WORKING PAPER

Assessing current social vulnerability to climate change

A participatory methodology

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Working Paper 169

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Photo by Charlotte Pavageau/CIFOR
Managing watershed for reducing risk of flood in Rwanda.

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Abbreviations

AFN	Asia Forest Network
AMFN	African Model Forest Network
ARECO	*Association Rwandaise des Ecologistes* (Rwandese Association of Ecologists)
CAR	Central Africa Republic
CBD	Convention on Biological Diversity
CBFP	Congo Basin Forest Partnership
CIFOR	Center for International Forestry Research
COBAM	Climate Change and Forests in the Congo Basin: Synergies between Mitigation and Adaptation
CoFCCA	Congo Basin Forests and Climate Change Adaptation
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organization of the United Nations
IFAD	International Fund for Agricultural Development
INDEFOR	*Institut national pour le développement forestier et la gestion des aires protégées* (National Institute for Forestry Development and Protected Areas Management)
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
NGO	nongovernmental organization
NTFPs	non-timber forest products
ROSE	*Réseau des ONG du Sud-Est du Cameroun* (NGO Network of South-Est Cameroon)
SEI	Swedish Environmental Institute
UEFA	*Union pour l'Emancipation de la Femme Autochtone* (Union for the emancipation of Native Women)
UNDP	United Nations Development Programme

Acknowledgments

This document describes the participatory methodology used for the regional baseline assessment conducted in five landscapes of the Congo Basin. It was developed in the framework of Climate Change and Forests in the Congo Basin: Synergies between Adaptation and Mitigation (COBAM) project, initiated and implemented by CIFOR under the African Development Bank grant to the Economic Community of Central African States for financing the Congo Basin Ecosystems Conservation Support Program. The main objective of this assessment was to analyze the current vulnerability of local communities to climate variability in the context of development processes. This assessment forms the basis for further research on future scenarios of vulnerability and the evaluation of possible adaptation strategies that can provide co-benefits with mitigation efforts in the Congo Basin.

The methodology for the regional assessment was developed in collaboration with many partners. Researchers from CIFOR and SEI worked closely with local partners in each site to refine and apply the different methods of the assessment. We would like to thank all local partners: ROSE, INDEFOR, ARECO, AMFN and UEFA. We are also very grateful to all the local communities in the research sites that took part in this research for their time and interest in the research; they really deserve to be co-authors, because we are sharing their knowledge in this report.

Foreword

Climate variability and change constitute a huge threat for local people whose livelihoods mostly depend on climate-sensitive activities such as agriculture and exploitation of natural resources. However, to date, vulnerability assessment has been concentrated on dry regions, leaving forest people out. Decision-makers are not fully aware that forest and dependent communities are vulnerable to climate change. However, recent studies carried out by CIFOR in tropical forest areas around the world started to uncover that forests and people dependent on them are vulnerable; but the extent and scope/depth of this vulnerability has yet to be measured. Therefore, having local people share their experience on climate change is one of the ways we can understand this. There are numerous participatory research tools but few are targeting climate change vulnerability assessment.

This document is designed to help researchers, practitioners and all those interested in assessing the extent and scope of local people's vulnerability to climate change, the responses they currently oppose and how efficient they are. In addition, research approaches proposed in this document can serve as a platform for dialogue, as such approaches give opportunities to communities to collectively discuss their common problems (i.e. climate change) and to initiate common responses necessary to building their social capital.

This document is not a manual; it is a collection of lessons learned from a number of participatory research tools, used in a logical manner, tested and refined, which helped researchers and practitioners from diverse backgrounds to explore the vulnerability of local populations to climate variability and change, while strengthening their capacity building. Many tools used were borrowed from participatory research action (PRA), while others were developed, tested and readjusted by CIFOR and SEI researchers with extensive experience in the development of research tools in social science and in the relationship of humans to nature and the environment.

This working paper starts with an overview of the concepts and framings of vulnerability. It then describes and justifies the approach taken in the assessment. The next sections describe the different methods that were used, providing concrete examples of results obtained from the different sites. Finally, the paper concludes with a short section on lessons learned on participatory approaches for vulnerability assessment in an African context, such as the Congo Basin.

Executive summary

The present paper describes the participatory methodology used to assess the current vulnerability of local communities in the Congo Basin. Vulnerability has been studied through the lenses of different dimensions: system and exposure units, dynamic processes, multiple threats, differential exposure, social capital and collective action. The purpose of this framework is to grasp the social (and ecological) dynamics in the system over the past decades, in order to identify future actions for reducing vulnerability and to enhance adaptive capacity.

To understand each vulnerability dimension, a combination of participatory and analytical methods and tools was used. An assessment of the differential exposure and the dynamic processes as contributors to current vulnerabilities was carried out by examining a range of actors, activities, livelihoods and resources and how they were affected by a number of identified hazards. The dynamic aspect defines the complexity of vulnerability as it encompasses many attributes or multiple stresses (social, economic, cultural, environmental) that may change at different speeds. Climate change is an added stress to these already existing and alarming stresses. As there are differences in the sensitivity and responses to climate variability within local communities and the system in which they live, it is not possible to capture the vulnerability of the system *per se* at any point in time.

The assessment was designed using participatory and holistic approaches to enable interaction with communities and to allow community members to discuss common concerns and negotiate a common vision. Participatory field exercises were used to characterize each vulnerability dimension as defined in this document. Methods were defined by the type of exposure unit thought to be vulnerable (e.g. natural resources, community, region), the nature of the hazard leading to that vulnerability, and the specific aspect of the vulnerability being described. Participatory exercises included: village profile analysis; resource mapping and land-tenure analysis; seasonal calendar, deforestation and forest degradation analysis; forest–people interaction analysis; flows analysis; trade system analysis; historical disturbance analysis; climate-related disturbance analysis; product importance and revenue distribution analysis; forest use and benefits analysis, disturbance-impact analysis; social capital, social network mapping, institutional and social infrastructure analysis; and adaptive capacity analysis. Each field exercise was modified to suit the different local conditions and specificities of the study sites.

Lessons learned from the methodology for participatory vulnerability assessment are discussed, considering the benefits as well as challenges and limitations of this approach.

1. Framing vulnerability: Context, key concepts, dimensions and sites characterization

1.1 Context

A vulnerability assessment is a systematic way of understanding who and what is being affected by climate change and in what way. There can be many different purposes for conducting a vulnerability assessment, including political and financial reasons that depend on its geographical focus and system for analysis. In the context of the Congo Basin, assessing current vulnerability can be considered against several purposes identified by different authors (Fussel and Klein 2006; Patt et al. 2009; Hinkel 2011). This assessment aims to explore the differential burden of vulnerability borne by the socially less advantaged; and to improve basic understanding of system functioning, scientific understanding of vulnerability and improve methods and tools for its evaluation. Applying the methods across the Congo Basin landscape also allows for refining and comparing methods. The work feeds into the other commonly cited reasons such as improving adaptation planning by devising measures; improving adaptation decisions that can minimize the negative effects or take advantage of positive effects of climate change; and identifying possible synergies between adaptation and mitigation in the forests of the Congo Basin (etc.). The methodology used for this document aims at exploring local communities' vulnerability to climate change using a bottom-up approach. The analysis centers mainly on the social aspects of vulnerability, understanding vulnerability as processes rooted in the actions of human actors and interactions with the natural resource base on which these actors depend. The baseline assessment applies different dimensions of vulnerability as the lenses of analysis to study past trends and current conditions in the study sites.

1.2 Key concepts

The term 'vulnerability' is used in a range of contexts including climate change (Berry et al. 2006). Vulnerability can be related to concepts and meanings that resonate differently in different research traditions (natural disasters, natural resource management, poverty reduction and development (Knutson et al. 2006)). There exists different definitions of vulnerability but there is no single conceptualization of vulnerability that would fit all assessment contexts and purposes (Downing and Patwardhan 2004; Kasperson and Kasperson 2005). 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 general, three tendencies arise. The first one considers only biophysical aspects. The second one, in addition to biophysical aspects, includes socioeconomic aspects, while the third tendency breaks up vulnerability into many dimensions. Following Schröter et al. (2005), IPCC (2007) describe vulnerability 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, social, economic and political marginalization); 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 advantage of opportunities or to cope with the consequences). Nowadays, consideration for both biophysical and social vulnerability is increasing in the scientific community (Clark et al. 1998; Luers et al. 2003; O'Brien et al. 2004; Polsky et al. 2007).

Several methods and tools exist for vulnerability assessment of either ecosystems or social systems (Ziervogel and Downing 2004) but all these methods and tools face the problem of quantification of vulnerability because this phenomenon cannot be directly observed. However, vulnerability assessment of 'socio-ecological' systems remains difficult because of the lack of integrated approaches (Locatelli et al. 2008).

The approach in the COBAM project can be most closely aligned to a political economy approach, which focuses on the socioeconomic processes that lead to differential exposure, impacts and capacities to deal with impacts. This approach focuses on why systems or populations are vulnerable (i.e. drivers of vulnerability) and why some groups are more affected by climate hazards than others (i.e. differential vulnerability) (Eakin and Luers 2006; Fussel 2006, 2007; Cutter et al. 2009).

The concept of dynamic vulnerability encompasses aspects of social vulnerability and interaction with the natural environment that the COBAM project is aiming to address. This conceptual framing, already described by Devischer et al. (2013), acknowledges that vulnerability is a complex concept, which encompasses many attributes, or multiple stresses (social, economic, environmental) which may change at different speeds (slow and rapid change), i.e. it is dynamic. Methodologically, therefore, it cannot be assumed that it is possible to capture a vulnerability state *per se* at any point in time. The use of static indicators is inappropriate, as they cannot be bounded, even if we attempt to incorporate many differing viewpoints of vulnerability using participatory processes. The system changes faster than it can be assessed (or perceived in many cases) and indicators do not capture the functional processes of the system or the interrelationships between these processes, particularly as they are often poorly understood.

Following Downing et al. (2005), dynamic vulnerability has been assessed using five vulnerability dimensions: exposure units, dynamic processes, differential exposure, multiple threats, and social capital and collective action.

1. **Exposure units:** These are elements or systems exposed to climate risks and on which vulnerability will be assessed. They can encompass population livelihoods or components of the economic development sector (UNDP 2011). Examples of attributes of concern include human lives and health; the existence, income and cultural identity of a community; and the biodiversity, carbon sequestration potential and timber productivity of a forest ecosystem (Fussel 2007). The system for this analysis is defined as 'landscape in the Congo Basin'.
2. **Differential exposure:** Different exposure units (i.e. components of the system) are exposed to, experience or anticipate threats in different ways (Downing et al. 2005). In this sense, vulnerability is specific, not general. It relates to specific exposure units (e.g. specific economic activities, livelihoods or social groups) and threats (e.g. drought, flood, sea level rise). Vulnerability is unlikely to be the same for all threats, even if all are climate-related threats (e.g. increasing temperature, flood, sea level rise, drought, etc.). As a result, it is difficult to produce a single composite index that reflects the aggregate exposure of all the exposure units to all of the potential threats (Downing et al. 2005).
3. **Dynamic processes:** Vulnerability is a dynamic process determined by the variation of climatic and socioeconomic stresses on it (Adger et al. 2007; Bouwer et al. 2010). It changes on a variety of interlinked temporal and spatial scales. It is modulated by the adjustments of strategies to new stresses or opportunities. Vulnerability assessments can correspond to the present conditions (i.e. the baseline conditions of vulnerability) and these conditions can be considered under different future scenarios to assess possible outcomes (Fussel 2007).
4. **Multiple threats:** A system or a unit can be affected by multiple threats, which can include ecological, social, economic and political change, as well as physical and technological change, innovation, etc. (RA 2010). In addition, it can also be internal but not part of natural variability, e.g. sudden movement of people due to conflict, new political forces taking power, or new institutional frameworks emerging. Climate change cannot be dissociated from other environmental or socioeconomic changes. In order to better understand the balance among social, economic and natural stresses, studies pay more attention to 'integrated vulnerability.' Such integrated vulnerability is conceived as a function of three components: (1) exposition; (2) sensibility; and (3) adaptive capacity. This division provides a strong structure for the analysis of the influence of different types of stresses (Hierpe 2012).
5. **Social capital and collective action:** Individuals, communities and societies need to be actively involved in the processes of change in order to minimize negative impacts and maximize any benefits from changes in the climate. In the context of resource-dependent livelihoods, social capital can facilitate adaptive capacity by exploring its interactions with natural capital (Crona and Bodin 2010). Both social capital and the social dynamics of adaptive capacity are defined by the ability to act collectively, which involves understanding the interdependence of actors through their relationships with each other, with the institutions in which they reside, and with the resource base on which they depend (Adger 2003). The ability to act collectively also depends on shared understandings and a common vision (Ostrom 2005).

