



## Vulnerability, adaptation and mitigation in the forests of the Congo Basin: a critical investigation

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## Abstract

Recent discussions on forests and climate change have highlighted the potential for conservation of tropical forests to contribute synergistically to both mitigation and adaptation. Key mechanisms through which adaptive advantages might be gained include the potential for forest resources to act as ‘safety nets’ in the context of climatic strains on agricultural livelihoods and the protection that intact forest ecosystems might provide against landslides, flash floods and other hazards related to extreme weather. This paper presents findings from field research with forest communities in three areas of the Congo Basin in Central Africa, in which the current adaptive role of forests in these respects is critically analyzed.

The investigation was carried out through a combination of structured and semi-structured qualitative techniques within six villages in Cameroon, Equatorial Guinea and Rwanda, as part of a wider collaborative research project, COBAM, funded by the African Development Bank. The methodology was designed to help describe how forest communities are experiencing and adapting to environmental change, and the role that forest resources and environmental management policies play in terms of people’s livelihoods. The findings of the research highlight the need to understand both the limits of synergy, and the constraints and trade-offs for rural livelihoods that may be associated with a forest conservation agenda driven by the additional impetus of carbon sequestration. The search for synergy may be conceptually laudable, but if forest management actions do not take account of on-the-ground contexts of constraints and social trade-offs then the result of those actions risks undermining wider livelihood resilience.

## Introduction

Recent discussions on forests and climate change have highlighted a potential for conservation of tropical forests to contribute synergistically to both mitigation and adaptation. The carbon storage function of forests is a central pillar of the climate change mitigation agenda, as demonstrated in the high profile of REDD+ and related initiatives. Perhaps less firmly established in climate change discourse is the argument that forests can provide a significant contribution to climate change adaptation for local populations, although momentum behind this perspective among forest researchers has been growing in recent years (Locatelli et al 2010). It is both important and timely for researchers from broader development fields to contribute to this debate. This paper presents findings from field research with forest communities in three areas of the Congo Basin in Central Africa, in which the current adaptive role of forests is critically analyzed. It presents both evidence for the adaptation potential of tropical forests and evidence to caution against overly-optimistic assumptions that might downplay the trade-offs for livelihood resilience that a mitigation agenda can generate.

Tropical and sub-tropical forests hold around 55% of global forest carbon stocks, with more than half of this being in biomass (Parrota et al. 2012). Forest loss and degradation now constitutes the second largest anthropogenic source of carbon dioxide, estimated at 7-14% of global emissions (Harris et al. 2012). The influential review of the economics of climate change by Stern (2006) recognised deforestation as a comparatively low hanging fruit for climate mitigation owing to its low unit costs.

The idea that low-cost forest-based mitigation could also bring co-benefits to local communities, including greater livelihood resilience, was prominent in the Bali Action Plan agreed at the 13<sup>th</sup> Conference of Parties of the UNFCCC in December 2007. This connects with an increasingly popular view that forest-based mitigation can provide 'win-win' outcomes that show synergies between mitigation and adaptation, especially where adaptation is considered broadly, as outcomes that render livelihoods more resilient (Nelson et al. 2007, Osbahr et al. 2008). In this perspective, mitigation activities that protect and enhance forests can potentially also contribute to livelihood security by provision of NTFPs and other goods that contribute to livelihood diversification and essential needs such as foods and medicines; regulation of ecosystems, including hydrological services; and insurance or 'safety nets' that help ensure protection of livelihood assets during extreme events (Nkem et al. 2010; Bele et al. 2011, Robledo et al. 2012).

Various governance approaches and policies could be deployed in attempts to capture ‘win-win’ mitigation and adaptation outcomes. These include government regulation and planning interventions such as protected areas and land use zoning; community-oriented interventions such as participatory forest management and NGO-led agroforestry projects; and market-oriented interventions such as the CDM, REDD+, and forest certification. In practice these different forms of governance and policy overlap in many landscapes, for example with REDD+ activities using PFM as the delivery mechanism (Parrota et al. 2012; Khatun et al, forthcoming).

