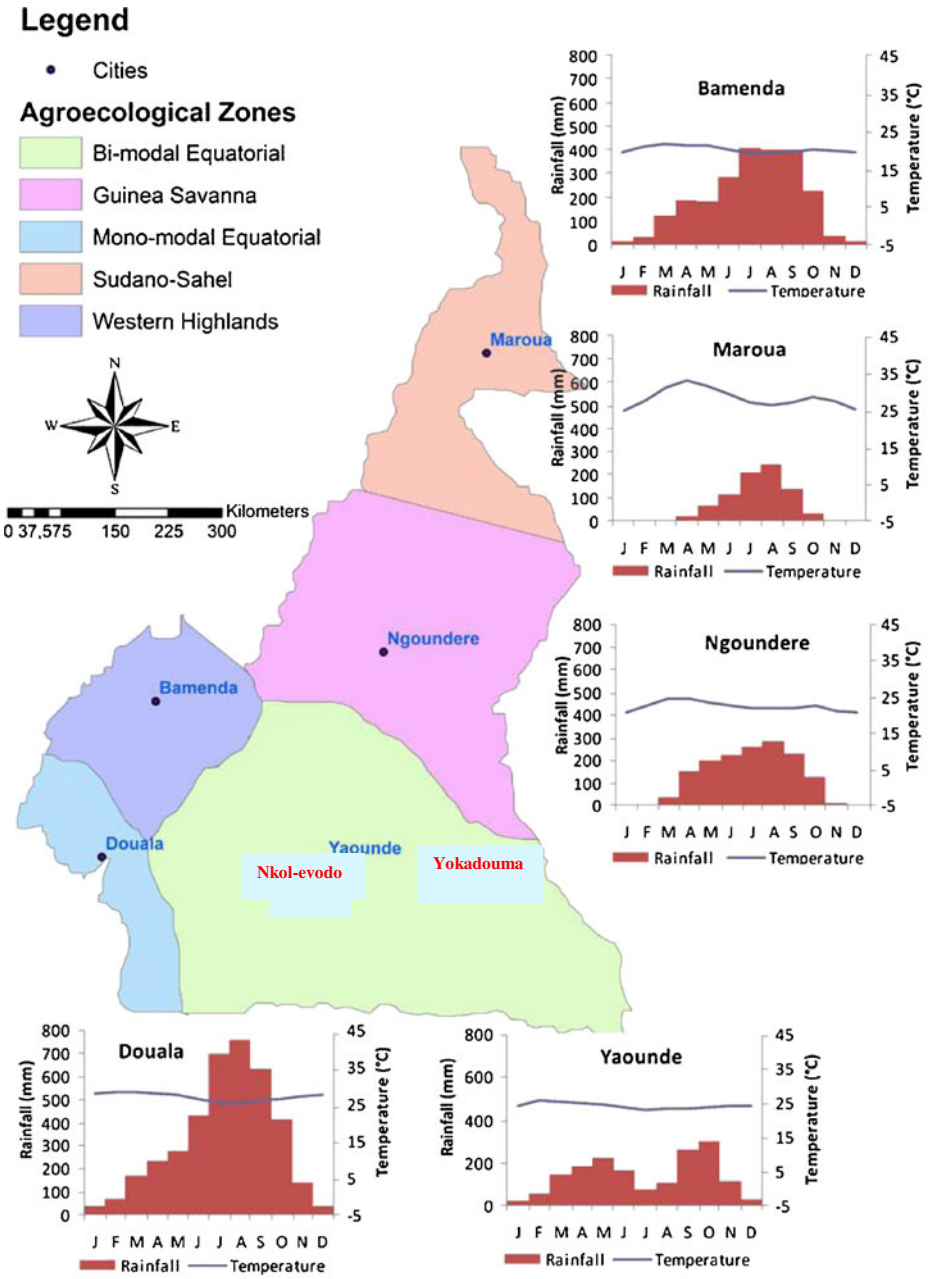


**Fig. 1** Major agro-ecological zones in Cameroon showing the selected sites. (Source: Yengoh et al. 2010)

## 4.2 General characteristics of participants

The average age of participants was 41 with the majority between 30 and 49 years. Most of the participants have no formal education (57 %), followed by literacy or primary levels

