

RESEARCH ARTICLE

What drives the vulnerability of rural communities to climate variability? Consensus and diverging views in the Congo Basin

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The vulnerability of rural communities to climate variability and change in developing countries is widely recognized. However, the question of what factors drive their vulnerability remains subject to different interpretations. This study explored the perceptions of local key informants on the factors influencing the vulnerability of forest communities to droughts and excessive rains in five contrasting socio-ecological zones of the Congo Basin forest. Results from the local level were discussed by national stakeholders. The analysis showed that people agreed on the positive effect of most community assets (physical, natural, human, social and financial) on vulnerability reduction. Diverging views arose with regard to the effects of population density and institutions on vulnerability, as well as to whether the dependence of communities on forest products increased vulnerability. The perceptions of local respondents depended on local contexts and the roles of the respondents in communities. The divergent interpretations revealed in this study underline the challenges faced by adaptation policy-makers and project developers in reconciling the opposing views of multiple stakeholders. National adaptation plans should identify broad priorities that must be converted into specific adaptation plans at the local level.

Keywords: adaptation; vulnerability factors; climate variability; climate change; ecosystem services; Congo Basin

Introduction

Climate variability and change threaten the livelihoods of millions of people in developing countries (Adger, Huq, Brown, & Hulme, 2003). African countries are commonly judged as vulnerable to climate variations and extreme weather events such as droughts and floods, because of the sensitivity of their main economic sectors to climatic factors and their low capacity to adapt (IPCC, 2007). Many argue that people's vulnerability to climatic variations is aggravated by poverty, weak governance and ecosystem degradation (IPCC, 2007; Sokona & Denton, 2001), but these generalizations overlook local specificities. Developing adaptation policies and projects requires an assessment of vulnerability and its underlying causes to understand how environmental changes affect societies, and how and why coping and adaptation responses are developed and reduce impacts (Füssel, 2007; Polsky, Neff, & Yarnal, 2007).

A commonly used definition of vulnerability states that vulnerability ('the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes')

depends on exposure (climate stimulus), sensitivity (how a system is affected) and adaptive capacity (adjustment possibility for moderating damages, seizing opportunities or coping) (IPCC, 2001). Previous studies on vulnerability have identified a wide array of direct and underlying factors (Brooks, Adger, & Kelly, 2005; Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009) and used theoretical assumptions on the relationship between factors and vulnerability. However, each factor is likely to have a different degree of influence in different contexts. As vulnerability is subjective and context dependent, with multiple and conflicting interpretations, vulnerability assessments often involve various stakeholders at one or several levels (Djoudi, Brockhaus, & Locatelli, 2012; Fekete, Damm, & Birkmann, 2010; Tschakert, 2007).

The sustainable livelihood approach (SLA) has been widely used in vulnerability assessments (Hammill, Leclerc, Myatt-Hirvonen, & Salinas, 2005). This approach focuses on how households or communities use their livelihood assets (human, natural, financial, social and physical) in a context of shocks, trends and seasonality (Chambers & Conway, 1992). The way households and communities

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choose livelihood strategies is mediated by structures (e.g. levels of government) and processes (e.g. laws, policies or culture). The strategies result in livelihood outcomes, such as income, well-being or food security (Chambers & Conway, 1992). Livelihoods and vulnerability are closely linked: livelihood strategies can contribute to reducing vulnerability and depend on livelihood assets, which are affected by the vulnerability context (shocks, trends and seasonality). Within the SLA scientific community, attention has been given to defining vulnerability metrics comparable across time and space (Adger, 2006). Several studies have measured vulnerability using components of the SLA, for example in Mozambique (Hahn, Riederer, & Foster, 2009), Botswana (Kgathi, Ngwenya, & Wilk, 2007), across Africa (Thornton et al., 2008) or in rural Australia (Nelson, Kokic, Crimp, Meinke, & Howden, 2010). In many studies, the SLA structured the analysis of vulnerability factors, around the five different forms of assets, the vulnerability context and the institutional processes (Cassidy & Barnes, 2012).

The objective of this paper is to analyse how local and national stakeholders perceive the effects of selected factors on the vulnerability of rural communities to climate variability in five zones of the Congo Basin. The paper contributes to a growing body of research that explores the links between vulnerability and human, social, natural, economic and institutional factors. Using the SLA as a conceptual framework, we present a method to elicit perceptions on the influence of selected factors on local vulnerability and to compare perceptions across levels. The elicitation of

perceptions is valuable for understanding the needs and priorities of different stakeholders and for identifying diverging views on adaptation that may result in ill-designed policies or projects. We assume that perceptions on vulnerability factors are shaped by the environment and personal experience (Brockhaus, Djoudi, & Locatelli, 2013; Conde & Lonsdale, 2004; Fekete et al., 2010). We compare perceptions across a gradient of population density, forest cover, accessibility and wealth, and between national and local stakeholders. This article focuses on two main questions: how do perceptions on vulnerability factors vary across actors and local contexts? Do local and national stakeholders have similar perceptions?