In order to distinguish current and future vulnerability, the terms can be thought of as vulnerability to climate variability (current and near-term climate conditions) and vulnerability to climate change (future climate conditions). This recognizes that there are two time horizons of interest in framing vulnerability, especially with respect to the implementation of adaptation responses (the importance of the temporal reference is discussed in Fussel (2007)). Social determinants contribute to the adaptive capacity and vulnerability of communities or systems today, and biophysical changes alongside the social and other prevailing conditions will affect exposure and vulnerability in the future. This methodology paper focuses on the current vulnerability to climate variability and change and the current adaptive capacity.

1.3 The Congo Basin and the dimensions of vulnerability

The IPCC (2001) report highlights that the impacts and vulnerability to climate change will vary across regions and sectors globally, with sub-Saharan Africa expected to be one of the most vulnerable regions because of multiple existing stresses and low adaptive capacity. The dimensions of vulnerability (i.e. sensitivity, exposure and adaptive capacity) identified by the IPCC are all of concern in the Congo Basin forest region. The forest is an integrated, interdependent social–ecological system, with humans interacting with nature over centuries. As a system, its functions are exposed and experiencing different environmental and socio-political stresses. Environmental stresses include temperature variations, variation in rainfall, disease outbreaks, strong winds and other natural disasters (de Wasseige et al. 2009), with subsequent impacts on humans. Social change (poverty, demographic pressure) and political reforms to organize human interaction with the forests has exacerbated stress to the system through processes such as deforestation and degradation, leading to system modification, decrease in both flora and fauna populations and an overall decrease in the system's adaptive capacity. The sensitive sectors in relation to the Congo Basin forest ecosystem include food/fiber, freshwater, fuel/energy and health (medicinal plants). A combination of environmental, socio-cultural and political processes might distort the flow of ecosystem goods and services (CoFCCA 2009; Sonwa et al. 2012). Humans' low capacity in the Congo Basin is characterized by limited rights and access to resources (CBFP 2006; Sunderlin et al. 2008), low level of income, lack of knowledge and information, and lack of technology that characterizes the adaptive capacity of groups and communities in developing countries (Klein and Smith 2003; Smith and Wandel 2006). The interplay of the different dimensions of vulnerability in the Congo Basin region is still poorly understood. More research on vulnerability is required to uncover and understand the links between the various processes, leading to change in the system and the region as a whole.

2. Participatory approach to explore current vulnerabilities and local perceptions of change

The assessment on the current vulnerability of local communities to changes in the climate was undertaken through the lenses of each dimension or key attributes that shape vulnerability (as defined in the previous section): system and exposure units, dynamic processes, multiple threats, differential exposure, and social capital and collective action. To conduct the assessment, it was necessary to use a set of participatory tools and methods.

In order to understand what makes people vulnerable in a particular setting, one needs to look at a greater and more diverse set of influences such as social, cultural, economic, institutional, political and psychological factors that form people's lives and the environment in which they live (Twigg et al. 2001). Due to the nature of the assessment, the use of participatory approaches enabled a holistic view of people. It also offered more flexibility in the selection of appropriate tools for each context and circumstance.

The use of participatory approaches aims to encompass the complexities of people's lives, starting with their understanding of the situation, their information and factors such as local knowledge, past experience, skills, household composition according to gender and age, and existing coping mechanisms. All these factors determine the alternatives people have to reduce risk and how they perceive risk (Slovic 1992; Smith 2001; Kirschenbaum 2005). Local responses of people and social groups to natural hazards and their judgments and preferences are influenced by their perceptions. Perceptions of risk are regarded as individual judgments under uncertainty. People make the best choice from several options, and take actions against hazards based on their personal perception of risk rather than on objective and scientific measures of threats (Slovic 1992; Oliver-Smith 1996; Lofstedt et al. 1998, 4 *in* Heijmans 2001).

A range of factors (e.g. knowledge on climate change, assets, access to appropriate technology, institutions, policies and perceptions) influences people's perceptions of and capacity to adapt to climate variability and climate change (Adger et al. 2003; IFAD 2008; Nyanga et al. 2011). Smithers and Smit (2009) argue that environmental perceptions are among the key elements influencing the adoption of adaptation strategies. Perceptions are context and site specific as these are influenced by diverse factors such as education, culture, gender, age, resource endowments and institutional factors. Local people have knowledge about their location, the history of major local events and threats, and how their vulnerability to disasters and different climatic conditions has changed over time (Heijmans 2001). Their participation is essential as they shall be 'actors' in decisions that affect their lives and the stability of livelihoods, safety, well-being and risk management.

People continuously look for new ways to adjust their livelihood strategies with the aim of reducing risk, sustaining their livelihoods, and avoiding making irreversible livelihood decisions (i.e. decisions that result in undermining the basis of their means of survival (Walker 1989, 50 *in* Heijmans 2001). They do not only take into account the possible exposure to danger and future damages, but they manage their resources as well as their capacities, options and alternatives, and the implications of their decisions to deal with the ongoing process of mounting vulnerability (Heijmans 2001).

Participatory approaches with local communities are part of an empowerment process. People's participation is not just the process of consultation and providing information to outsiders during assessments. Joint assessment of capacities and vulnerabilities creates awareness, increases the quality of data, ideas and solutions coming out of the process and enables those involved to gain confidence in expressing their views and the formation of new local institutions or to the strengthening of existing ones (Slovic 1992; Oliver-Smith 1996; Heijmans 2001; Twigg et al. 2001). Hence, participation is key in understanding people's perceptions of risk, assessing their vulnerable conditions and identifying appropriate measures and any assistance needed for the problems faced.

3. Conceptual framework and methodology applied in the study sites

The vulnerability assessment focused mainly on current vulnerability by analyzing past trends and coping strategies in the sites. The analysis centered mainly on the social aspects of vulnerability, understanding vulnerability as processes rooted in the actions of human actors and interactions with the natural resource base upon which they depend.

The point of departure of the proposed conceptual framework for assessing current vulnerability is the understanding of the system of analysis, particularly the social aspects (actors, networks, institutions and governance structures) and how humans use and benefit from forests and other natural resources upon which they depend (Figure 1). The dynamic processes and interactions between humans and their local environment were also explored, but were mainly based on local perceptions and without conducting a biophysical study.

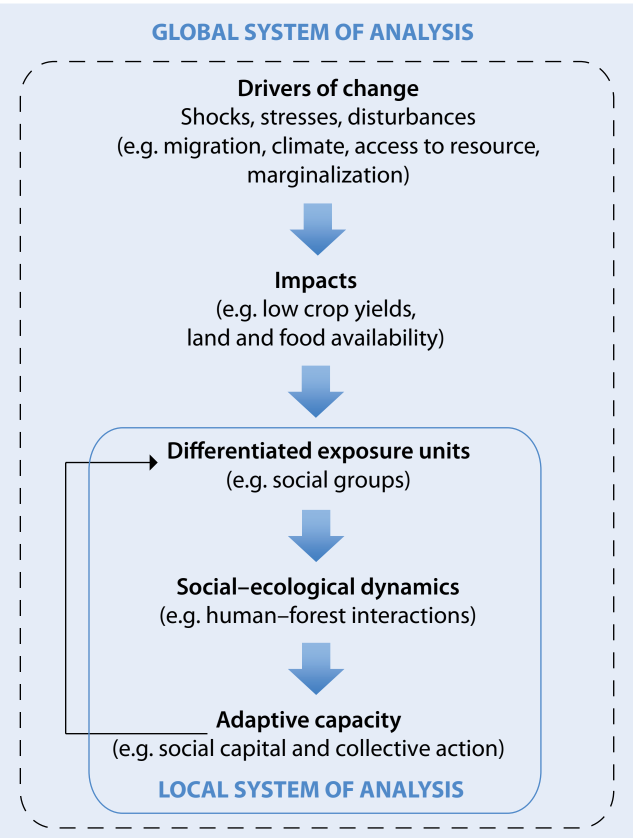


Figure 1. Conceptual framework for assessing current vulnerability.

Multiple drivers of change (e.g. multiple stresses and shocks including climate-related disturbances) shape the system of analysis. The degree to which the system is affected by or responds to multiple drivers will depend on the extent and magnitude of the impacts at the local level, and the vulnerability of the overall system. The multiple stresses, shocks and climate-related disturbances affect different exposure units of the social–ecological system in different ways. Enabling factors for adaptive capacity such as social capital and collective action will determine the ability of the system to respond to multiple drivers of change.

Current vulnerability was assessed in a systematic way by looking at different assets such as the livelihood, human, social and natural capitals, the drivers of change, the differentiated exposure and impacts, and the social capital and collective action as enablers of adaptive capacity. Each aspect encompasses different vulnerability dimensions. For each research framework component, a set of participatory tools and methods was used to understand local perceptions and elicit information for the analysis. Table 1 lists the different participatory exercises applied in the local communities. Before implementation, all methods were previously tested and refined by working together with local partners and representatives of the local communities. The next sections describe each participatory method in more detail and provide examples from different project sites.

The time period considered for the current vulnerability analysis covered at least three decades. Local perceptions were captured through the participatory exercises in focus group discussions to explore changes over time from the 1970s to the present. This was important to understand multiple threats that may have affected the villages in the past, as well as processes of change in terms of coping mechanisms, social dynamics (e.g. formation of associations or institutions) and ecological dynamics (e.g. degradation or maintenance of forests resources).

Table 1. Vulnerability framework aspects, dimensions, focus and methods.

Aspects	Vulnerability dimensions	Focus	Main participatory methods to understand the vulnerability dimensions	Complementary participatory methods
System	Exposure units	Socioeconomic and ecological exposure units	• Village profiles • Resource mapping • Land tenure • Pebble game and scoring	--
	Dynamic processes	Social and ecological dynamics and interactions	• Seasonal calendar • Deforestation and forest degradation analysis • Forest–people interaction analysis • Flows analysis • Trade system analysis	Forest use and benefits analysis
Drivers of change	Multiple threats	Multiple stresses and shocks	• Historical disturbance analysis	--
		Climate-related hazards	• Seasonal calendar • Climate-related disturbance analysis	--
Differentiated impacts	Differential sensitivity	Differentiated impacts to climate-related disturbances	• Product importance and revenue distribution analysis • Forest use and benefits analysis • Disturbance-impact analysis	Trade system analysis
Adaptive capacity	Social capital and collective action	Enabling factors for adaptive capacity	• Observations • Social infrastructure and institutions analysis • Social network mapping • Response/ • adaptation analysis	Product and revenue distribution analysis, trade system analysis

Adapted from: Devisscher et al. (2013).