(25 %), secondary education levels (10 %), post-secondary levels (3 %) and University levels (5 %). Most participants' activity was agriculture, especially rainfed farming, sometimes combined with animal husbandry (60 %). Main crops included cocoa, cassava, plantain, potato, vegetable, etc.

## 4.3 Data collection and analysis

### *4.3.1 Preparatory phase*

Before conducting the fieldtrip we first started a preparatory process that involved literature review of documents and data relevant to the sites, as well as the development of survey questions and the liaison with key stakeholders in the project sites. Our local facilitators on the sites worked with us during the preparatory stage to identify key stakeholders. Local authorities were also informed of our work and objectives. A visit was made to the sites prior to field work proper for a formal introduction to all the relevant local authorities.

### *4.3.2 Participatory action research*

Participatory action research (PAR) was used between 2009 and 2010 to engage communities and institutions into defining and implementing adaptation strategies. It entailed empowering the actors themselves to identify key development bottlenecks and to experiment with different approaches for addressing and ultimately breaking through them.

Focus group discussion was used (Nzeadibe et al. 2012). In each sites there were two focus group discussions for local administration representatives, five unisex focus group discussions and plenary sessions for sharing results from different focus groups. Tools used included brainstorming, historical trend analysis, diagnosis, visioning, process documentation, etc. A total of 140 respondents were involved in both study sites. Participants included local people (men, women, different ethnic groups), community leaders, local or national development NGOs, local administration representatives. Youth participation was encouraged and was merely to let them learn from the elders.

Group discussions were facilitated by the research team. Facilitation involved applying a set of processes and "soft skills" to help groups to attain their objectives (German et al. 2010) by jointly identifying problems and opportunities; discussing and negotiating desired future states; perceiving and responding to emerging challenges and opportunities, etc.

### *4.3.3 Surveys*

To complement PAR, surveys were carried out to assemble information on the communities' knowledge and experiences of climate change and its impacts, coping and adaptive strategies. Only community members above ca. 30 years of age were included in the survey to ensure that they could make meaningful comparisons between the past and present and also on the assumption that younger people have less experience on climate change impacts. From the focus group discussions, individuals who showed appreciable knowledge of environmental changes around them were selected for in-depth interviews conducted on 24 and 35 participants in Nkol-evodo and Yokadouma respectively. They were mainly local farmers who could attest to noticeable changes in rainfall and temperature, and traditional leaders involved in community decision-making. Interviews were conducted in French and/or local language where necessary with the aid of an interpreter. The interviews followed a predesigned semi-structured questionnaire containing questions regarding

livelihood, agriculture, climate change impacts etc. and centred on people's perceptions of climate changes that had occurred in their life time (e.g., rain, temperature), the impacts on their lives and their environment.

#### *4.3.4 Date analysis*

Analysis of the data utilized simple descriptive statistics, while the results were presented as Tables, Figures and Charts. As a matter of fact, while searching literature on impacts of climate change in particularly study areas, a dearth of literature compelled to rely on ground data, rather than scientifically tested evidence. This limitation created a window of opportunity of considering this study as important contribution for the project as well as country's climate change research profile.