Methods

Selection of study zones in the Congo Basin

The study was conducted in five zones situated in the tropical forests of three countries in the Congo Basin (Cameroun, Central African Republic or CAR and Democratic Republic of the Congo or DRC). We selected zones with different population densities, forest cover, accessibility and wealth (Figure 1 and Table 1), because we assumed that these differences would influence views on vulnerability factors. Practical reasons also influenced the selection: because of the lack of valid socioeconomic data at the regional scale and because of safety and accessibility concerns, we selected zones where we had contacts and information about and could travel.

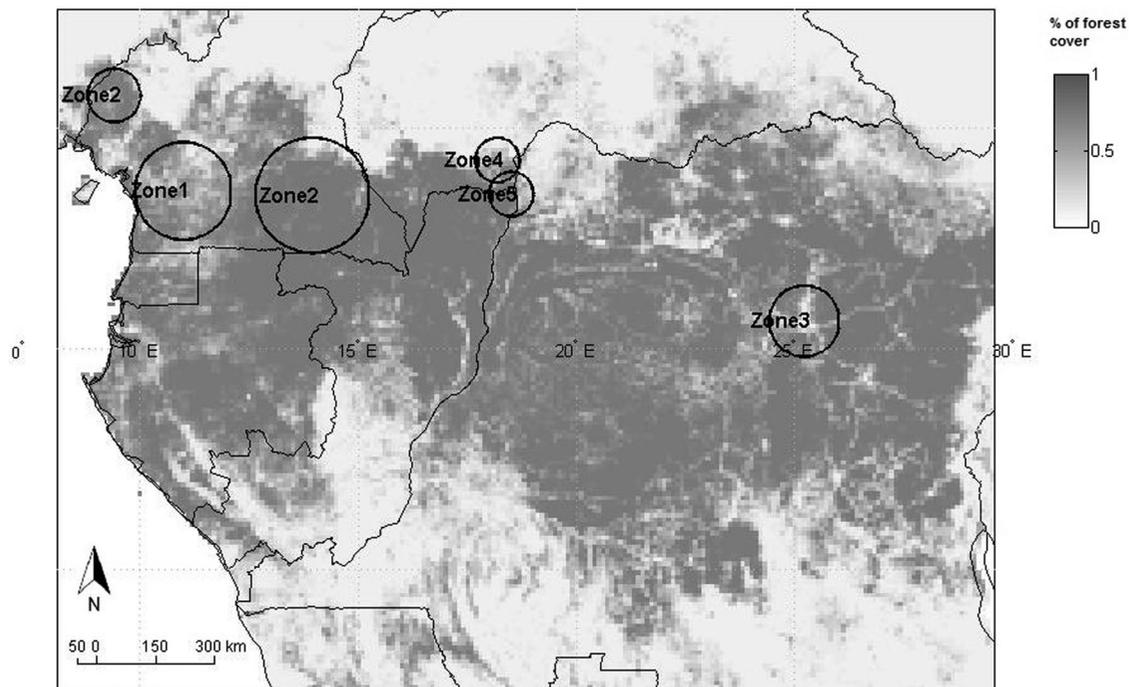


Figure 1. Map of forest cover and study zones in the Congo Basin (map elaborated by the authors, using forest cover data from CARPE, 2004).

Table 1. Selected attributes of study zones according to the perceptions of the interviewees and existing regional data.

Attributes	Measurement	Zone 1 Cameroon	Zone 2 Cameroon	Zone 3 DRC	Zone 4 CAR	Zone 5 CAR
Population density	Perception	High	Low	High	Med-high	Med-low
	Data: Mean density in hab/km ² (1)	132	7.52	128.34	22.56	15.94
Forest cover	Perception	Low	High	Low	Low	High
	Data: % Forest cover (2)	45	78	28	78	76
Financial capital	Perception	Med-high	Med-low	Low	Med-high	Low
	Data: Gross product (3)	814	280	17	246	2
Accessibility	Perception	High	Low	Med-low	High	Low
	Data: Mean distance to permanent road (km)	6.92	59.22	11.71	19.57	105.25
Dependence on agriculture	Perception	Med-low	Med-low	High	Med-high	High
Dependence on forest products	Perception	Low	High	Med-high	Med-high	Very high
Infrastructure (health, water)	Perception	Med-high	Med-low	Low	Med-high	Med-low

Data source: (1) CIESIN (2005), (2) CARPE (2004), (3) Nordhaus et al. (2006); gross product is the regional equivalent of gross domestic product, estimated in 10⁶ US\$ per square arc-degree pixel.

Dense humid forest covers 40% of the six countries of the Congo Basin. Climates are diverse in the region, with equatorial or tropical characteristics and monomodal or bimodal distributions of rainfall (Balas, Nicholson, & Klotter, 2007). Despite the diversity of local ecological and cultural situations, the communities living around the Congo Basin forests share some livelihood characteristics (Bahuchet & de Maret, 1995; de Wasseige et al., 2009). The main activity is agriculture and the main products are cash crops, such as cacao, and subsistence crops, such as cassava, cultivated partly in slash and burn. Forest products provide incomes, food, energy, medicinal products and materials to households. Many economic sectors are sensitive to climate variability in the Congo Basin, with risks for agriculture and food security, health, water resources, energy and infrastructure (IPCC, 2007; Molua & Lambin, 2007; Yengoh, Tchuente, Armah, & Odoi, 2010).