A gendered approach was used throughout the information and data collection process, as vulnerability to climate change is shaped by gender roles and relations, with poor, rural women in developing countries generally being considered to be the most vulnerable to climate change (Brown 2011; Djoudi and Brockhaus 2011). This implies adopting systematically gender-specific research questions to capture men's and women's specific knowledge and priorities for forests and forest goods and services, to sort out differential access rights, capabilities and vulnerability to climate changes, and to be sure men, women and other disadvantaged social groups have been taken into account. When possible, local perceptions were compared with observed climate data at the station level. The comparison between different types of data provided new insights in the understanding of perceptions and was useful to characterize the variability of environmental parameters.

It is assumed that the system is constantly responding to new changes and conditions through coping mechanisms and/or adaptation measures. A historical approach helped us understand how the system has evolved to its current condition and the nature of its evolution.

In all sites, the baseline assessment comprised three main phases: preparation, fieldwork and a feedback workshop.

Preparation

The preparatory process involved a literature review of documents and data relevant to the landscapes. This review led to site characterization of landscapes in our study (Table 2). This phase also involved establishing a liaison with local partners, who played an important role in the selection of communities to include in the assessment and stakeholders to engage in the process. Inevitably, local partners helped to refine the participatory methods and pilot them with representatives from the local communities before their implementation in the sites.

During the preparatory phase, local authorities were informed about the research work and objectives. This was carried out through individual visits or in workshops, where concepts on climate change, adaptation and mitigation were discussed in the context of the specific countries and local development plans.

Fieldwork

The vulnerability baseline assessment was carried out in five of the 12 Central Africa Regional Programme for Environment (CARPE) landscapes of the Congo Basin (Figure 2). Most of these landscapes are cross-boundary, spanning more than one country of the Congo Basin. For practical purposes, in the framework of our study, the specific sites where the assessment was conducted are located in one country of each landscape, in the following way: Tri-National de la Sangha (sites in Cameroon), Monte Alén-Monts de Cristal (sites in Equatorial Guinea), Lac Tele-Lac Tumba and Maiko-Tayna-Kahuzi-Biega (sites in Democratic Republic of Congo), and Virunga (sites in Rwanda). Figure 2 shows the study sites on a regional map.

The methods used in the fieldwork involved different participatory exercises applied in unisex focus groups (men and women). Division of participants into homogeneous groups of men and women was carried out to gain more balanced participation and different gender perspectives. However, groups were mixed during restitution in order to have different groups share their vision for compromise options. Participants included women, men, the elderly, youth, NGO representatives and local administration representatives. The inclusion of elderly people made it possible to go back at least two generations. Generally, village chiefs and local partners selected the participants for the participatory exercises, which were largely representative of different ethnic groups and socioeconomic profiles in the sites. The cooperation with village chiefs could be considered as a risk factor in the data collection process as the process was not fully independent in this regard. In the village, all participants were first gathered together for a round of introductions and a general discussion about the purpose of the visit. Then, participants were divided in groups according to the exercises planned in the sites, the number of villages and the extent of each of them. In each village, exercises were conducted over several days and in some sites several visits were needed for the exercise to be completed.

Feedback workshop

After completing the fieldwork, a workshop was conducted to deliver the results obtained from the participatory research to community representatives. This workshop served as a validation exercise and involved mainly village chiefs, local NGO representatives and key stakeholders from the sites engaged in the fieldwork. During the workshop, group work was encouraged to discuss strategies that could improve current adaptive capacity in the sites.

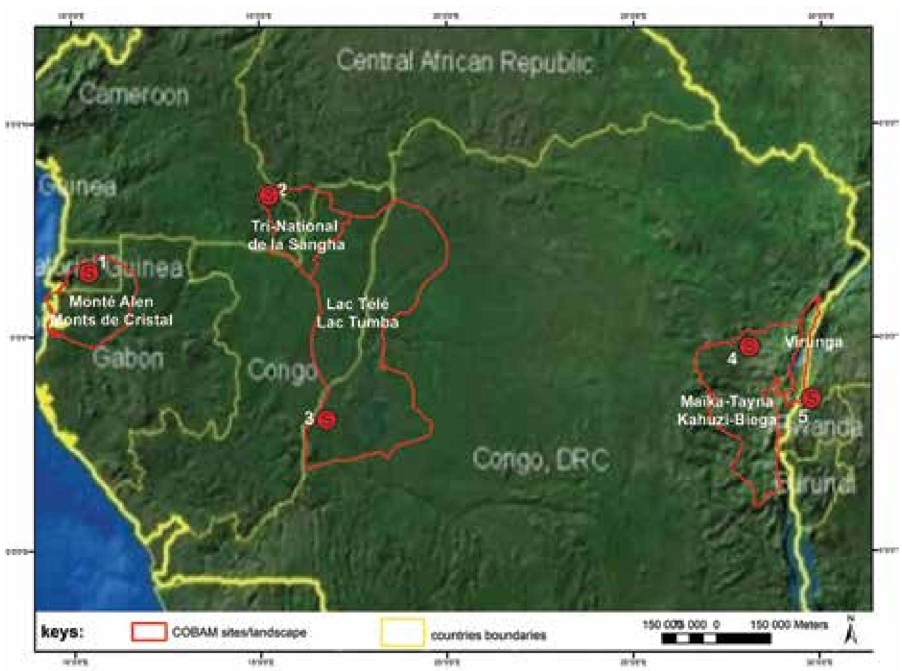


Figure 2. Study sites in the COBAM project landscape.

Table 2. Characterization of COBAM project landscapes.

		Monte Alén-Monts de Cristal (Gabon, Equatorial Guinea)	Tri-national de la Sangha (Cameroon, CAR Congo)	Lac Télé-Lac Tumba (DRC, Congo)	Maiko-Tayna-Kahuzi Biega (DRC)	Virunga (RDC, Rwanda)
Biophysical characterization	Forest cover (x 10^3 ha)	2000: 2610.1	2005: 4,260.8	2005: 9,917.7	2005: 9,060.0	2005: 314.3
	Deforestation (ha)	1990–2000: 12,800 Rate: 0.49%	2000–2005: 13,500 Rate: 0.33%	2000–2005: 18,900 Rate: 0.19%	2000–2005: 80,400 Rate: 0.88%	2000-2005: 13,600 Rate: 4.14%
	Main causes of deforestation	Forest exploitation	Slash-and-burn agriculture	Agriculture	• Agriculture expansion, • Illegal mining	• Agriculture • Artisanal forestry
	Vegetation/ forest types	• Lowland moist forest • Mountain forest • Degraded mountain forest • Secondary forest • 500 ha of abandoned Okoumé	Dense humid forest dominated by *Terminalia superba, Gilbertiodendron dewevrei, Triplochiton scleroxylon*	• One of the largest humid zones in the world • Swamp areas	Inland dense forest	• Forest–farmland–savanna mosaic • Tropical dense forest
	Biodiversity	• Rich • One of the highest mountain elephant densities known in Central Africa region	• Rich flora • High number of primates and mammals, birds	High number of mammals: 13,000 gorillas 3,000 chimpanzees, 300 bonobos	High number of mammals	• Rich biodiversity and high level of endemism: • 218 mammals; 22 primates • 380 mountain gorillas
	Threat to biodiversity conservation	• Agriculture • Poaching • Illegal fishing • Unsustainable exploitation of NTFPs • Signs of climate change	• Illegal hunting • Marketing of bushmeat • Unsustainable commercial forest exploitation • Uncontrolled forest mining • Marketing of Jaco parrots	• Intensive poaching • Presence of refugees in the landscape • Road construction • Forest fires	• Agriculture • Uncontrolled forest mining • Illegal hunting	• Agriculture • Artisanal forestry • extension of savannah
	Zoning and land use	Land-use plan developed and implemented in some national parks and forest concessions	• Multiple land-use zones	• 23 macro-zones • Land-use plan not finalized	• Land-use plan not finalized	

continued on next page

Table 2. Continued

		Monte Alén-Monts de Cristal (Gabon, Equatorial Guinea)	Tri-national de la Sangha (Cameroon, CAR Congo)	Lac Télé-Lac Tumba (DRC, Congo)	Maiko-Tayna-Kahuzi Biega (DRC)	Virunga (RDC, Rwanda)
Forest and land use	Presence of concessions and certification	65% of the landscape is forest concessions belonging mostly to French and Asian companies	• 1,051,600 ha forest concessions • 3,388,003 ha certified			
	Parks, reserves, etc.	• 3 parks • 3 reserves	• 3 national parks	• Two protected areas and 4 proposed • RAMSAR sites • 13 community forests • 6 resource extraction zones	• 2 national parks • Community forests	• 2 national parks • 1 hunting zone • Community forests
	Other values		Artisanal mine exploitation		Mining	Artisanal mining (5% of the landscape)
Governance and accessibility	Viable partnership	ECOFAC (GE) WCS (Gabon) WWF; IUCN-CARPE, MBG, CUREF INDEFOR, IUBioma	WWF, WCS, GTZ, COVAREF, SEFAC, ETC	WCS, WWF, UMD-CARPE, OSAFAC, FORAF	CI, UMD-CARPE, OSOFAC, FORAF, UICN, ICCN, Tom Patterson, US National Park Service	AWF, UMD-CARPE, OSOFAC, FORAF, UICN, Tom Patterson, US National Park Service ICCN, ORTPN, FFI, BRD, WWF, ZSL, CBO, CBV
	Challenges	• Inefficient coordination of activities • Border problem with the two countries	• Differences in forest legislation • Differences in hunting legislation • Problem of access to resources • Presence of communities living in the landscape	Many gorilla populations still to be discovered	• Very large forest area (10 million ha) • Problem of communication • Insecurity due to the presence of armed groups	Insecurity due to the presence of armed groups
	Accessibility	accessible	accessible	accessible	less accessible and dangerous	Accessible, but many armed groups
Human presence	Human density	16–18 inhab/km^2	5–7 inhab/km^2		Increased density from west (30 inhab/km^2) to east (300 inhab/km^2)	300 inhab/km^2
	Indigenous ethnic groups	Beyele	• Baka (Cameroon) • BaAka (south of CAR) • Mbenzele (north of Congo)	Batwa	Twa	Batwa

Source: Compilation from CBFP (2006, 2008).

4. Participatory field exercises used in the vulnerability assessment

The participatory field exercises used to characterize each vulnerability dimension as described in this paper included: village profiles; resource mapping and land tenure; historical disturbance analysis; climate-related disturbance analysis; deforestation and forest degradation analysis; forest–people interaction analysis; flows analysis; seasonal calendar; product importance and revenue distribution analysis; trade system analysis; forest use and benefits analysis; disturbance impact analysis; social capital and collective action analysis (including social infrastructure and institutions, and social network mapping); and adaptive capacity analysis. Each field tool was modified to suit differing local conditions and specificities of the study sites.

The following sections provide a short description of the field tools used to characterize *current vulnerability*. Examples are presented in boxes to show the practical applications of the tools, the type of results that can be generated and the potential use and analysis of the data after the fieldwork. Each participatory tool contributed to one or more vulnerability aspects and dimensions of the proposed conceptual framework. A combination of tools provided a more comprehensive approach to understanding the social vulnerability context.