## 5 Results

### 5.1 Perception on climate change

Whether during focus group discussions or individual interviews, almost everybody involved in this study from both Nkol-evodo and Yokadouma was aware of climate change. Community members in Nkol-evodo (72 %) and Yokadouma (66 %) were in agreement that most changes in climate began during the last 15 years (Fig. 2). 12 % and 20 % respondents were of the opinion that change started 10 years ago in Nkol-evodo and in Yokadouma respectively. The fact that people depend mostly on rain-fed resources for their subsistence makes it easy to quickly notice changes in rainfall patterns and increased droughts. In Nkol-evodo, a 62 year old woman said: "*Long ago, I could know when rains started. Nowadays, we have to gamble with the rains. We do not longer know when and what to plant. If you plant early you might lose and if you plant late you might win. We are at a loss of what to do*."

### 5.2 Indicators of climate change

In Nkol-evodo, the community identified the increase in drought conditions and food crop yields failure as the main indicators of climate change. With regards to dryer conditions, a farmer said: "*Today's sun is another sun. It is different of the sun we were used to. It is so*

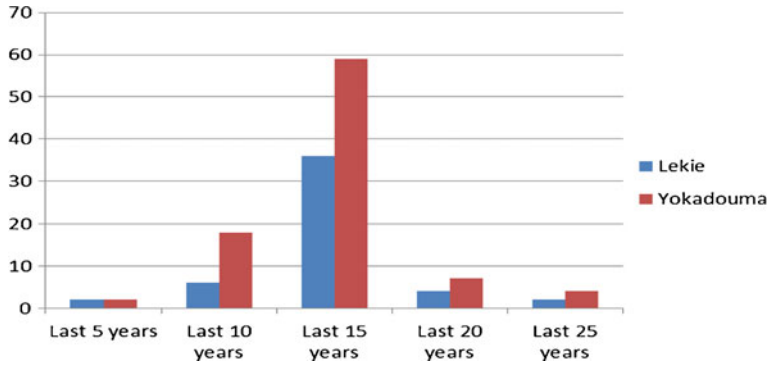


**Fig. 2** Distribution of the perceptions on beginning of changes in climate

*harsh and so direct. I don't really know what is happening. We can't do anything under this sun. It is affecting our activities and thus our life.*"

In Yokadouma, shifts in seasons and more heavy downpours during rainy season were the main indicators of climate change. A 60 years old participant said: *"Until 15 to 20 years ago, seasons were clearly recognizable. The weather was more beautiful in former times. It was not like today where we have dry or rainy season from one day to the other."*

In both study sites, other indicators included poverty, malnutrition, dust storms (mostly in Yokadouma) and decrease in ground water table (especially in Nkol-evodo).

### 5.3 Climate risks, impacts and responses

Through a process of participatory diagnosis, communities first discussed the climate conditions they suffered from and the magnitude of the effects of climate change on their livelihoods. Results from focus group discussions showed strong similarities in the climate change risks and their effects across the two study sites as summarized in Table 1.

Table 1 shows that despites its negative impacts on livelihoods resources and activities, climate change provides some opportunities that are important to local communities. These communities take advantage of occasional rainfall during the dry season to boost production of some foodstuffs. Such rainfall has had positive effects on the growth of banana and plantain. Local communities take advantage of the drying of swampy areas to develop the culture of maize in the off season

Climate risks impact differently on most important livelihood activities (Table 2).

Table 2 shows how different natural livelihood resources and activities are affected differently by different climatic disturbances. Changing seasons and droughts represent the highest potential impact for agriculture. 80 % and 65 % respondents were in agreement that the 1982 drought severely affected agriculture, damaging production of cacao, cassava and the gardens in Nkol-evodo and in Yokadouma respectively. In Nkol-evodo, local people argue that their traditional knowledge on temperature and crop season cannot result into good practice in recent years. They do not know how to get rid of such problems or why nature is behaving abnormally.