However, simplistic ‘win-win’ rhetoric is being tempered by increasing understanding of trade-offs between mitigation and adaptation. Trade-offs can occur for different reasons. First, some trade-offs have a more ecological dimension, for example where managing forest to maximise carbon storage trades off against its biological diversity and contribution to local livelihoods (d’Amato et al. 2011). Second, trade-offs can occur across spatial and temporal scales (Harvey et al. 2014), for example where extensification of cocoa production improves local livelihoods but reduces global mitigation. Thirdly, trade-offs occur between different interests or priorities locally, for example where forest conservation increases local biodiversity, with negative effects for those whose crops are most vulnerable to wild animals.

The findings reported in this paper provide additional empirical evidence to feed into this debate. They are based on case study research conducted in six communities within and close to forest environments in three areas of the Congo Basin. The following section briefly introduces the sites and the methods of data collection. This is followed by three sections discussing the climate-related stresses experienced in the sites, the role that forests play in supporting livelihoods and wellbeing, and the actual and potential trade-offs for local people associated with forest conservation and/or reforestation. The concluding section draws out implications of the empirical findings for mitigation-adaptation synergy debate.

## **Methodology and case studies context**

The investigation was carried out from July 2012-March 2013 within six villages in three study areas in Cameroon, Equatorial Guinea and Rwanda. The study was part of a wider collaborative research project, COBAM (Climate Change and Forests in the Congo Basin), funded by the African Development Bank and led by CIFOR (Centre for International Forestry

Research). The research was designed to help describe how forest communities are experiencing and adapting to environmental change, and the role that forest resources and environmental management policies play in terms of people's livelihoods.

The study areas in each country lie within one of the regional 'landscapes' prioritized under the Congo Basin Ecosystems Conservation Support Programme (PACEBCo): the Tri-National de la Sangha landscape for the area in south-east Cameroon, the Monte Alen-Mont Cristal landscape for the area in central Equatorial Guinea and the Virungas for the area in north-west Rwanda. For each landscape, baseline assessment studies undertaken at an earlier phase of the COBAM project were used to select 2 local sites for detailed research. These villages were Djalobekoue and Mang in Cameroon, Atom and Kukumankok in Equatorial Guinea, and Kamiro and Masasa in Rwanda.

Djalobekue (DJ) and Mang (MA) lie 7km and 40km respectively from main town of Yokadouma in south-east Cameroon, located adjacent to the border with Central African Republic in lowland forest terrain in the north of the Congo Basin. The village economies are dominated by agricultural production for subsistence and cash crops, with cassava, plantain and cocoa as principal crops (Devisscher et al 2013).

Atom (AT) and Kukumankok (KU) are located approximately 140km by road from the coastal port of Bata in Equatorial Guinea, within lowland forest terrain in the west of the Congo Basin. Economic livelihoods are again principally agricultural, including slash-and-burn production systems for subsistence and cash crops, principally cassava, plantain, groundnut and sugar cane (Pavageau et al 2013a).

Kamiro (KA) and Masasa (MS) lie adjacent to the Volcanoes National Park in Rwanda, and close to the border with Democratic Republic of Congo. This is highland terrain at the eastern rim of the Congo Basin. Agriculture is again the principal livelihood of the villagers, with production of crops such as potatoes, maize, wheat and beans, together with cash crops such as tea and pyrethrum (Pavageau et al 2013b).

In both the Cameroon and Equatorial Guinea sites secondary forest and clearings for cash crops start at the periphery of the villages, and primary forest exists within several kilometres of the village centre. Villagers enter the forest for hunting and small-scale extractive use of NTFPs. Industrial logging concessions and mineral extraction occur in the wider area around the Cameroon sites (Devisscher et al 2013), and there is a history of logging in the

forests around the Equatorial Guinea sites (Pavageau et al 2013a). At the Rwanda sites the landscape is predominantly agricultural, with fields extending up to the boundary with the strictly-protected montane forest of the Volcanoes National Park. Local people have few rights of access to the protected forest ecosystem (Pavageau et al 2013b).