4.1 The system of analysis

A number of participatory tools were used to understand the system of study including the different social groups and social arrangements, the economic sector, the geographical region or location and the natural ecosystem, as defined by Fussel (2007). A range of participatory tools can be useful to characterize this aspect of vulnerability (i.e. the system of analysis). There may be additional tools that are helpful in providing further insights about the system or context of analysis (that were not applied here), as no single tool fits all purposes.

4.1.1 System and exposure units

The use of the *village profile, resource mapping and land tenure* participatory exercises were the main activities used to characterize the exposure units of the system of analysis and the first step in the fieldwork process.

The *village profile* aims to help our understanding of the system, as it provides a brief description of many different aspects of village life as a whole and helps identify the main issues of concern. The main purpose is to help outsiders who have never visited the village to understand local constraints and opportunities. It is the basis for more precise analytical field exercises conducted later in the process. A group discussion among the participants is held and a series of questions are posed to the village members. The questions are tailored to the specific needs of the study. The approach provides initial information about the social and ecological exposure units, and particularly, on the formation of the village and its overall profile, including the history of settlement, migration patterns, presence of ethnic groups, the development and environmental context, main livelihood activities and the main issues affecting the village.

Another tool used to characterize the exposure units (as a coupled socio-ecological system) was the *village resource map*. A *village resource map* represents a holistic visual representation of the resource system and is based on the local perceptions of community members. Participants determine the content of the map and boundaries based on what is important to them and the way they understand their context. Different features such as infrastructure (e.g. roads, houses, buildings), water sources, agricultural lands (e.g. crop varieties and location), agro-ecological zones (e.g. soils, slopes, elevations), forest lands, grazing areas, shops, markets, health clinics, schools, and religious facilities may be represented (FAO 2001; Geilfus 2008). The map generated provides insights on the perceived distribution of environmental (e.g. forests, agricultural land, water resources, etc.), economic and social resources as well as management issues that are important to the community members.

The participants are asked to draw a map of their village showing the resources present in their locality. To start the process, a distinctive central feature of the village is drawn on a flip chart and identified as an important landmark. After the participants have drawn the map of their village, they are asked to describe it and discuss the features they have represented. Participants can indicate the resources they would like to see in the future and those that are not presently included in the map. This can help in planning processes and encourages participants to start contributing with their thoughts and needs at an early stage of the participatory process (FAO 2001). This exercise provides an opportunity to discuss community-use patterns, land-tenure dynamics and conflicts over resources access and control (if any). Box 1 shows an example of the results that the village resource map provides.

4.1.2 Dynamic processes

There are different tools that help characterize the dynamic processes taking place in the system of study. The main participatory exercises used in this research that are useful to assess the dynamic processes of the vulnerability context are the *seasonal calendar, the deforestation and forest degradation analysis, the forest–people interaction analysis, flows analysis and trade system analysis*. There are several other complementary participatory tools that may contribute to this vulnerability dimension such as the *forest use and benefits analysis*. However, the latter plays a greater role in the characterization of differential exposure (see Section 4.3.1 on differential exposure for further insights).

The *seasonal calendar* helps to understand the dynamic processes occurring throughout the year. It is possible to find out what people do during the year and explore changes in the livelihood systems taking place over the period of a year (FAO 2001). The results obtained help identify seasonal patterns and variations in availability of different natural resource products over the year that affect local livelihoods and that might not be obvious to someone who does not live in the study area. On the calendar it is possible to represent different economic activities, resources, production activities, food availability, gender-specific workloads, water and forage availability, human diseases, migration, and natural events/phenomena on a seasonal time scale (FAO 2001; AFN 2002). In the vulnerability baseline assessment conducted within the COBAM project, the focus of the *seasonal calendar* was on the timing for the preparation of land, harvest (i.e. main resources collected/harvested during a year) and the seasonality of gender-based livelihood activities in the village.

Understanding local patterns in the context of the immediate area will help guide the development of viable coping mechanisms and adaptation strategies, from agronomic practices to crop insurance in the face of uncertainty (FAO 2000; Geilfus 2008). A matrix can be drawn indicating the months of a calendar year along one axis against livelihood activities and/or strategies. Discussions are then held about the reasons for different responses taking place at different times of the year, and linkages between different topics are established in order to identify and elicit group priorities.

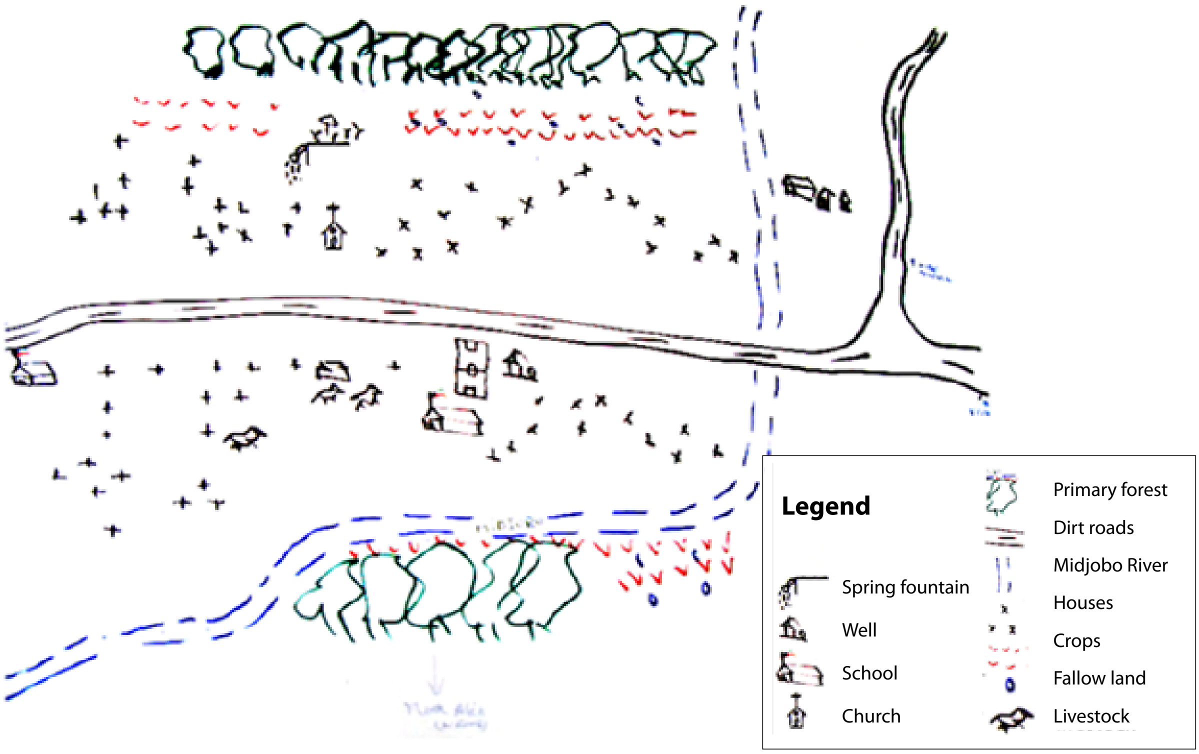
There are many advantages of undertaking such an exercise. It is helpful, not only to understand seasonal differences in livelihoods, but also to illustrate the dynamic nature of vulnerability, different dimensions of well-being as well as the cause and effect relationship of various activities between seasons. In addition, it helps us to understand the time of the year when different social groups might be more or less vulnerable or those that tend to suffer periods of hardship and the kind of livelihood strategies that people use to manage risk (i.e. mitigating, coping/ adaptation strategies). This information is relevant to find appropriate 'safety nets' in harsh conditions and what needs to be prioritized for adaptation planning. Box 2 shows an example of the type of results that can be produced with the participatory tool which was used in Rwanda.

The participatory tool on *deforestation and forest degradation analysis* is useful to understand dynamic processes of the system and changes related to forest resources in terms of decreasing area covered by forest (i.e. deforestation) and trends in forest degradation over time. Forest degradation mainly involves a quality decrease in the condition of the forest, related to the structure or function of one or different forest ecosystem components (e.g. vegetation, fauna, soil) and the interactions between these components (FAO 2001; Lanly 2003). The same process can be extended to other ecosystem components or land-use types within the landscape of the site.

A table may be drawn on a flip chart with a group of people where discussion among participants is encouraged. In the context of the COBAM project, participants were asked to discuss the evolution of different factors affecting the condition of the forests around the village since the 1970s. Participants use stones or pebbles to proportionately represent trends in land-use coverage and the presence of natural resources over time. It is also possible to draw trend lines for specific factors (e.g. slash and burn shifting cultivation or other forms of agriculture, cash cropping, pasture, development of logging road infrastructure, hunting, human settlements) affecting the state of forest resources based on participants' local experience (see Box 3).

Box 1. Resource mapping in Equatorial Guinea.

The map below is the type of output that can be generated with this exercise. The participants draw resources that are important to them. Then the participants are asked to explain the map they have produced.



Example of story that may be obtained from community members:

The village of Atom has developed on both sides of the main road. Its boundary is limited by other villages, the Monte Alén National Park and forests that belong to other villages.

- Past forest exploitation has been a major factor in the development of the village, through the opening of a forest track and expansion of the village along the road.
- Agricultural plots have been organized in the immediate vicinity of the settlements. Land for agriculture has increased in recent decades. The abundance of forest has encouraged slash and burn shifting cultivation and the use of mature forest for the renewal of agricultural plots.
- The distance from the village to the agricultural plots is, at most, about 2 km (according to the villagers' perceptions). Beyond this, land is covered by mature forest. In the 1990s, the creation of Monte Alén National Park limited the expansion of forest activities but was not a major constraint for agricultural activities.
- Subsistence agriculture remains the main production activity. A large portion of meat is bought at the nearby city of Evinayong. Cocoa plantations were introduced several decades ago in the proximity of the main road along with some palm plantations. New cultivations are created in forested virgin areas.
- There is wide access to ecosystems by all villagers. Customary rights to woodlots are held by village chiefs. Access to land from outsiders is frequently requested and approved by the chiefs but is normally granted for just one cropping period or one year.
- Crops that require the most effort have been progressively abandoned (e.g. yam).[1]
- All residents are of the Fang ethnic group, with four sub-tribes/clans: Yemendjim, Olá, Amvom and Ntun.

Source: COBAM (2012).

1 This is likely to be linked to the increase in average age of the village's population due to many young people leaving to find work elsewhere, e.g. in the mining concessions.

Box 2. Seasonal calendar in the Virunga landscape in Rwanda.

Table 3 is a visual representation of the seasonal calendar conducted in the Virunga landscape (in Rwanda) with the community members. The facilitator draws a table on a flip chart (as shown below) and the participants provide insights about the questions posed regarding the production system in a calendar year and the different activities involved.

Table 3. Seasonal calendar based on the production system in the Virunga landscape in Rwanda.