Selection of vulnerability factors

Our vulnerability analysis focused on the sensitivity and the lack of capacity to cope with, and adapt to, current climatic variability. In this paper, we consider two manifestations of climate variability: droughts and excessive rains, because of their impacts on livelihoods in the Congo Basin (Wilkie, Morelli, Rotberg, & Shaw, 1999; Yengoh et al., 2010).

The SLA was used to structure the analysis, synthesize the information and make comparisons across study sites (Adato & Meinzen-Dick, 2002). In line with the SLA, we chose 15 vulnerability factors and tested their relevance in the region through discussions with key informants. These factors included nine factors related to financial (monetary resources), natural (forest resources), human (education), social (gender equity, equity between

community groups) and physical assets, including infrastructure for water (e.g. wells and pumps), accessibility (e.g. roads), health (e.g. rural hospitals) and information (e.g. telecommunication equipment). Three factors were related to the linkages between population and livelihoods: population density, dependence on agriculture and dependence on forest products. Three factors were related to the presence of local or external institutions in the community: the state (e.g. through the presence of technicians of national agricultural extension services), non-governmental organizations (NGOs) and farmer organizations.

Local interviews

The research was conducted through on-site interviews with 39 informants living or working in one of the five study zones. The informants were identified firstly using a preliminary list established with the help of partners with long experience in the region and secondly through snowball or referral sampling. In order to elicit local perceptions of vulnerability, we selected either community members (71% of respondents) or actors who had worked in close collaboration with communities. Respondents were 21 community respondents (10 traditional leaders, 10 leaders of farmer organizations, one local elected representative) and 18 technical respondents (8 representatives of local NGOs, 4 technical assistants in forest management, 3 civil servants and 3 researchers). The use of experts or key informants has rapidly developed in the field of vulnerability and risk assessment as an effective way to access knowledge and experience, complementary to more time-consuming household surveys (Brooks et al., 2005; de Franca Doria, Boyd, Tompkins, & Adger, 2009; Lowe & Lorenzoni, 2007).

We interviewed key informants between July 2010 and May 2011, using both open- and closed-ended questions. The interviews guide was structured around the selected vulnerability factors and the central questions, which related to the effects and values of vulnerability factors, were tested with a few key informants. First, we asked preliminary open-ended questions on perceptions of the impacts of drought and excessive rainfall on livelihoods. Second, respondents evaluated the influence of the selected factors on vulnerability. They were asked whether an increase in a given factor would increase or decrease problems caused by drought or excessive rains on a scale from +3 to -3, where positive values represent increasing problems and negative values decreasing problems. Two separate questions were asked for the two climatic events and each factor. During the interviews, the term 'problems' was described as 'negative impacts and difficulties in responding to them'. Third, actors were asked to assess the value of each factor in the zone on a 7-point scale from low to high; for example, whether population density was low or high in the zone. Fourth, the interviews were followed by open-ended questions and discussions in order to understand the rationale beyond the responses and to let respondents share their ideas and experiences.

Analysis of local interviews

We grouped the vulnerability factors according to how respondents perceived their effects on vulnerability. The 'Major disagreement' group included the factors whose mean effect was not significantly different from 0 in the overall sample of responses, which revealed a diversity of positive and negative views on the factor. This was assessed with the non-parametric Wilcoxon Signed Rank test (p -value < .05, $n = 78$ with 39 people responding about drought and excessive rain). Some of the other factors were included in the 'Minor disagreement' group if the mean effect was not significantly different from 0 in at least one site. The remaining factors were included in the 'Agreement on context-dependent effect' if the correlation between the perceived value and the perceived effect of the factor was significant. Otherwise, they were included in the 'Agreement on similar effect across sites' group.

National interviews

We presented the analysis of local interviews in the form of summary statements (see examples in Table 2) to 10

Table 2. Vulnerability factors (classified according to the perceptions of local stakeholders), summary statements, and level of agreement of national stakeholders with statements (in the case where there was no summary statement, it was not possible to rate the agreement of national stakeholders).

Type of factors ^a	Factor	Summary statement from the analysis of interviews at the local level	Agreement of national stakeholders with summary statement ^b
1. Major disagreement among local stakeholders about the effect of the factor			
SE	Dependence on forest products	No statement (diverging views on this effect)	n/a
IN	Presence of the state	No statement (diverging views on this effect)	n/a
2. Minor disagreement (among local stakeholders of one or two sites) about the effect of the factor			
IN	Presence of farmer organizations	Higher presence of farmer organizations = lower vulnerability	Low
IN	Presence of NGOs	Higher presence of NGOs = lower vulnerability	Low
3. Agreement on context-dependent effect of the factor			
A(N)	Forest resources	More forest resources = lower vulnerability, particularly where cover is low	High
SE	Population density	Higher population density = higher vulnerability, particularly where density is high	Medium
4. Agreement on similar effect of the factor across sites			
SE	Dependence on agriculture	Higher dependence on agriculture = higher vulnerability	High
A (S)	Equity between groups	Higher equity between groups = lower vulnerability	High
A (H)	Education	Higher education = lower vulnerability	High
A (P)	Health services	Higher access to health service = lower vulnerability	High
A (P)	Water equipment	Higher access to water equipment = lower vulnerability	High
A (P)	Accessibility	Higher accessibility = lower vulnerability	Medium
A (P)	Access to information	Higher access to information = lower vulnerability	Medium
A (S)	Gender equity	Higher gender equity = lower vulnerability	Medium
A (F)	Financial resources	More financial resources = lower vulnerability	Medium