Results obtained from surveys also confirm the focus group discussions on perceived climatic risks and its effects on livelihood activities in the study sites (Fig. 3). In general, forests appear to be less affected by changing seasons at least for now. In addition, women, children and elderly were reported to be the most vulnerable social groups in study areas. With regards to women vulnerability, a 42 year old woman in Yokadouma said: *"Most farmers in our village are women. Women have few income-earning opportunities compared to men. They also have disproportionate burden in household activities. But they have less power household and community decision making as tradition often keeps them out of policymaking roles."* And another woman apparently in her late 30 said: "*When yields are low and market prices are high, women are the first to suffer. For example when there is no enough food, my kids and husband are served first, and I may go hungry.*"

### 5.4 Examples of coping and adaptive strategies and their limits

Figure 4 is a summary of some strategies applied so far in the study sites. Those strategies were carried out either individually and/or collectively with very little or no planning or institutional support.

**Table 1** Climatic risk and their effects in the study sites

| Climate risks | Perceived effects | Identified solutions |
|---|---|---|
| Positive effects | | |
| Pockets of rain in the dry season | • Rapid growth of some plants such as banana, plantain, cocoyam and cassava | • Extending their cultivation over a wider area |
| Drying of some swamps | • Positive impact on the production of off-season corn, with a shift from one to two cycles of annual production | • Expand their production and increase yields |
| Negative effects | | |
| Changing seasons | • Affect most livelihoods activities | • Planting more trees |
| | | • Reduce deforestation and forest degradation |
| Torrential rains in the rainy season | • Cassava tuber rot | • Seeking improved seeds |
| | | • Relocating fields |
| Pockets of drought in the rainy season | • Rapid dry up of peanuts and corn | • Seeking tolerant seed varieties |
| | • Withdrawal of wild game during pockets of severe drought | • Training in raising domestic livestock |
| High winds | • Loss of branches of multipurpose trees such as Jansang (Ricinodendron heudelotii) and andok (Irvingia spp.) | • Keeping trees around important species as windbreaks |
| | • Failure of cacao flowers | |
| Intense and longer heat spells in the dry season | • Fewer edible caterpillars and mushrooms | • Planting caterpillar host plant species around homes |
| | • Decrease in fish stocks | • Promoting livestock raising techniques |
| | • Animal morbidity | • Raising awareness on the dangers of bushfires |
| | • Increasing numbers of bushfires | • Promoting exchange groups on pharmacopoeia |
| | • Outbreaks of diseases such as malaria and typhoid | |
| Dust storm | • Respiratory disease | • avoid random walking in the streets |

In Nkol-evodo, other strategies mentioned by few participants as a core strategy to deal with prolonged droughts included ritual ceremonies as well as church or community level prayers. These practices were believed to be profitable to the whole community if successful.

### 5.5 Limits to adaptation strategies and identification of new ones

In the sites, there was almost a consensus from participants that some strategies used so far are no longer appropriate and may be jeopardized by future climate change and may lead to "maladaptation". Especially in Nkol-evodo, such adaptation strategies included soil fertility and soil water management. As a matter of fact, soil fertility is restricted by fertilizer availability and cost; and soil water managements by irrigation equipment, labour or water availability. In Yokadouma, populations complained about grasses with are getting more

**Table 2** An example of impacts on livelihood activities

| Livelihood activities / Climatic exposure | Agriculture | | Livestock | | NTFPs | | Hunting | | Fishing | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Nkol-evodo | Yokadouma | Nkol-evodo | Yokadouma | Nkol-evodo | Yokadouma | Nkol-evodo | Yokadouma | Nkol-evodo | Yokadouma |
| Changing seasons | --- | --- | --- | --- | - | 0 | | 0 | | |
| Prolonged drought | --- | - | --- | - | 0 | 0 | - | 0 | - | - |
| Heavy rainfall | --- | --- | 0 | 0 | 0 | 0 | 0 | 0 | + | + |
| Punctual droughts during dry season | --- | - | -- | - | - | | 0 | | | 0 |
| Occasional rainfall during dry season | ++ | + | + | | | | 0 | | | |
| Low rainfall during the year | + | + | - | - | 0 | 0 | | | | - |
| Strong winds | --- | - | | | 0 | 0 | - | - | | 0 |
| Heat waves during dry season | --- | - | | | 0 | 0 | - | - | | 0 |

Agriculture and livestock: Very sensitive to climate

Forest-related activities: Less sensitive (safety nets?)