Activities	J	F	M	A	M	J	J	A	S	O	N	D
Seasons		Dry	Rainy season				Dry season				Rainy season	
Field with potatoes												
Selection of seeds	■	■										
Preparation of the field		■	■	■								
Seedling	■	■	■	■								
Maintenance[a]		■	■	■	■							
Weeding		■	■	■	■							
Insecticide		■	■	■	■	■						
Watering			■	■	■	■						
Pruning branches				■	■	■	■					
Harvesting					■	■	■	■				
Pyrethrum field												
Preparation of the field			■	■								
Seedling				■	■							
Weeding				■	■	■	■	■	■	■	■	■
Harvesting	■	■	■								■	■
Sun drying	■	■	■									■
Selling	■	■	■									
Other activities												
Beekeeping	■	■	■	■	■	■				■	■	■
Breeding	■	■	■	■	■	■	■	■	■	■	■	■
Weeding in forest						■	■	■	■	■	■	
Construction						■	■	■	■	■	■	

a Care of young plants and rejections

Note: The cells indicate when different productive activities take place during the year. The names of each season are also shown on the table.

Example of a narrative that may be obtained:

Agriculture is the main livelihood of the population. Other non-agricultural opportunities are rare. The most important products for revenue generation are: potatoes, maize, beans and wheat. The main cash crops are tea and pyrethrum. Other livelihoods include livestock, local crafts, small business, beekeeping, coal production, and fishing. The main agricultural practice is based on permanent fields, allowing two to three cycles of production per year, based on a rotation of the crops. An example of rotation is potatoes alternating with beans or maize.

Plantations of pyrethrum are functioning under a sharecropping system. Plantations were formerly run by the State (*Office du Pyrèthre au Rwanda*). They have recently been redistributed to farmers in individual indivisible plots.

continued on next page

Box 2. Continued

Those plots are exploited by family cooperatives. Farmers are expected to maintain the plantations and to follow a fixed cultural calendar. Pyrethrum is grown mixed with other crops, such as potatoes.

The dry seasons are the most profitable for revenue due to the sales of harvested crops, and the harvesting and sale of honey; these are also peak times for milk production. Farmers tend to experience damage and losses caused by hazards during the rainy season (floods, landslides). According to the communities, changes in the seasons, such as prolonged droughts are affecting the production calendar, as most of the preparation and seeding occurs at the end of the dry season.

Source: Pavageau et al. (2013).

Box 3. Deforestation and forest degradation analysis in the Trinationale de la Sangha (TNS) landscape, Cameroon.

The participants used stones to proportionately represent the trends in the area covered by each ecosystem component or land-use type and other relevant trends (e.g. population), as perceived since the 1970s up to the present time. The discussion generated provides an understanding of the condition of the natural resource base from a historical perspective, especially with regard to forest resources and what affected community members. Two graphs were created based on the data gathered from the participants showing the relative perceived trend of each component analyzed over time (Figures 3 & 4).

How can the field exercise be illustrated?

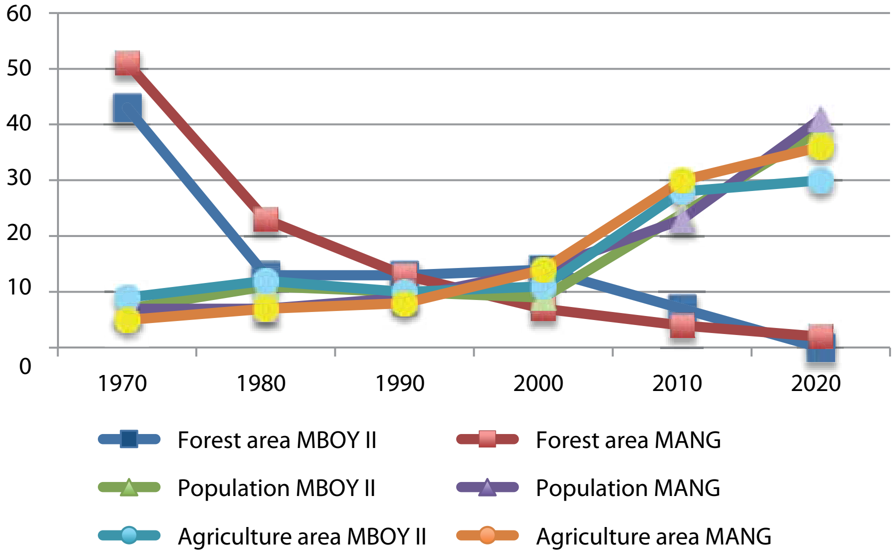


Figure 3. Perceived trends in agriculture, forest area and population in Mboy II and Mang since 1970.

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Box 3. Continued

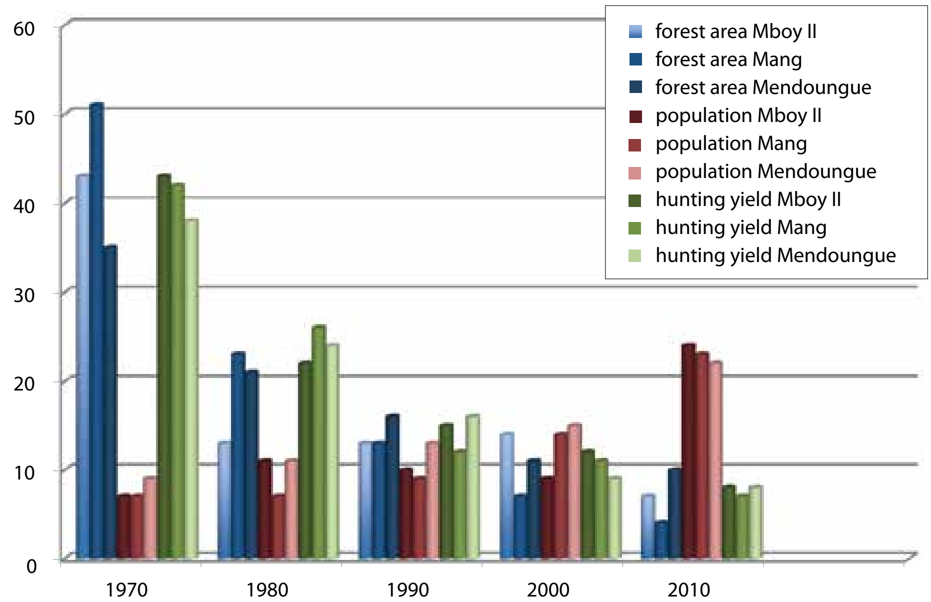

Figure 4. Perceived trends in forest resources since 1970 in Mboy II, Mang and Mendoungue.

Narrative and interpretation of results from the exercise:

Population growth is the main reason for agriculture land expansion, particularly after 2000. This is reflected in Figure 3, which shows a positive relationship between population growth and size of agriculture area in Mboy II and Mang. According to the villagers, population growth was mainly due to migration into the villages, the practice of polygamy and a decrease in child mortality due to the introduction of vaccinations (against measles, tuberculosis and tetanus). Due to rapid development in the east of Cameroon, participants expected the population growth to continue. Another important change observed by villagers was the decrease in both forest cover and the availability of non-timber forest products (NTFPs). In all cases, villagers witnessed deforestation of both primary and secondary forests, as well as a decrease in the availability of bushmeat and fish, and increased difficulty in locating NTFPs. The forest area and availability of bushmeat decreased while population in the villages grew over time. According to the villagers, deforestation started when forest concessions were introduced between the 1970s and 1980s. Since 1980, deforestation has continued due to an expansion of agricultural areas mainly driven by population growth, competition for natural resources, and low agricultural production due to changing seasons. Low agricultural production has also led to the expansion of agriculture land to compensate for production loss. This has been recently exacerbated by the immigration of a large number of paid workers who came to work in the forest concessions in the 1990s.

Source: Devisscher et al. (2013).

The use of this participatory exercise provides context-specific quantitative data as perceived and experienced by local communities, including resource users. It helps us to understand the trends in the forest cover area and the factors affecting its quality in the local context from a resource user and historical perspective. Box 3 shows an example from the TNS landscape, in Cameroon, including the type of results the tool can generate and how the findings may be illustrated.

The *forest–people interaction analysis* helps to explore the feedback between the social and ecological processes in the site. This diagram can serve as the basis for the development of a conceptual model about the system dynamics, which later can be complemented with additional data and validated by the community or local partners.

It is necessary to identify and list the main actors in the site who manage or benefit from natural resources on separate cards (illustrated in the *resource map exercise*), before starting to develop the diagram (shown in Figure 5) with the participants. The main resources and ecosystems mapped by the participants are listed inside the circle. If the actors interact directly with the resources/ecosystems (e.g. harvest, hunt, collect, produce), they are placed inside the circle. If they interact indirectly with the resources/ecosystems (e.g. manage, decide, advise), they are placed outside the circle. Once resources and actors are positioned, interactions are drawn between the actors and the resources/ecosystems (using arrows). For each arrow, a verb describes the action of the actor on the resource/ecosystem. After completing the interactions between actors and the resources/ecosystems, it is possible to add an additional layer of information by illustrating interactions between ecosystems using a different set of arrows (e.g. in a different color). This second set of arrows can indicate the perceived dynamic between ecosystems that are not driven by human actions (e.g. transformation from fallow to forest).

The main advantage this participatory exercise offers is the realization of the existence of multiple and complex feedback between people and the resources/ecosystems in the site. This can sometimes be an abstract concept and it will therefore require good facilitation and a set of examples to guide the process. It is also important to bear in mind that the conceptual diagram will reflect the mental model of the participants. It may be helpful to repeat this exercise with different groups to obtain diagrams from different points of view, which then can be used in combination for the development of a common conceptual model. This conceptual model will need to be validated and refined by the participants of all groups.

Another important tool that is useful to understand dynamic processes is the *flows analysis*. This field activity helps to identify and understand the inflows and outflows between the village and other areas. The types of flows may be resources, materials, groups of people, and/or others. A series of discussion questions can be helpful to work with a group of people. A flow diagram can be drawn to illustrate the discussion (see Box 4).

The *trade system analysis* aims to provide information on access to markets within the system of analysis (e.g. the village). The products ranked in the *product importance analysis* (see Section 4.3.1 on differential exposure) are taken forward in this exercise and for each product, and locations for trading are indicated as well as the price per unit of each product in each market. Data generated from the field exercise include: information on how the products are sold (e.g. individually or as part of a group); the best sale period of products; where, when and how the best price could be obtained; the criteria needed to join an association; and the transportation means used to get access to markets.

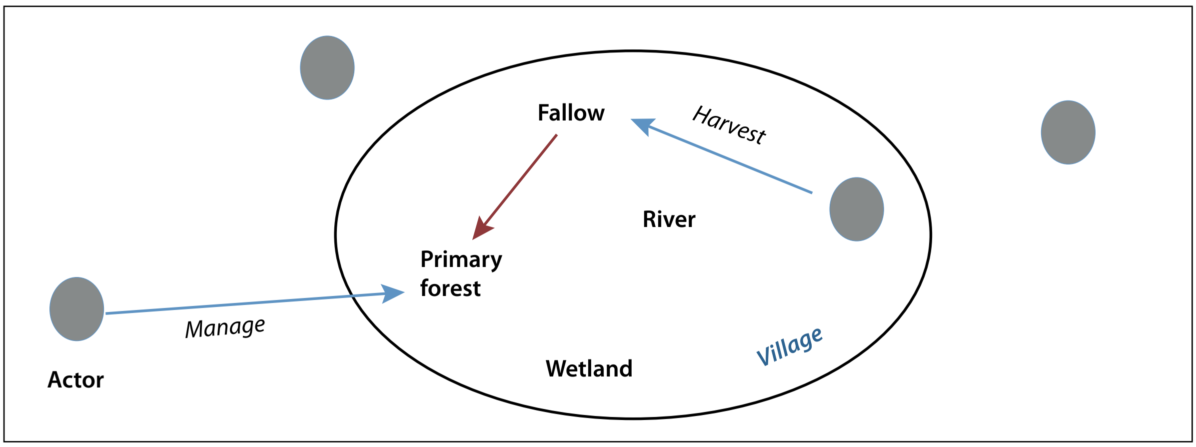

Figure 5. Simplified diagram for actor–ecosystem interactions.