^aSE: social-ecological relationship, A: assets (Financial, Natural, Human, Physical, Social), IN: institutions.

^bBased on the percentage of national-level respondents who agreed with the summary effect: High agreement = 80–100% of respondents, Medium = 60–80%, Low = 40–60%.

stakeholders working at the national or regional level with governments ($n=3$), national or international development organizations and NGOs (4) and research organizations (3). Four of them are working for multi-country institutions operating in the whole Congo Basin, while the other national actors are based in Cameroon (3) or DRC (3). No national actors could be interviewed in CAR at the time of the research. These stakeholders expressed their agreement or disagreement with the statements and commented them.

Description of study zones

Zone 1 is located in degraded forest and agricultural mosaics in the centre, littoral and southwest regions of Cameroon. Population density is high, composed of various ethnic groups mainly from the Bantu groups. The proximity of major cities (Yaoundé, Douala and Buea) and the presence of roads facilitate market access and drive the development of commercial food production in addition to the subsistence cropping system (mainly cassava in association with other crops). Droughts and excessive rains have a major effect on crops production (Molua & Lambin, 2007).

Zone 2 is located in the humid forest zone of Cameroon (in the east, south and southwest regions). Landscapes are dominated by high forest cover, swidden agriculture and fallows. Cacao, coffee and oil-palm plantations are also common due to favourable agro-ecological conditions. Forest products, including fish, game and non-timber forest products (NTFP), are also affected by climatic stresses but to a lesser extent than agriculture. NTFP can represent up to 80% of mean annual income of households (Ingram, Ndoye, Iponga, Tieguhong, & Nasi, 2012). The population is ethnically diverse, with mainly Beti and Fang groups; there are also pigmy communities and a Nigero-Congolese population in the southwest.

Zone 3 is located around the provincial capital of Kisangani in DRC. It has been identified as a hotspot of deforestation since 2000 (Ernst et al., 2013) due to high population growth and the development of charcoal production. The proximity of the Congo River has supported the commercial and economic development of the region and has attracted people from different ethnic groups. Livelihoods are based on subsistence agriculture, oil-palm plantations and fishing. In addition to the impacts on agriculture similar to other zones, climate variability affects water availability for human consumption.

Zone 4 is located close to the urban centre of Bangui in CAR. This zone attracts migrants and has high demographic growth. The land saturation in Bangui has pushed people to move in surrounding rural areas but this migration has not been followed by an increase in agricultural productivity as in zone 1. Landscapes are dominated by agriculture, coffee and oil-palm plantations and

degraded forests. Impacts of droughts and excessive rains are similar to the ones in zone 3.

Zone 5 is located in southern CAR, further from urban centres and close to the DRC border and the Oubangui and Sangha rivers. The population is mainly composed of Bantu ethnic groups and the minority Baka pigmy population. The population density is lower than in zone 4; however, the area attracts migrants from neighbouring countries due to its mining and forests resources. Landscapes are dominated by forests. Mining and forest harvesting represent a source of revenue for youths, but the infrastructure is poor and the sanitary situation is of particular concern in this region. Water-related diseases are reported during severe dry periods or outbreaks of malaria during prolonged rainy seasons.

Results and discussion

Overview

Perceived impacts of climate variability by respondents did not differ greatly from secondary data. The values of vulnerability factors perceived by respondents showed little variation inside each zone and good correlation with available indicators in the region (Table 1). This partially validates the use of the knowledge of local informants.

We present the results of local interviews by showing the level of agreement or disagreement among local respondents about the effect of vulnerability factors (Table 2 and Figure 2). We report differences in perceptions between types of respondents, if any, and the views of national stakeholders.