In each country field research was conducted in collaboration with COBAM local partners ROSE in Cameroon, INDEFOR-AP in Equatorial Guinea, and ARECO in Kamiro and Masasa in Rwanda. The field methodology for this phase of the research was a combination of structured and semi-structured qualitative techniques, conducted in the local languages (Mbimou, Fang and Kinyarwanda) and subsequently translated (the team has endeavoured to ensure that quotes provided in the paper are as faithful as possible to the original words of the interviewee).

Research activities in each site entailed initial work at community level followed by the main qualitative fieldwork with households. In each village a meeting was first held with community leaders to discuss overall characteristics of the village and its population, followed by a group interview format to identify major environmental changes/events and their consequences, and to explain local patterns and norms of forest management.

Subsequently, 20 households were selected at random in each of the 6 villages, with in-depth interviews conducted with one or more heads of household. Because the Cameroon villages contained residents of the Baka ethnic minority group, in both villages we stratified the sample to include 5 Baka households. The interviews were structured in the first stage to track household social and economic trajectories, perceptions of environmental change, and changes in access to resources. This was followed by semi-structured, second-stage discussions designed to explore householders' perceptions of major livelihood threats and possibilities for adaptive action, and broader perspectives on forest and land use management.

In the sections that follow we explore some of the findings from these data, across the case study sites and the 126 interviews. It is recognized that the qualitative focus of the research did not enable the team to survey a statistically representative sample of the population of each village, nor provide for a rigorous social stratification of data. However, the team believe that the complex nature of the topic and the process of discussion that it required with interviewees made it difficult to justify use of extensive survey techniques. It is through intensive qualitative work that the subtleties and trade-offs of forest-based adaptation can best be explored; and it is the perspectives that emerge from people's individual testimonies that are most



illustrative and informative at this stage in assessing the potential of mitigation-adaptation synergies on the ground.

## **Climatic Stresses**

A key task of the research was to analyze how villagers in the six sites perceive their vulnerability to climate stresses arising from climate variability and change. Understanding perceptions of climate stresses is key to understanding both how people respond (or not) in an adaptive sense and their perspectives on the priorities and appropriate modes for intervention. We underline that this is important regardless of how closely perceptions align with meteorological and other scientific data – not least because of the coarse scale at which climatic data tends to be collected (especially in the regions under study).

### **Rainfall patterns**

In all six villages people described an increasing variation in the onset of seasons and intensity of rainfall that in turn affects crop and livestock health, and in some cases impacts on habitations, water quality, and human disease. Heavy rains and rainstorms associated with flooding were commonly raised as one priority ‘environmental problem’, but the most consistently raised issue in group and household interviews was an increasing unpredictability of rainfall and shifting patterns of seasonality (36 households in Cameroon, 24 in Rwanda and 33 in Equatorial Guinea). Broadly speaking, rainfall is reported to be less predictable and falling in more intense bouts but for shorter periods than before in all sites. In the Cameroon and Rwanda sites at least, people tended to suggest that these shorter, more intense, less predictable rains were initiated in the last few years – a period of time that is too short for us to reliably distinguish a pattern of climate change from background climate variability .

One quote from Cameroon is illustrative of the experiences:

*‘Most of the time now, the dry season extends and occupy the period that was reserved to the rains. And when rains come, they extend also and occupy the period that was reserved to the dry season. More to that, there are heavy rains that can fall the whole day, and even 2 to 3 days successively, but those rains are not regular. Generally, there is less rain now than before. The situation appeared abruptly, it is getting to 3 years [now],’ (Djalobekue, household 11).*

In Equatorial Guinea, households reporting an increasing seasonal unpredictability referred to a combination of lower than expected rainfall, late arrival of rains and torrential rains causing destruction of crops and damage to property. However, 5 households reported no perceived change in annual rainfall.