--- High negative; -- Med negative; - Low negative; 0 No; + Low positive; ++ Med positive

difficult to get rid of due prolonged rainy season. They also complained that prolonged rainy season and heavy downpours during rainy season have negative impacts on some foodstuff such as cassava, potatoes, beans and also on cocoa. Overall, participants expressed the need to identify and test new strategies plus institutional support. Specific adaptation needs identified were many and varied and could be summarized in the following points: (1) Technical options for current activities: agriculture (resistant crop varieties, timing of planting and harvesting, etc.), post-harvest (better food storage); NTFP (domestication, change in hunting and gathering patterns); (2) New activities for livelihood diversification; (3) Knowledge generation and training; and (4) Governance

However, many obstacles were also gathered that could hamper the implementation of new strategies: limited access to scientific innovation and information on climate change; socio-economic stresses; weak education and preparedness for disasters; low or insufficient financial resources that impedes collective action; lack of appropriate agricultural outreach relevant to climate change adaptation.

Research participants also identified External interventions (NGOs, extension services, etc.) as a mean to facilitate processes of adaptation through:

- Establishing a climate change warning system in Central Africa with weather forecasting to help local communities adjust their agricultural practices;
- Establishing a network of vulnerability observatories at local level to help decision makers and researchers take decisions that suit local population needs;
- Developing information channels and appropriate messages on climate change adaptation for local communities;
- Establishing information sharing and experience exchange platforms at local level on climate change and adaptation;
- Establishing research programmes to support best practices in community adaptation strategies.