Physical and financial assets for reducing vulnerability

Respondents at the local level agreed that higher physical and financial assets (linked to accessibility, health services, water equipment and financial resources) reduced vulnerability. Local respondents explained that accessibility was important to reduce vulnerability because it facilitated access to services and markets. Other studies have shown that this improved access provided opportunities for diversification or agricultural intensification, which reduced the dependence on climate-sensitive activities (Paavola, 2008; Reardon & Vosti, 1995). However, some national respondents defended another view. In remote places, even if better accessibility can provide opportunities, road openings can facilitate emigration and increase pressure on resources. National respondents close to conservation organizations stressed the risk of resource overexploitation in newly accessible zones, reducing assets and opportunities for households. In addition, near paved roads, many livelihood strategies rely on transportation to bring products to markets. As transportation costs can increase

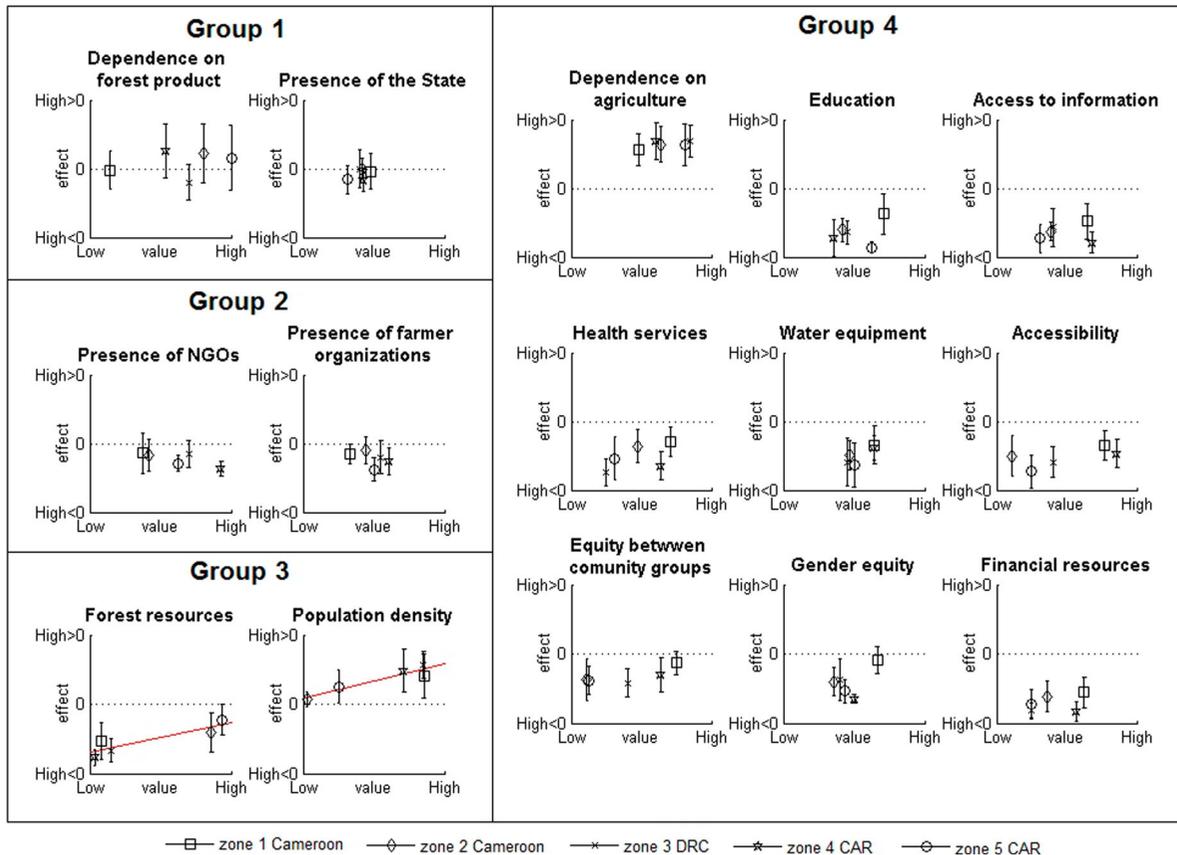


Figure 2. Relationships between the perceived values of vulnerability factors and their perceived effects on vulnerability, according to the 78 responses for each factor. Mean values and standard deviations for each zone are represented by markers and vertical bars. Positive (negative) y -values correspond to factors increasing (decreasing) vulnerability. Factors are grouped as: (1) major disagreement, (2) minor disagreement, (3) context-dependent effect and (4) similar effect across sites.

with fuel prices or climatic events that degrade roads, this reliance can create additional vulnerability. In addition, changes in the prices of traded goods can affect communities that have developed market-oriented activities in accessible areas. For example, O'Brien et al. (2004) associate shorter distances to ports with higher vulnerability to economic globalization.

Respondents at all levels agreed that better access to health services and water equipment decreased vulnerability. Nevertheless, some also added that access to physical capital (i.e. rural medical centres and wells) was necessary but not sufficient, because lack of trained medical staff, limited access to drugs, and lack of technicians and funding for maintenance can impede the functioning of these infrastructures. One local respondent said that 'the hospital building is not sufficient; there is no money for equipments, which are expensive because we are too far from the city. As a result, people use traditional medicine rather than the hospital'. Infrastructure and human or financial assets are interrelated in vulnerability reduction: human and financial assets are needed to ensure that this infrastructure contributes to reducing vulnerability, while infrastructure also has implications for

human assets (health and education) and incomes, because better health or water access increases the time available for income-generating activities (Paavola, 2008).