Box 4. Flows analysis in the TNS landscape, Cameroon.

Figure 6 illustrates the flows of people and resources as perceived by villagers in Mboy II. Incoming flows can be differentiated from outgoing flows with different colors. The flows can be described using key questions:

- What resources/materials/groups of people are coming into the village? From where, since when and why?
- What resources/materials/groups of people are moving from the village to other countries/to different parts of the country from where the village is located? Since when and why?

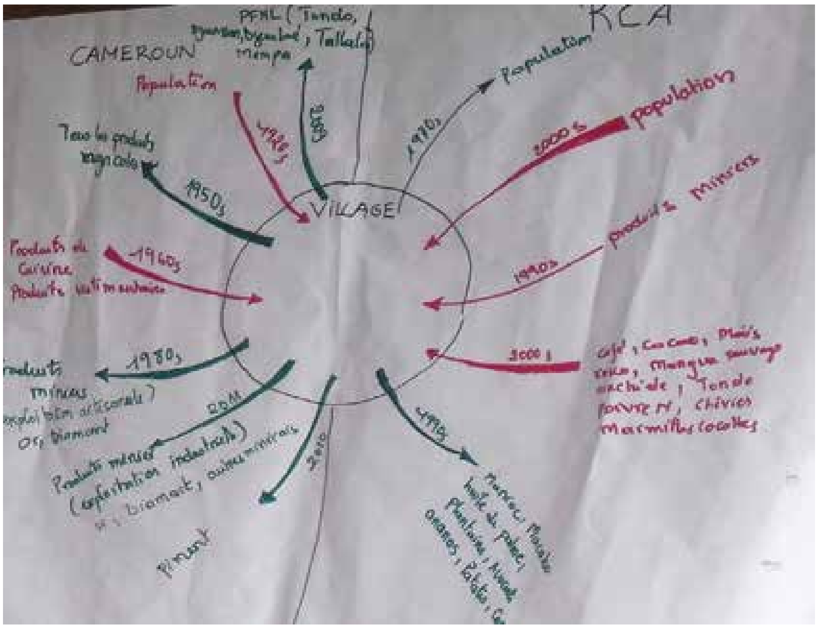

Figure 6. Flows of people and resources as perceived by populations in Mboy II.
Note: red = incoming flows; green = outgoing flows

Example of narrative generated from the exercise:

Flows from Central African Republic (CAR) to the village:

- People from CAR have been migrating to the village of Mboy II since 2000 due to the political instability and war in CAR, in search of new life opportunities.
- Mining products have been entering the village from CAR since the 1990s, but in low quantities.
- Different agricultural products coming from CAR have been sold in the village since 2000, as Mboy II hosts a large frontier market on Saturdays.

Flows from other parts of Cameroon to the village:

- Since the 1920s, people from other parts of Cameroon have migrated to the village. The first settlers were the Mpiemon (currently the largest ethnic group in the village).
- Products such as petrol, clothing and kitchen utensils come from other regions of Cameroon and the village has been importing them since the 1960s.

Flows from the village to Central African Republic:

- Mainly through marriages, some people of the village have migrated to CAR since the 1970s.
- The village has been exporting agricultural products to CAR since the 1990s, mainly palm oil, plantain, avocados, pineapples, potatoes and sugar cane.

Source: Devisscher et al. (2013).

4.2 Drivers of change

Villagers in the project sites have seen important changes since the villages' creation, both in ecological and socioeconomic terms. Groups involved in the participatory exercises included elderly people, which facilitated the researchers to go back in time for two generations. This allowed understanding multiple threats that may have affected the villages in the past, as well as coping mechanisms, social dynamics (e.g. formation of social networks and/or institutions) and ecological dynamics (e.g. degradation or maintenance of biodiversity and ecosystem services).

The villages considered in the study have moderate to high pressure on the forest resources, and in general on the natural resource base. This is caused by different broad drivers of change, including political, social, economic, and environmental drivers as well as a range of local factors that shape past and present vulnerability. In the TNS for instance, villagers were left out of the land planning process. Almost 90% of lands were set as permanent forest for biodiversity conservation, council forests and productive forest for timber management purposes.

Villagers recognize a number of threats that affect their livelihoods. Among the main climate-related disturbances, villagers mentioned increasing temperature with prolonged dry periods, changing seasons and strong winds. Climate-related disturbances combine with a myriad of other threats to shape the vulnerability of villages in the study sites.

4.2.1 Multiple threats

In order to understand shocks, perturbations, or pressures on the system over time, the *historical disturbance analysis* and *climate-related disturbance analysis* tools were used.

The overall aim of the *historical disturbance analysis* is to obtain a time line of the main events, facts and disturbances that took place or affected the area or village in the past. These can include social, political, economic, technological and environmental disturbances, among others. It provides a series of events listed chronologically on a horizontal axis. The discussion is usually initiated around an important event in the past. This exercise provides an idea of the cyclical changes over time.

Using a time line or a table that runs from the 1970s to the present, participants were requested to list and explain the main disturbances that have affected their village in one way or another. The disturbance profile for the Virunga landscape in Rwanda is shown in Box 5. The involvement of elderly people ensured that relevant historical disturbances were elicited. This tool is helpful to get an idea of the multiple drivers of change shaping the local context from a more system's perspective. Furthermore, it is useful to identify significant changes in a community's past that continue to influence events, practices and attitudes in the present.

The aim of the *climate-related disturbance analysis* tool is to gain an understanding of the local context in terms of disturbances from climate variability and how these affect livelihoods. Ultimately, the tool aims to provide a list of the main climate-related disturbances and each climate disturbance identified by the participants is then classified as a shock (i.e. singular event) or as a continuous event (i.e. gradual change).

The data generated through this exercise are very contextual and useful as meteorological stations may not be immediately available in the area of study or the climate data available from a meteorological station nearby might not represent local conditions of the specific system of analysis. If available, climate data from reliable sources such as the Climate Information Portal (Climate Systems Analysis Group, University of Cape Town) may provide useful information and this can be compared with the perceptions at the community level.

It is important to capture a description of the effects of the disturbance and the main concern around it (Box 6). It is equally important to know the duration and spatial extent of the disturbance, or whether there are specific areas at higher risk and the expected frequency of occurrence that might provide useful insights for other vulnerability dimensions such as the differential exposure.

4.3 Differentiated exposure, impacts and adaptive capacity

There is limited scientific knowledge on the impacts of changes in climate on local communities and ecosystems in the Congo Basin (IPCC 2007). Local information and experience was used to evaluate the differentiated effect of climate-related threats on different social actors, activities and resources (Box 7).

Box 5. Historical disturbance analysis in the Virunga landscape, Rwanda.

Figure 7 shows the visual representation of the field tool conducted with the community members in the Virunga landscape (in Rwanda) on the disturbances that have affected the area over time. A discussion of the main historical events is encouraged.

Year	Major events
1959	Revolution
1962	Independence (1st Republic)
1978	2nd Republic
1985	Droughts
1990	War for the revolution
1994	Death of Habyarimana – Genocide – July: End of the genocide
1996	Return of the refugees
1997	War (in Congo)
1998	Floods
1999	Revision of the matrimonial code
2000	Conflicts due to migration – Livestock disease – Droughts and floods
2003	New constitution
2004	Reactivation of Gacaca
2006	Human disease (Ebola) – AIDS protection program
2007	Earthquake – Commission for national unity and reconstruction
2008	Crop disease (bacterial wilt)
2009	Pork disease (Swine flu)
2011	New education program – Lightning
2012	Floods – Lightning

Figure 7. Visual disturbances that have affected the area over time.

Interpretation that may be obtained from the field exercise:
Conflicts, and political and social changes resulted in famine and overexploitation of natural resources and livelihoods. The mass exodus of refugees took its toll on the environment. Many conservation workers fled their posts or were killed during the ethnic violence in 1994, while soldiers and refugees moved into the national parks, hunting wildlife and felling trees for fuelwood and building materials. Loss of human life and destruction of livestock also impacted the food availability at that time.

One of the major droughts occurred in 1985, followed by a migration movement and a famine period. Floods caused landslides and destruction of goods, infrastructure and crops. The outbreak of diseases has increased, affecting crops (e.g. bacterial wilt in potato, banana diseases in recent years), livestock (e.g. anthrax) and human beings (e.g. Ebola).

The reestablishment of the system of community justice, *Gacaca* court for the crimes committed during the genocide, had many implications on social organization in communities and indirect consequences on land rights and access. The Commission for National Unity and Reconstruction also attempted to remedy past discrimination and injustice among community groups. The women's group also mentioned the revision of the matrimonial code, which has suppressed many restrictions limiting access to work and ownership for women.

Adapted from: Pavageau et al. (2013).

Box 6. Climate-related disturbance analysis in the TNS landscape, Cameroon.

Table 4 is an example of the results generated with the climate-related disturbance exercise conducted in the TNS landscape in Cameroon with community members. The facilitator draws a table on a flip chart and leads the overall exercise. The activity is done with a group of people and a table or a vertical axis may be drawn, with the main events represented along an axis. Information on the type of climate disturbance, whether the event is singular or continuous, the frequency, and the magnitude of the disturbance affecting livelihoods and the surrounding environment is provided. Discussion questions are useful to help participants develop their own and the researcher's understanding of climate disturbances over time in the specific context of analysis.

Some of the threats identified by the villagers relate to stresses (i.e. gradual changes) such as a shift in the seasons and scarcity of water resources, while others relate to shocks (i.e. abrupt or discrete events) such as diseases, pest invasions and intense droughts. For the climate vulnerability analysis, the focus was on threats that directly depended on climate variables such as changes in mean temperature and total rainfall.

Table 4. Climate-related disturbances based on Mboy II, Mang and Djalobekoe villages.

Climate-related disturbances	Shock or stress	Increase in frequency	Magnitude
Drought	Shock	No	High
Strong winds	Stress	Yes, recently	Medium
Shifts in the seasons	Stress	Yes, since 2000	High

Example of interpretation that may be obtained from the field exercise:

Some of the climate-related disturbances identified by the villagers have become more frequent over time. While some are isolated events that only happened once in the memory of the villagers, other events (e.g. violent winds, shift in the seasons, drying water sources and incidence of diarrhea) have developed gradually and have become more frequent since the 2000s. In Djalobekoe, one of the villages in the site, strong winds in the past would only appear during the long dry season, but now they have become more frequent and tend to affect the village during the short rainy season as well. These gradual events are probably related to each other. Changes in the seasons (e.g. longer dry season, sporadic rain) decrease the availability of water sources, and the lack of water sources forces the population to use water from the rivers, which is causing health problems (diarrhea) due to poor river water quality.

Source: Devisscher et al. (2013).

4.3.1 Differential exposure

In order to characterize the differentiated vulnerability of different exposure units (i.e. components of the system) such as specific economic activities, livelihoods or social groups, a set of tools such as the *product importance and revenue distribution analysis, forest use and benefits analysis, and disturbance-impact analysis* were used. Complementary tools such as the *seasonal calendar* and the *trade system analysis* (see Section 4.1.2 on dynamic processes) provide additional data for the assessment of this particular vulnerability dimension. These tools help to complement who is more exposed to what or who has more access to specific resources, the time of the year when different social groups might be more or less vulnerable or who tend to suffer periods of hardship, and the kind of livelihood strategies that people use to manage risk (i.e. coping/adaptation strategies).