Soil erosion associated with heavy rains was considered a particular problem in the Rwanda sites, with short-duration heavy rainfall identified as an increasing issue by 35 people. Instances of gullying have recently taken place in the vicinity of the villages on the lower flanks of the volcanoes, causing loss of land and damage to dwellings sited close to the developing ravines.

Meteorological records are not available directly for the three study areas, and there tends not to be sufficiently reliable data to confirm or disprove perceived trends. Data from stations in similar zones was collected for the baseline assessments and suggests that some of the 'change' in rainfall and seasonality described by people in the study sites may be associated with normal climate variability over annual and multi-year cycles (Pavageau 2013a, Pavageau 2013b). However, the available data is not conclusive on this point. As James et al. (2013) underline, considerable uncertainty also remains over projections of future climatic changes in the rainforest regions of Africa. Some signals are stronger than others: outputs from model ensembles that they analysed suggest an increased rainfall trend in the east of the Congo Basin during the next four decades and a potential intensification of the dry season toward western Africa. But factors such as topography and land cover will create local variations around these coarse-scale regional trends – which are presently not robustly modelled.

### **Other climatic variables**

Responses about changes in temperature were less consistent across and within the sites. In Rwanda and Equatorial Guinea, a majority of the households interviewed (31 and 27 respectively) felt that average temperatures had been steadily increasing. However, There was considerable variation in households' perceptions of *when* this change began: households in Rwanda for example stated the change started as early as 1976 and as late as 2011. It is difficult to gauge the reliability of these statements, and, as with rainfall, even if change is reliably experienced over a period of a few years, it is not necessarily an indication of climate change *per se*.

In Cameroon, the largest proportion of households (24) reported a decrease in temperatures. Once again, however, there was considerable variation in perceptions as to when this change started. Three additional households in Cameroon qualified the changes by suggesting that there is greater daily or seasonal fluctuation in temperatures than a simple 'increase' or 'decrease' pattern in average temperatures. For example, one interviewee stated: *'When the dry season comes places are very hot and when the raining season is coming it is colder than before. We have been enduring that situation for 2 years now,'* (Mang, household 20).

The communities in Equatorial Guinea also listed increase in the occurrence and intensity of windstorms as a major concern, creating damage to property and crops such as banana and cassava. A total of 25 households described the winds (often associated with severe storms) as increasing in intensity, although once again estimates of when this trend began varied from as early as 1990 to as late as 2012. Not all households were in agreement, however, and 12 households described no change.

### **Crop productivity and disease**

The interviewees were also invited to discuss their perceptions of how climate variability and extremes impact on their lives and livelihoods. For such rural communities impacts on farming were predictably of high concern, and responses particularly focussed around perceived impacts on crop productivity. In the Rwandan sites, two major extreme events are highlighted in the interviews: an intense dry period in the early 2000s during which potatoes suffered a wilt (*urunyo*) and more recently in 2011-2012, a period of intense rainfall that similarly impacted on potato harvests.

Several villagers in Cameroon and Rwanda described how the unpredictability of the rains has consequences including disruption to planting, the need for multiple sowings (due to crop failures or heavy erosion), and reduced crop yields. An interviewee in Equatorial Guinea described how heavy rains at the time normally used for burning plots had disrupted this activity (Atom, household 02). One household in Cameroon also indicated no longer being able to utilize wildlife signs for planting purposes, suggesting ecological changes have been caused by the shift in seasonality.

*'It is now a total disorder, and it has consequences on the harvest. Before, seasons have signs that signal their coming. For example for the raining season we had groups*

*of storks passing. For the dry season, there were butterflies. And we were organizing our activities in line with that,'* (Djalobekue, household 08).

Plant diseases were often described as being triggered by the mixing of seasons. It is important to recognize that plant diseases are likely to have a complex causation, not necessarily related to coincident climatic variation. Nevertheless, neither can lay explanations necessarily be dismissed. In Cameroon, plant diseases in particular for cassava and cacao were identified, resulting in a reduction in crop productivity and harvest.