Local respondents agreed that greater financial assets reduced vulnerability. The lack of financial resources is perceived as a major barrier to strengthening other assets for long-term adaptive strategies. For example, access to education, access to health services and acquisition of agricultural tools depend on financial capacity. Financial resources are not only related to incomes but also to loan availability and secure financial savings, which are lacking in the region. Other studies have shown that access to credit and farm and non-farm incomes increased the implementation of adaptation strategies by households (Deressa et al., 2009; Hassan & Nhemachena, 2008). However, according to some national respondents, financial resources can reduce vulnerability only if communities have access to market and investment opportunities, for example, for buying quality tools and improved seeds, as shown elsewhere (Hassan & Nhemachena, 2008).

In addition to the effect of particular assets, some respondents mentioned the interdependence between assets in influencing vulnerability, for example, between

infrastructure, education, health and incomes. Adaptive capacity depends on how assets can be converted from one to another, for example, from financial to other types of assets. In the SLA, the interdependence between assets is crucial to achieving desirable livelihood outcomes (Chambers & Conway, 1992) and vulnerability is linked with the inability to transfer assets for facing changes (Knutsson & Ostwald, 2006). Many assessments of adaptation priority are based on strengthening livelihood assets (IPCC, 2007) and should not overlook the interdependence of assets.

Information and education for reducing vulnerability

Local respondents agreed that better education and information decreased vulnerability. For example, appropriate weather information allows farmers to anticipate seasonal patterns (Tall, 2010). For many respondents, education and information were similar issues: both were seen as useful to making informed decisions by increasing understanding (education) and awareness (information). Other studies showed that a higher level of education was associated with better access to information (Deressa et al., 2009). Education and access to information were also associated with innovation and access to new knowledge, for example, through capacity building on agricultural techniques, as shown elsewhere (Silvestri, Bryan, Ringler, Herrero, & Okoba, 2012). Some national respondents mentioned that physical assets for communication (e.g. radios) are not sufficient to access information because content, language and media are often not adapted to local communities.

Equity between gender and community groups

Local respondents agreed that increased equity between gender and community groups decreased vulnerability. National respondents showed high agreement on the effect of group equity and a medium agreement on the effect of gender equity. The general view was that equity between community groups (ethnic groups, young and old people, etc.) decreased conflicts, increased solidarity and translated into better representation and involvement in collective decision-making, which can strengthen adaptive capacity. One local respondent said that ‘the inequity within the village creates conflicts which worsen the situation of the worst-off’. Other studies suggest that adaptive capacity is greater when access to resources is equitable within a community or a region and when empowerment creates equity in decision-making (Tompkins & Adger, 2004).

When discussing equity, respondents generally referred to marginalized groups, particularly pigmies in CAR and eastern Cameroon, rather than discussing equity between all social and ethnic groups in the community. The

discourses of development and human rights NGOs on the marginalization of pigmies may explain why equity issues are reduced to the dichotomy between pigmy and other groups, masking other equity issues (Dkamela & Oyono, 2003). Equity is a complex concept and respondents may have had different interpretations of it and of its effects on vulnerability. Given the complex links between equity and adaptation, more research is needed in the context of communities depending on natural resources (Thomas & Twyman, 2005).

Some local respondents mentioned that equity between men and women was important because an unbalanced distribution of workload reduced household capacity to act, particularly when climatic stresses increased women’s workloads. National respondents expressed only medium agreement with this view. Some said that the differentiation between men and women is cultural and context-specific. For example, whereas men traditionally collect a specific forest product (*Gnetum* spp.) in eastern DRC, the whole family participates in some regions of Cameroon (Ingram et al., 2012).

The role of gender equity is confirmed by other studies that show how women have mobilized communities in anticipating and responding to disasters (Yonder, Akcar, & Gopalan, 2005) and how they are in charge of finding solutions to drinking water or health problems, which are related to climate variability. Gender relations shape the practice of adaptation to climate variations by women and their communities and adaptation can be limited by women’s disempowerment and lack of access to resources (Carvajal-Escobar, Quintero-Angel, & García-Vargas, 2008). Adaptation policies need to ensure that gender analysis is fully integrated to avoid exacerbating gender inequalities and increasing vulnerabilities (Nelson, Meadows, Cannon, Morton, & Martin, 2002).

Population density: two contrasting views

According to local respondents, increasing population density increases vulnerability, particularly where density is high (e.g. in zones 1 and 3 close to urban centres). Respondents explained that an increase in population density decreased access to land and exacerbated pressure on natural resources during difficult periods. Indeed, population growth means that increasing numbers of people are exposed to the impacts of climate variations, that scarce resources (e.g. water and food) have to be shared among more people (McLeman, 2010). The Malthusianist view of population growth was agreed upon by local respondents but rejected by some national respondents, who defended a Boserupian view (Turner & Ali, 1996), associating population growth with increased labour force, agricultural intensification, diversification and more opportunities for facing climate-related shocks. Indeed, population growth can stimulate changes in livelihood strategies towards a

more efficient use of resources (Demont, Jouve, Stessens, & Tollens, 2007), which can reduce vulnerability to climatic variations.