In the *product importance analysis and revenue distribution* exercise, natural resource products are ranked by the people living in the village in order of importance and based on local priorities (Box 8). This also relates to the importance of each product for revenue generation and the total time invested to generate the profit. Sex disaggregated data can also be obtained so that the results can be analyzed from a gender perspective by looking at the differences (if any) in the priority for specific products and time spent.

Box 7. Example of impacts of climate disturbances and adaptive capacity.

Agriculture seems to be the most exposed and climate-sensitive activity in the study sites (impacted by increasing temperature and changing seasons) putting additional pressure on the forest resource base due to expansion of agricultural fields in forest areas to compensate loss. Increased climate variability in the form of increased unpredictability of rainfall patterns has led to adverse impacts on agricultural production, and hence food security and the local economy, shaping current vulnerability in the villages. Villagers recognize the uncertainty in their ability to predict wet and dry periods and follow the 'traditional' production calendar for their activities. Forest resources including NTFPs seem to be less vulnerable to changes in the seasons and provide a 'safety net' during times of hardship. Erratic rainfall and drought have also indirect implications for human health such as an increasing number of diarrhea outbreaks, among others.

Children and the elderly seem to be the most vulnerable social groups in the villages. Women are responsible for most of the agricultural work to provide the household food supply, whereas men are mostly involved in the high income-generating activities such as the cultivation of cash crops and hunting in the forest. Compared with men, women seem to rely on a more diversified portfolio of activities for revenue generation. Men and women have different ways to allocate revenues generated from their economic activities, depending on each country. Alcohol making is one of the most important activities for women for revenue generation in times of hardship (i.e. as a safety net) in all the vulnerability assessments conducted.

Source: Devisscher et al. (2013).

Box 8. Product importance analysis and revenue distribution in Atom village, Equatorial Guinea (Monte Alén-Monts de Cristal landscape).

Group discussions were held to conduct the exercise. Participants used stones to represent quantitatively the importance of each product for income generation and the time used to generate revenue for each product. The exercise was done in groups of men and women separately. The process involves listing the pre-selected products. Participants were then asked to assign a score or give weight with stones for each product based on their preference considering the given use or benefit from it.

Source: Author.

Example of interpretation that may be obtained from the field exercise with community members:
The most important product is cassava as it is considered a staple crop used for daily consumption and may be sold at any time of the year. Although other products (e.g. groundnuts) can generate more income, cassava offers a more reliable source of income. Hunting constitutes a secondary income source for men and women. Producing sugar cane alcohol (i.e. *malanba*) is a specific women's activity that can generate a large part of their income. Due to the long manufacturing period (up to 7 months), the profit is not immediate and is not perceived to contribute to daily needs. This activity provides, however, large amounts of money for specific expenses such as paying school fees or for health care. It can be used as a cash reserve in case of need (i.e. a safety net). Other activities may complement household incomes. For example, sand and stones are exploited and sold for road construction; NTFPs collection; breeding and fishing. Chiefs of family groups authorize independent small-scale loggers to fell trees in a given area. They can receive money or wooden boards as payment.

continued on next page

Box 8. Continued

How can the field exercise results be illustrated?

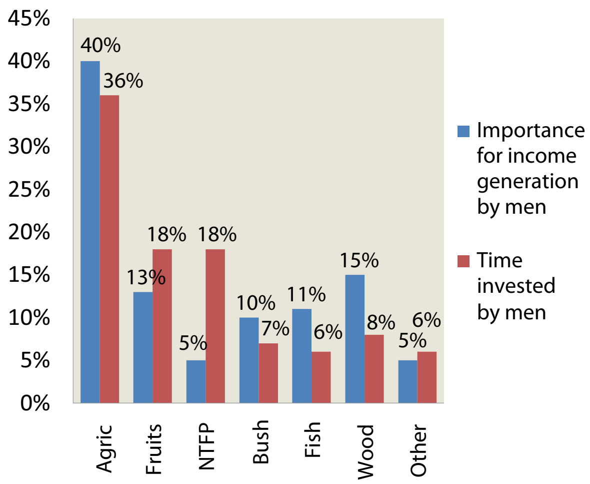

Figure 8. Perceptions on most important products for income generation and time invested by men.

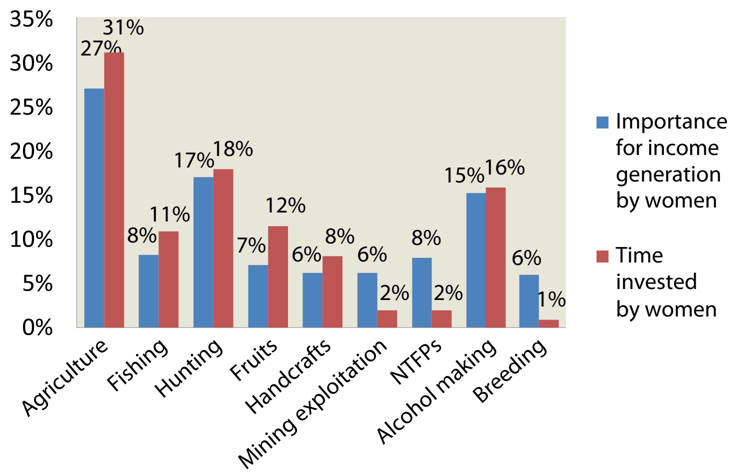

Figure 9. Perceptions on most important products for income generation and time invested by women.

Example of interpretation that may be obtained from the gender-focused field exercise:

NTFPs collection, and to a lesser extend fruits, are perceived by men as products that are time-consuming for the income generated through them (Figure 8). Those products are mainly used for self-consumption and the market chain for such products is too weak to generate large income. They also represent minor activities. Bushmeat, fish and wood provide higher income and are less time consuming. Cassava, sugar cane and plantain generate the largest income. Agricultural production remains the most important source of income for men.

For women, NTFPs collection, mining exploitation, alcohol making and livestock keeping are activities that provide most income generation for the time invested (Figure 9). All the other activities require more time compared with the income generated. Agriculture, hunting and alcohol making are the activities that provide most income for women.

Source: COBAM (2012).

The *forest use and benefits analysis* helps to explore the different ways forests benefit people in the site as a way to capture the role of forests for climate change adaptation (see Box 9). The idea is to capture not only direct uses of forest resources, but also indirect benefits such as protection from winds or cultural provisions.

The first step is to identify all the needs that participants have in relation to forests that surround the village. A table can be used to list these needs. Once everybody has agreed on the list, the needs can be used as the column headings of a matrix. The row headings can then be used to list all the forest resources participants can think of, including water, soil, etc. To explore the benefits of forests as a whole, it is helpful to add also “forests” to this list. Once the matrix is ready, stones can be used to give weights on the specific direct uses of forest resources.

The challenge is to think of indirect benefits from forests, which are not always easy to express by the participants. To overcome this, it helps to facilitate a discussion regarding the activities community members normally conduct in the forest. Information gathered through this discussion needs to be validated with the participants through verification questions before adding benefits/needs to the list.

Box 9. The role of forests for climate change adaptation.

New attention is being given to forest management as a key climate change adaptation strategy (Seppala et al. 2009; Locatelli et al. 2010). This growing interest is aimed at enhancing forest ecosystem services necessary to strengthen the capacity of forests and forest-dependent societies to adapt to climate-related changes (Locatelli et al. 2010). For example, greater attention is being put on water and nutrient cycling services provided by forests and the role forests play in maintaining rainfall regimes, contributing to cloud formation and soil moisture, while benefiting vegetation growth (Pöschl et al. 2010). Other forest ecosystem services that can facilitate climate adaptation include regulating services that reduce the exposure of human populations to extreme events, for example, by moderating the force of waves or wind (Adger et al. 2009). Forest provisioning services can also serve as safety nets to human populations. For instance, many rural communities in the Congo Basin use non-timber forest products (NTFPs) for direct consumption and for informal commerce when their main income-generating activity is affected by extreme weather or climatic events (Nkem et al. 2007; Paavola 2008; Shackleton et al. 2008).

To date, the importance of forests in supporting social adaptation has not been adequately reflected in current management and cross-sectoral policies, even though there is growing awareness of the value of forest ecosystem services. The concept of 'ecosystem-based adaptation' (CBD 2009; Chapin et al. 2009; Colls et al. 2009; Piran et al. 2009) has recently emerged in international negotiations on climate change adaptation, with proposals submitted by countries and NGOs to the UNFCCC (e.g. IUCN 2009) and the recent establishment of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).

Finally, uncertainty is inherent in any forest-based climate adaptation planning. Future changes in climate and the associated biophysical impacts and interactions continue to be estimated at temporal and spatial scales that are not easily applicable to decision-making. Dealing with these challenges requires new modes of governance that address changes over time, uncertainties and cross-scale interactions. These new modes of governance entail paying attention to local specifics as adaptation processes need to be adjusted to local ecological and social contexts. This involves a more participatory approach, engaging multiple actors in the decision-making and the identification and adaptive implementation of strategies (Folke 2005; Agrawal 2008; Gluck et al. 2009).

The *disturbance impact analysis* tool helps understand the impact of climate disturbances on different exposure units (i.e. social group, resource, livelihood activity) perceived by people in the local context.

The exposure units affected by different climate disturbances are listed by the community members, and the participants rank the impact intensity and quality (e.g. positive or negative impact) of each climate disturbance on these exposure units (Box 10).

4.3.2 Social capital and collective action

Social capital analysis can be used to generate interventions that respond either specifically to climate change or to a broader set of pressures. It can also be used to analyze institutional change that responds to multiple disturbances or to climate change in particular. Social capital and collective action, in the context of this study, are considered as enabling factors for adaptive capacity in the context of climate change (Woolcock 1998; Woolcock and Narayan 2000; Adger et al. 2001). In this study, social capital and collective action analysis use a historical perspective to understand the dynamics of social capital as individuals and communities change and create new local institutions or associations over time to manage their commons. It is also useful to identify collective activities and the social conflicts and conflict resolution dynamics that may be encountered in the village.

Discussion questions are helpful to encourage participation among people in order to create a list of infrastructure, organizations and activities that capture the forms of social organization in the village (see Table 6).

The relationships between formal and informal organizations are explored using *social network mapping*. This exercise provides a broad understanding of the relationships between key actors and processes that could be strengthened to enhance adaptive capacity to future stressors. Exploring socio-institutional relationships can help understand individuals and collective change when faced with climate hazards or other external pressures.

The participatory social network mapping is based on the Net-Map tool (Schiffer 2007). The method starts with the identification of actors that are

Box 10. Disturbance impact analysis in Rwanda.

Table 5 and Figure 10 (radar diagrams) show the data obtained with this field exercise with women from non-Batwa communities from 12 districts adjacent to the Volcanoes National Park in Rwanda.

Table 5. Example of data obtained with the field exercise from Rwanda.