### **Impacts on income and wellbeing**

According to the reports above, the change in weather patterns, particularly the shifts in seasonality, is resulting in a reduction in crop production and ultimately, hunger and income loss in the study sites. Some households had altered their planting schedules, planting multiple times, but with no reported success. As one household from Cameroon noted:

*'It was when we were sowing corn and peanut. I sowed like everybody, but after that we had a burning sun for 3 weeks. All the corn that germinated got burnt. I replanted twice, thinking that things will change, and I had the same result. All got burnt,'* (Djalobekue, household 09).

Other responses to crop production problems across the case studies included actions to improve water storage, increase of manure and fertilizer input, increased pesticide use, and changes to crop types and varieties that are more resistant to drought or plant diseases. However, few households reported being able to actively pursue such responses and even fewer reported success in their application. Commonly a combination of lack of knowledge about new methods and lack of finance to undertake them was cited as fundamental constraint.

Production losses have wider repercussions for human wellbeing because of their impact on subsistence and income. Households suffering from crop disease in Cameroon stated that they had to change their diet, for example to eating more yams, and that the loss of income led to a need to reduce expenditures on household items and children's school fees. It is important to recognize the way that climatic impact on farming can have a cascading effect on many other aspects of people's livelihood assets.

Some households had attempted to respond to the challenges in more radical ways, such as cases in Rwanda of raising income by selling land and working

on other peoples' property, and taking alternative livelihoods such as production of sorghum beer. However, without external assistance, livelihood transformations are inherently difficult for the rural poor, particularly for those close to the poverty line who have little or no surplus resource to invest to change practices in an adaptive sense.

Climate variability can also affect wellbeing in more direct ways. Periods of low rainfall decreased access to water in the Cameroon sites and some households stated that this resulted in consumption of 'dirty' water and increased exposure to waterborne disease risks. Communities living close to the Volcanoes National Park in Rwanda spoke of the (unmet) need for water storage tanks during the dry season, although some households had recently gained access to piped water and a few had installed simple means to capture rainwater.

The gullying problem around the Rwandan sites also brought direct losses of cropland and property. One interviewee stated that some people responded to such loss by digging pits and creating waterways to channel the water off of their fields and away from their homes (Kamiro, household 01), although it appears that many households are responding to more to cope with impacts than to reduce risk. Some households that reported property loss stated that they sold or were renting out a portion of their remaining land to try and make up for their financial losses.

### **Compounding factors**

Of course, climatic stress on livelihoods and wellbeing does not occur in isolation from wider socio-environmental pressures and dynamics. The impacts identified by villagers in the six sites were also associated directly and indirectly with other factors. It was not possible to analyse all these factors in a systematic manner, but here we draw on one example from each country to illustrate that any analysis of climate impacts has to be set within a wider context.

In Rwanda, a key exacerbating factor was felt to be policy constraints on land use. Policies on crop planting in Rwanda have exerted tight controls on what can be grown by farmers. Under the Crop Intensification Program, locations are typically expected to specialise in no more than three out of the seven government priority crops, with even more severe constraints on what individual farmers are allowed to grow. Farmers complain that this undermines the traditional systems of polyculture that have evolved locally as an adaptation to complex environmental conditions. . One householder

from Kamiro village explained that in the past if a harvest such as maize was damaged by weather conditions then the household could usually still rely on the yield from other crops. Another from the same village added:

*'We have to accept it, but the remaining problem is when the authorities enforce the community to plant one crop. This crop may not grow well and causes some problems including hunger' (Kamiro, household 09).'*

In Cameroon, the repercussions of crop failure for the villagers were compounded by livestock diseases (themselves potentially linked to climate variability although no clear explanations were given for such linkages by the interviewees). Animal diseases, in particular for chickens and pigs, were identified as a problem of increasing importance in Cameroon with death of animals resulting in regular loss of income.

In Equatorial Guinea, an environmental change factor of widespread concern was a growing incidence of crop-raiding by wild animals, which was already said to be depleting crop production. This exacerbated the effects of climatic stresses on crop production. The crop-raiding issue is explored in greater depth later in the paper.