As local respondents also acknowledged the importance of the labour force, contrasting views between local and some national respondents can be explained by migration: in densely populated zones, migration has largely contributed to population growth and local respondents often associated high population density with social exclusion of newcomers. In this case, a key factor for adaptation is to ensure the inclusion of migrants in local institutions for natural resource management and development. The effect of population growth on vulnerability cannot be reduced to a single dimension (population density), as it depends on other parameters such as age distribution, social networks and social capital (McLeman, 2010). For example, the outmigration of young people reduces workforce but also provides access to new knowledge or information and additional incomes through remittances (Adger, Kelly, Winkels, Huy, & Locke, 2002).

Forest resources and dependence on forest and agriculture: ambiguities on the role of forests

Local and national respondents agreed that a higher dependence on agriculture increased vulnerability and explained this effect with the sensitivity of agriculture to climate variations in the Congo Basin (as shown by Molua & Lambin, 2007) and the lack of diversification into other farm and non-farm activities (Deressa et al., 2009).

Local respondents agreed that larger forest resources reduced vulnerability, especially where these resources were scarce (Figure 2). They recognized the importance of forests for protection, basic needs and income generation for the population in forest areas. This is in line with other studies showing that the ecosystem services of forests and trees can reduce people's vulnerability (reviewed in Pramova, Locatelli, Djoudi, & Somorin, 2012). Respondents explained that forest products constituted a safety net reducing vulnerability to climatic shocks, as part of their coping strategies in reaction to stresses (like in Takasaki, Barham, & Coomes, 2004 and McSweeney, 2005) and for income diversification as an adaptive strategy in anticipation of stresses (like in Paavola, 2008).

There were major disagreements among local and national respondents on how the dependence on forest products influenced vulnerability. Around 24% of local respondents thought that communities dependent on forest products were resilient because forests provided safety nets and were less affected by climate variability than agricultural production. These respondents highlighted the collection of diverse forest products (including fish and game) affected differently by droughts or excessive rains. According to these respondents, the role of forest products in livelihoods needs to be considered in

adaptation. These respondents were mainly social scientists or had a technical background in forest management and tended to promote a multi-functional approach of forest management and conservation.

Approximately 59% of the respondents perceived that a high dependence on forest products made communities more vulnerable because of low livelihood diversification, forest degradation caused by overharvesting, access restrictions and conflicts with other forest users, such as logging companies. In addition, these respondents thought that some forest products could not function as safety nets because they can become scarce during droughts or excessive rains. Most of these respondents came from local development NGOs promoting alternative income-generating activities outside the forest. This view was also shared by agricultural support services and heads of farmer organizations, who viewed agricultural development as the priority for local communities.

This diversity of perceptions shows that the role of forest products in reducing vulnerability (either as the main source of livelihood or only as a safety net) needs to be further explored in the Congo Basin, to enhance our understanding of the potential of ecosystem-based adaptation (Vignola, Locatelli, Martinez, & Imbach, 2009). The diverging views about the role of forests in adaptation are similar to those on forests and poverty ('out of forests, out of poverty?' asked Levang, Dounias, & Sitorus, 2005). Even where forests play a minor role in daily livelihoods, they can still play a role as safety nets when other livelihood activities are affected by climate events (Pramova et al., 2012).

Ambiguities on the role of institutions

The effects of three types of institutions (state, NGOs and farmer organizations) on vulnerability were perceived differently by respondents. There were major disagreements among local respondents about how the presence of the state can reduce vulnerability but, in general, people considered that state interventions had limited – positive or negative – effects on vulnerability. There is evidence elsewhere that the local impacts of climate variability can be modulated by state interventions (Lemos, Boyd, Tompkins, Osbahr, & Liverman, 2007). These interventions can improve collective infrastructure for education, health, transportation or information, which are important to adaptation, as shown above. In other studies, the access to public extension services was found to be correlated with the implementation of adaptation measures by households (Deressa et al., 2009; Hassan & Nhemachena, 2008).

In our case, public agricultural extension services were, however, perceived as ineffective because of limited means (finance, staff, vehicles and tools), unclear strategies and remoteness of service offices from communities. Other reasons for the ineffectiveness of state interventions

included limited investments in community infrastructure (e.g. schools, roads or medical centres), the lack of coordination between administrative units and the shortcomings of decentralization limiting the actions of local authorities. This view was mainly shared by technical respondents in remote zones. Some respondents at the national level disagreed strongly with this view and explained that state interventions could reduce vulnerability, for example, through decentralization and the regulation of access to natural resources.

The local respondents agreed overall on slight positive effects of NGOs and farmer organizations on vulnerability reduction; however, we found disagreements in Cameroon and DRC sites. In addition, around half of the national respondents disagreed on the positive effect of these institutions. According to some respondents, NGOs develop infrastructure and alternative production activities, empower local communities and compensate for the weaknesses of the state by responding to the needs that are not addressed by public organizations. This view is justified by the long-lasting experience with NGO-driven initiatives in Africa and reduced state involvement. According to other respondents, NGOs cannot reduce vulnerability because of: (1) the limited duration of their projects and the frequent abandonment of infrastructure and innovations after the end of the project; (2) the lack of a broad vision of local issues (e.g. a project developing commercial vegetable production without addressing the issue of transportation and marketing); and (3) the limited funding and capacity of some NGOs. These arguments reflect common criticisms of NGOs (Reimann, 2005) and were mainly expressed by community respondents in the accessible zone of Cameroon. This can be explained by unmet expectations and fatigue of communities with external interventions.