Exposure unit	Impacts			
	Floods	Landslides	Strong winds	Prolonged drought
Subsistence agriculture	Field: –5 Crops: –3 Harvest: –2	Field: –4 Crops: –4 Harvest: –5	Field: 0 Crops: –3 Harvest: –3	Field: –3 Crops: –4 Harvest: –4
Cash crop	Field: –5 Crops: –2 Harvest: –1	Field: –3 Crops: –3 Harvest: –3	Field: 0 Crops: –1 Harvest: –1	Field: –2 Crops: –1 Harvest: –1
Livestock	Fodder: –1 Milk: 0	Fodder: –4 Milk: –3	Housing: –1	Fodder: –4 Milk: –4 Vector-borne disease: –4
Beekeeping	Hive: –2 Harvest: –2 Bee mortality: –1	Hive: –1 Harvest: –1	Hive: –2 Harvest: –2	Bee mortality: –3
Fishing	Catch: –2	Catch: –1	Activity: –3	No impact
No impact	Population Housing: –3	Food availability: –3 Housing: –2 Food availab.: –4 Death: –1 Financial resources: –3	Housing: –2 Food availability: –3 Illness: –2 Financial resources: –2	Food availab.: –3 Financial resources: –1

Note: Level of magnitude or potential impact can range from: '1'=low to '3'=high; potential impact can be either '+'= positive or '–'= negative.

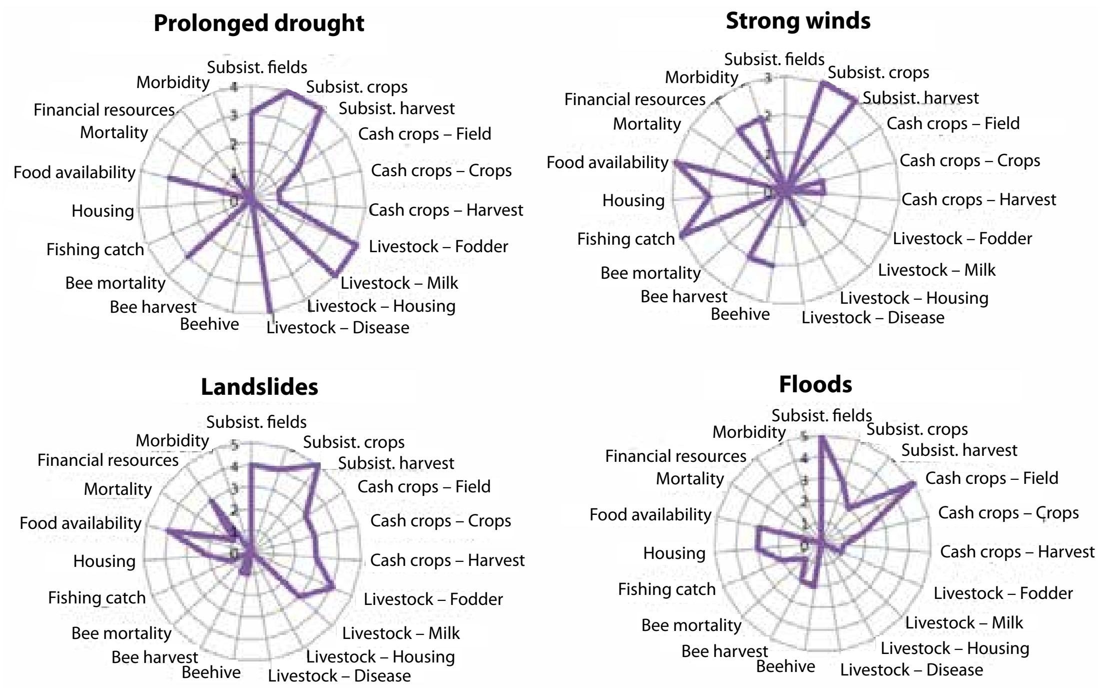

Figure 10. Results from workshop with non-Batwa communities, group of women, Rwanda.
Levels of impact. "0" = no impact (or positive impact); "1" = low negative impact, "5" = very high negative impact

continued on next page

Box 10. Continued

As seen in Figure 10, radar charts can be generated from Table 5. The scales and signs used in the table are qualitative, but they help provide an idea of the magnitude of the threat should it become an impact (i.e. the potential effect) and the type of this potential impact (i.e. positive or negative). Values in the plots provide an idea of the climate-related threats that represent a high potential impact and the exposure units that appear to be most vulnerable.

Interpretation of radar diagrams:

Agricultural activities are highly affected by hazards, although cash crops in Rwanda seem to be a little more resistant to climate hazards compared with Cameroon. For example, pyrethrum is less sensitive to change in rainfall patterns and can resist flooding. Poor management was also noted as a contributing factor to how agricultural activities are affected by flooding.

In Rwanda the population is considered as a whole, and the higher mortality and disease outbreak in the population is identified as an impact of drought, landslides and strong winds.

In Rwanda, there were experiences of positive impacts (not indicated for simplicity on plots), for example, heavy rains help the recharge of water tables in a context of lack of natural water sources in the region. Rains also favor the growth of plants, trees and fruits when they are not destructive. If the rainy season is prolonged, the production of maize, vegetables or bananas benefits from an increase in the growing season length. A prolonged dry season is positive for construction works, trade, small businesses, and exploitation of swamps for agriculture.

Adapted from: Pavageau et al. (2013).

Table 6. Summary of social infrastructure in selected villages, Cameroon.

Village	Social infrastructure	Construction entity and year	Maintenance responsibility	Current state
Mboy II	Market at Mboy II	Rural community Yokadouma (C.R.Y.) in 2003	C.R.Y.	Neglected
	Frontier police post at Mboy II	Forestry Society RCA (Sesam) in 2001	Police	Neglected
	Hospital at Mboy II	State of Cameroon in 1977	State/C.R.Y.	Neglected
	Military post	Fengeau Marc in 1992		Neglected
	Catholic church at Mboy	Vatican 2 in 1996	Christians in Mboy	Regular
	Well at Mboy II	State of Cameroon and local population 2003	Population of Mboy II	Broken down
	Public school CES (secondary level)	Council/State	Mairie/State	Regular
Bompello	Building with two classrooms	RFA 1996	State and APE	Good condition
	Village hall or community hall	RFA 1996	Population	Good condition
	Generator, satellite dish and TV	2006 Community forest	Population	Neglected

Source: Devisscher et al. (2013).

important for the (direct and indirect) management of forest resources, if this is the central research question. Once the actors are identified they are mapped on a flip chart according to their level of interaction (i.e. actors that interact frequently are located closer to each other). Once all actors are on the flip chart, links between the actors are explored in terms of financial flows, information flows, enforcement and capacity support. Flows are defined with the participants. Finally, actors with influence in the network are identified. These are generally actors that have power over the decision-making that defines the management of natural resources in the site. Once the influential actors are selected, participants analyze the network in terms of weak and strong relationships, missing links, clusters and power dynamics, if appropriate. In the latter case, participants identify the actors in the network that have the power to influence decisions and actors that are very important because of the knowledge and guidance they can provide on the collective management of forests. The last objective in the baseline assessment is to capture the perceptions on possible local strategies that have the potential to enhance adaptive capacity in synergy with climate mitigation. An analysis of the *current adaptive capacity* aids the understanding of the capacity of communities to deal with changing climate hazards and this can be used to inform analysis of future vulnerability to climate change, assess current needs and as a platform to monitor future progress. There is also value in identifying difference in attitudes between actors to climate hazards, which can be useful in decision-making and negotiations in regard to future pilot projects.

This field exercise was best employed in Rwanda and it is through the application of the exercise in that particular context that it can be best explained.

5. Lessons learned from this methodology

5.1 Advantages and benefits of this approach

A participatory approach for vulnerability assessment has many benefits when implemented in collaboration with local partners and as the first step for a longer term process of capacity building and adaptation planning.

The first advantage of this approach is its degree of flexibility. Activities considered in the methodology can be selected and adapted to the context and refined to best suit the local realities and fieldwork capacities. In the pilot studies, for example, activities were refined and modified to fit the specifics of each site and to account for the time, financial and human resources available for the fieldwork. It is recommended that the exercises are tested with a group of stakeholder representatives first, so that activities can be improved based on their feedback before implementation in the field.

Another important benefit is the trust and empowerment this approach can build with local partners if the collaboration is successful and partners become involved in the implementation of activities as part of the field research team. This depends on the preparation phase and time spent with partners in refining the methodology. Training in facilitation, transcript writing and analysis also helps empowerment. Giving local partners the opportunity to contribute to the methodology and the selection of communities and stakeholders also creates ownership of the process and contributes to capacity building.

Another positive aspect of this methodology is the collective learning. Through the series of activities implemented with local communities, it is possible to enable a process of learning, particularly if a space for reflection is created and multiple meetings are planned to allow for an iterative process. A closing workshop to provide feedback and validate results with local actors can also contribute to reflection and learning. This can be even more beneficial if it is combined with pilot activities aimed at increasing the adaptive capacity of local communities.

This approach provides the advantage of capturing different perspectives from different actors on the ground. This is important to gain a clear understanding of differentiated vulnerabilities at the local level. This approach recognizes that the personal understanding and experiences of different local actors determine their perceptions and the way they respond to different climatic conditions. To identify effective adaptation measures for the future, different perceptions from local communities, social associations and public institutions should be considered and combined. In addition, involving different local actors in the process helps to address, to some extent, the subjectivity inherent in the results generated with this methodology.

5.2 Challenges and limitations of this approach

While there are important advantages and benefits to this methodology, it does have its limitations and challenges. The first limitation is its subjectivity. The qualitative nature of this approach to elicit local knowledge through discussions at community level can provide rich information about different local perceptions to assess social vulnerability. However, the assessment of local perceptions could be deepened if complemented with other streams of information, such as analyses of climate data, land cover and land-use change, carbon and ecological dynamics.

Another important challenge of this methodology is its high demand of time and resources for implementation. Time, human and financial resources need to be invested in traveling to the sites, testing and refining the activities with local partners, training local field research assistants and working with local communities over a period of time to conduct the different activities tailored to local realities. Ideally, a workshop can be implemented at the end of the process to provide feedback to local stakeholders on the results, validate and complement them.

Finally, there is no guarantee that effective adaptation responses can be promoted by taking into account local people's perceptions (Weber

2010; Nyanga et al. 2011). This methodology is appropriate to understand local current vulnerabilities for a baseline assessment, but it is only the first step to plan for climate adaptation. This first step needs to be complemented with studies of future vulnerability and impact studies based on scenario analysis that help to identify possible adaptation options under different possible future conditions. These further steps will require integrating both social and biophysical information, as well as qualitative with quantitative data.

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CIFOR Working Papers **contain preliminary or advance research results on tropical forest issues that need to be published in a timely manner to inform and promote discussion. This content has been internally reviewed but has not undergone external peer review.**

This document is designed to help researchers, practioners and all those interested in assessing the extent and scope of local people vulnerability to climate change, the responses they currently oppose and how efficient they are. Vulnerability has been studied through the lenses of different dimensions: system and exposure units, dynamic processes, multiple threats, differential exposure, and social capital and collective action. The purpose of this framework is to grasp the social (and ecological) dynamics in the system over the past decades, in order to identify future actions for reducing vulnerability and to enhance adaptive capacity. In addition, research approaches proposed in this document can serve as a platform for dialogue as such approaches give opportunities to communities to collectively discuss their common problems related to climate change and to initiate common responses necessary to building their social capital.

This document is not a manual; it is a collection of lessons learned from a number of participatory research tools, used in a logical manner, tested and refined which helped researchers and practitioners from diverse backgrounds to explore the vulnerability of local populations to climate variability and change, while strengthening their capacity building. Many tools used were borrowed from participatory research appraisal (PRA), others were developed, tested and readjusted by CIFOR and SEI researchers with extensive experience in the development of research tools in social science and in the relationship of humans to nature and the environment.

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