## **Adaptation via mitigation: the potential**

Given the problems and adaptive constraints touched on above, a key objective of the research was to gauge the extent to which people are, or could be, drawing on forest resources as an adaptation resource. This links to the ideas of deriving adaptive co-benefits from mitigation via carbon management. However, in order to understand this potential synergy between adaptation and mitigation in a humid tropical environment, the role and potential of arboreal landscapes to contribute to livelihood support and resilience has to be critically analyzed. Again, this includes giving voice to the priorities and concerns of local communities.

As an opening statement it is useful first to note that local perspectives on conservation and management of forest resources are complex and differentiated, not just between households but between forms of management and land use. There is not the space in this paper to explore these perspectives in detail, but some examples are illustrative.

In the Cameroon sites responses from villagers about the impacts of expansion of mining concessions were finely balanced (19 versus 19) between

those who regarded it as positive and those who considered it as a negative change. Interestingly, both arguments were economic, in that mining concessions were seen as increasing local prosperity through employment, but conversely would reduce access to forest resources and therefore to income derived from forest products.

When questioned about possible expansion of forest concessions to logging companies, the majority of villagers in the Equatorial Guinea sites was in support of such a change, again on the grounds that they (or their spouses) would gain employment and an increase in household income. However, one household in each village expressed a dissenting view rooted in a conservation ethic. According to one of these interviewees:

*'Even if young people got jobs I do not support it because young people do not realize the importance of the forests because exploitation is temporary and for me the forest is very important, I do not like the thought of a timber company arriving to work in the forest,'* (Atom, household 09).

Several other households in Atom and Kukumankok described a sense of the moral value of protecting the forest, for future generations but also as a means of sustaining their own lives and sense of wellbeing. Appreciation of the forest as a place of refuge for solitude and relaxation was also expressed by some householders in Cameroon.

This sense of attachment to the landscape appears to be endogenous, in that there was no evidence of external influence from conservation or environmental projects in the Cameroon and Equatorial Guinea sites. The Rwandan case was quite different, in that the villagers lived adjacent to a high-profile and strictly-protected national park. Here there were community-based organizations active in the areas including an investment scheme aimed at both development and reducing human activity in the park and a cooperative comprised of ex-poachers designed to improve relations between the community and the park management authority. It was also different in that the villagers discussed development of increased tree cover (including agroforestry) on their own land as a possible means to safeguard against crop losses, provide a source of timber and reduce soil erosion. The effect of standing trees in buffering against wind and extreme temperatures hazards was also raised in the Equatorial Guinea sites.

Through the evidence of people's testimonies, we now look in more detail at quite how communities can derive benefit for livelihood resources from forest landscapes (the surrounding forests and standing trees on their land),

together with the constraints on these benefits. In the section that follows after that we then concentrate on the possible trade-offs.

### **Forests as a source of income and subsistence**

Utilization of products from the forest is woven into the traditions of all these settled villages. In Rwanda, the extraction of NTFPs from the park now appears to be at a low level though there is evidence that people do still enter the forest at times to collect resources such as bamboo for selling. Indeed, discussions in one village suggest that some people regularly access the park to collect water, firewood and bushmeat. Moreover, many of the interviewed households were beekeepers and prefer to set their hives near the park boundary so that the bees can access the forest flowers.

In Cameroon 25 of the interviewed households reported deriving income from the sale of NTFPs collected from the forest including bushmeat, bush mango, fish, koko, caterpillars, djembe, and djansang. One household indicated that access to forest products is a kind of insurance against times when regular sources of incomes are lean. In Equatorial Guinea, 39 households described the collection and sale of forest items in particular bushmeat, fish, palm oil, wild fruits and melongo (basket weaving material). For example, in Atom one householder (Atom, household 09) stated:

*'Yes I am interested [in protecting the forest], because I completely depend on forests for food and for earning money, medicine, drinking water, everything is found in the forest, therefore I want to it to stay.'*

Medicinal plant use occurs in all countries – reported by 17 households in Cameroon, 18 in Rwanda and 8 in Equatorial Guinea - and most of these plants can be sourced from the forest. However, many households in Rwanda indicated that the plants are cultivated around the home and less relied upon now that access to formal health care has improved.