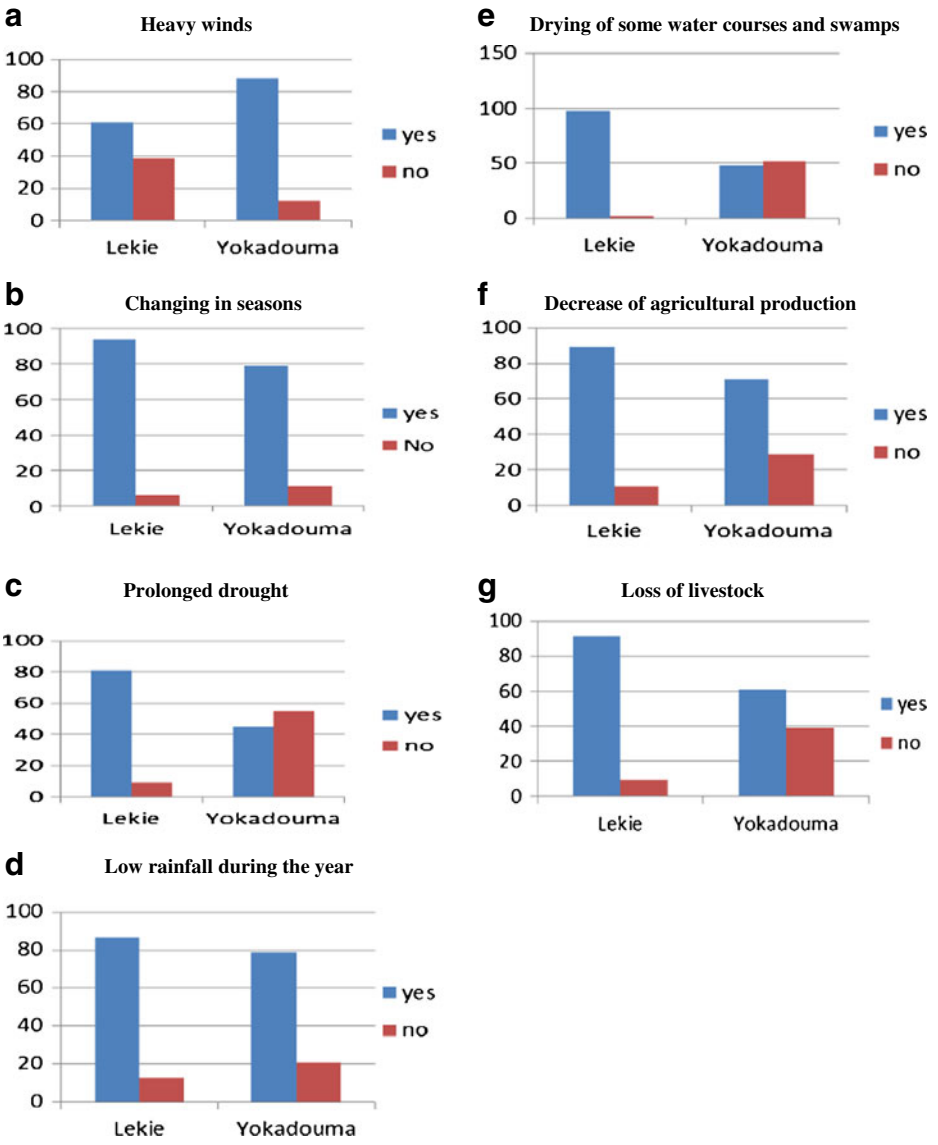


**Fig. 3** Some perceived climatic risks and impacts

## 6 Discussions

### 6.1 Perceptions on climate change

In Cameroon, the period over which scientists reported that the climate has changed (~60 years) (Molua and Lambi 2007) is higher than that perceived by farmers (~15 years). This difference between farmer reported date of change and science literature may be explained due to the response time to a given environmental shock (Akponikpè et al.

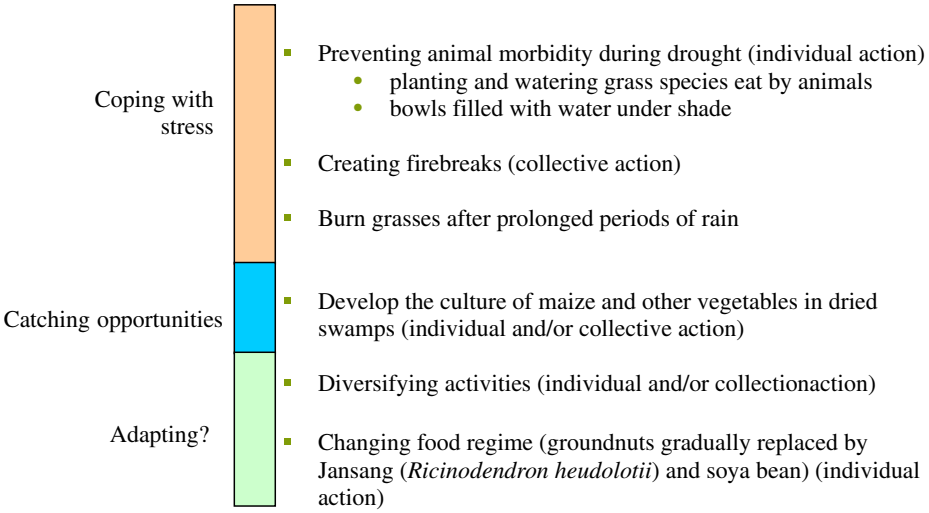


**Fig. 4** Some coping and adaptive strategies in the study sites

2010). As a matter of fact, if there is an environmental shock, people may take time to notice and the followings three processes or steps may be distinguished: (1) time when the shock physically occurs (2) time that the shock signals are felt (3) time for verification of the change (4) time required before a reaction occurs (coping, adaptation, etc). Therefore, farmers that realize that climate change is real or that reach this step will often report the date reflected during phase 3. A variable time period may elapse between phase 1 and 3 depending on people and experience. On the contrary, a scientific method may capture the change as early as at the 1st phase depending on the accuracy of the trend detection technique. The time between 1 and 3 may explain difference between literature reported time of change and local people perceptions.