Respondents emphasized that farmer organizations have the potential to foster local collaborative action and to improve agricultural productivity, market integration and resilience to climate variability. Diverse organizations can provide solutions to problems at different levels; for example, cooperatives providing opportunities for selling agricultural products at stable prices and ‘tontines’ (traditional group saving and microcredit schemes) playing a micro-level financial role. However, respondents also recognized the limitations of these organizations: for example, most organizations were created in reaction to external requests (e.g. from donors), and do not always have the capacity or legitimacy to foster local development.

Literature has emphasized the role of local institutions (with a broader definition including more than just organizations) for collective adaptive responses to climate variations and the delivery of external support to adaptation (Agrawal, 2008). In Cameroon, the positive effect of local farmer associations was perceived as higher by community respondents in the remote zone than by technical

respondents or people in the less remote zone. This may be explained by the fact that these communities have always coped with climatic variability without many external interventions. The absence of state or external aid means that endogenous solutions, including local institutions, have been developed to reduce vulnerability (Sendzimir, Reij, & Magnuszewski, 2011).

As local institutions play a critical role in adaptation, external interventions or policy regulations that strengthen these institutions may contribute to reducing vulnerability (Agrawal, 2008). In the Congo Basin, decentralization processes and the strengthening of local institutions have shown mixed results, sometimes leading to internal conflicts, new power distribution and the marginalization of traditional authorities (Oyono, 2005). Enhancing local institutional capacity and institutional coordination for adaptation should be promoted keeping in mind the lessons learned from past decentralization projects (Agrawal, 2008).

Discussion of the method

Our method allowed analysis of the perceptions of different stakeholders on factors affecting the vulnerability of rural communities in selected sites of the Congo Basin. The analysis showed clear agreements on the effects of some factors, while others were more controversial. However, one weakness of the method is its inability to address the interdependence between assets, which was highlighted by some respondents who gave examples of assets convertible to, substitutable for or complementary with others. Another weakness is the selection of zones and informants. Communication and transportation problems in the region prevented us from selecting zones and respondents in a more structured way, to provide a sample that was more representative of the diversity of the region. In addition, we applied different methods for the local and national interviews, as national respondents were asked to comment on the findings at the local level.

Even though the national interviews provided useful discussion, local and national respondents were actually talking about different realities, respectively, the case of a specific zone vs. the results from the five zones. This problem is not specific to this study. Local vulnerability assessments bring interesting results about the drivers of vulnerability in a specific place but national decision-makers and regional or international donors have to define priorities, either geographic or thematic, for national policies or regional programmes. Thus our approach can be seen as a first step to identifying key vulnerability factors whose effects need to be explored in local vulnerability studies. Similarly, national adaptation planning can be seen as a framework for identifying broad priorities that have to be converted into specific adaptation plans at the local level (Füssel, 2007).

Conclusions and policy implications

This paper contributes to a growing body of research that explores the links between vulnerability and human, social, natural, economic and institutional factors. We assessed how several stakeholders perceived the effects of selected factors on the vulnerability of rural communities to droughts and excessive rains in five zones of the Congo Basin. The results from local interviews revealed divergences of views, explained by either the local context or the attitudes and roles of the respondents. These results were compared to the perceptions of national-level actors, to identify diverging views and consensus. The analysis showed that people agreed on the positive effect of most community assets (physical, natural, human, social and financial) on vulnerability reduction, which is line with the conceptual framework of the SLA. Diverging views arose with regard to the effect of institutions on vulnerability, as well as the dependence of communities on forest products. The effect of population density on vulnerability was also debated. More research is needed in the Congo Basin to understand how vulnerability is influenced by some of the most controversial factors revealed in this study. The divergent interpretations revealed underline the challenges faced by adaptation policy-makers and project developers in reconciling the contrary views of multiple stakeholders.

According to the perceptions elicited, the vulnerability of rural communities to climate variability could be reduced in the Congo Basin by policy interventions that strengthen community assets, as well as interventions that reduce the dependence on agriculture or increase its productivity and resilience. However, for reducing climate vulnerability, these interventions must address current and future climate-related risks rather than promoting business-as-usual development activities. In the Congo Basin, forests have a role to play in adaptation policies and projects but relying on forest products as safety nets can be a poverty trap, particularly when forest resources are under pressure and alternatives are lacking. One key question identified in this study is under which conditions, sustainable forest management can contribute to adaptation. Another key policy question is what kind of institution is appropriate for facilitating or supporting local adaptation. Are local organizations such as farmer institutions or external organizations (NGOs and states) better suited or more legitimate to the task? The appropriate institutions or combination of institutions with different roles will certainly depend on local contexts and this question deserves more research in the Congo Basin and elsewhere.

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