### 6.2 Climate risks, impacts and responses

In Cameroon and elsewhere in the Congo Basin, poverty exacerbates and is exacerbated by the impacts of environmental change. Most of the recent natural disasters are climate, weather and water related (e.g. Molua and Lambi 2007). Livelihoods are highly dependent on climate-sensitive resources. These same livelihood resources contribute a significant proportion of the Gross Domestic Product of the country, making national development also susceptible to climate change uncertainties (Nkem et al. 2007). Natural livelihood resources and activities are affected differently by different climatic disturbances (Table 2). Agriculture is the most impacted activity. People have in fact lost their ability to estimate wet and dry periods, because ‘rain has become erratic’. This agriculture is still highly dependent on climate. Temperature, light, and water are the main drivers of crop growth. Therefore, the key uncertainty for agricultural outlook is the weather. In the study communities, forest foods are most extensively used to help meet dietary shortfalls during periods of crop failures. This corroborates the findings by Shackleton et al. (2007) and Nkem et al. (2010). This is because forest seems to be less affected, at least for now, by changing seasons probably due their diversity and resilience to climate

variability. This makes forest resources to be also less affected by climate change and thus constitute a safety-net for local communities for traversing periods of hunger. But there is also evidence that forests will suffer a lot under certain unfavorable climate conditions (e.g., IPCC 2007; Locatelli et al. 2008; IUFRO 2010).

### 6.3 Adaptive strategies and their limits

Assessment of adaptive strategies shows that adaptation is not new to the local communities studied. They have always had to develop and implement individual and collective strategies to adapt to climate variability and environmental change. In Nkol-evodo for instance, some indivual households have successfully avoided animal morbidity in prolonged periods of drought by planting and watering around their houses some grass species animals can eat or by placing vessels filled with water under shade for them to drink. Collectively, the community created firebreaks to protect their forests and farms from forest fires. In both study areas, populations have taken advantage individually and/or collectively of opportunities provided by climate change. These communities take advantage of occasional rainfall during the dry season to boost production of some foodstuffs. Such rainfall has had positive effects on the growth of banana and plantain. These communities also take advantage of the drying of swampy areas to develop the culture of maize in the off season. However, while individual adaptive measures have in some cases succeeded in reducing the effects of climate change on some livelihood resources and activities, there is a limit to the extent of broader community resilience that can be attained through stand-alone efforts by individuals. This is due to the fact that limited by financial, technological, and educational constrains, augmentation of current coping strategies is hindered. Some coping strategies that are employed are hardly commensurate with the rate and magnitude of change being experienced, and therefore are no longer seen as useful. Some adaptive actions, while effective, are resource-inefficient, and potentially translate pressure from one sector to another, or proliferate into secondary effects. Haddad (2005) confirms that low adaptive capacity yields ineffectual adaptive actions that exacerbate effects. In addition, in the study sites, current public infrastructure such as roads, and agricultural research and extension are inadequate and weather forecasts do not exist to secure appropriate adaptation.

## 7 Conclusion

In Cameroon, evidence of global warming and the increasing impact of climate change on society and the environment are being increasingly acknowledged and felt. However, though communities' members have had to develop and implement individual and/or collective adaptation strategies in the past related to changes in climate, current speed and intensity of changes give no room to autonomous adaptation and even threaten to undermine adaptive capacity of the local poor and many years of efforts towards sustainable development. Efficient adaptation to climate change necessitates therefore the development of novel strategies. But the implementation of these strategies faces a number of difficulties and requires support from partners such as international organizations, national and regional authorities and NGOs. However, this support must be coordinated and action oriented. However more studies should be conducted to document local knowledge and adaptive strategies for community-based adaptation measures and to complement broader-scale scientific research with local precision

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