In Cameroon, 35 households stated that there had been a decrease in NTFP availability, generally attributed to clearing of forest for new agricultural land and concurrent increase in demand for sale of such products. In Equatorial Guinea, there was a balance between those who perceived that NTFP availability was decreasing or becoming highly variable and those who felt there had been no change. Four households indicated that the distance travelled to access NTFPs had increased and 5 indicated that they felt the reduction in access was due to deforestation and competition with forest animals.



A total of 32 households in Cameroon and 22 households in Equatorial Guinea described bushmeat access as declining, with most who gave a reason attributing the decline to an increase in hunting activities, including greater use of guns and increased hunting for sale rather than subsistence. Discussions with villagers indicate that a recent change in hunting practices may have taken place, with fewer traps now set in the primary forest and more in the cultivated, ekoro secondary forest. This was also linked to the problem of crop-raiding, with traps set to reduce crop losses doubling up as a source of bushmeat.

### **Forests as an alternative source of resources**

Some of the arguments around an adaptation value of forest management are that it provides an alternative source of resources (or potential safety net). In the Rwandan sites, where most of the surrounding landscape is deforested and the dense protected forest on the higher slopes of the volcano provides a backdrop, collection of water from watercourses in the park is undertaken by some households, particularly during the dry season.

Access to reliable water sources is also seen as a benefit of the forests that surround the villages in Equatorial Guinea, but there one of the key assets that a forested landscape is also seen to bring is access to land. With a tradition of shifting cultivation, villagers view the forest as a resource from which one can obtain new farming land. In the words of one interviewee: *'We still have a lot of forests spare.... you can go to another place'* (Atom, household 05). It seems that most commonly farmland is inherited but there are indications that, if you do not have plots, you may go to an area of forest to 'clear' or 'weed' it, thereby making it your own land. Similarly, in the Cameroon sites, a commonly stated response to problems of declining crop productivity and/or spread of crop diseases was to abandon the plot and clear elsewhere in the forest. The irony in this sense is that the livelihood support (adaptation) value of the forest is the existence of unfarmed land – but in bringing that support into operation the result is release of carbon.

One other way in which the forest acts an alternative resource is provision of space for isolation. Animal diseases, in particular for chickens and pigs, were identified as a problem of increasing importance in Cameroon. One potential response identified by most households was to send the animals to the forest for protection during epidemics.

## **Tree-planting (in Rwanda)**

To some extent, communities in the Rwandan villages have undertaken tree-planting in and around their villages, which can be expressed as a 'forest management' measure to provide hazard protection and a source of fuelwood. For some households this had not offset a reported decline in firewood access, and some stated that they were constrained in tree-planting by labour resources. A contrasting 3 households reported an increase in firewood availability because of success in production of trees on their land. One household (Masasa, household 2) reported: *'Nowadays, no one is allowed to enter into the park for collecting firewood. We don't have fire problems because we planted our own woodlot.'*

The potential to develop agroforestry in the area has also been discussed, although households commonly expressed uncertainty about skills for successful tree cultivation and the compatibility of the trees with their crops, as well as issues of ownership if tree-planting were to be supported externally,

## **Adaptation via mitigation: the trade-offs**

In the discussions with villagers it was clear that most people derived positive benefit from forest resources in their surrounding environment. But it was also clear that the existence of the forest and the existence or potential existence of forest conservation and management practices were also perceived to have negative implications for various aspects of people's livelihoods. We argue that it is just as vital for researchers to explore those negative aspects, if the potential synergy between adaptation and carbon management is to be fully understood. Here we present these as a series of trade-offs for local people of maintenance and/or increase in forest coverage.

### **Trade-off 1: Forest proximity versus Crop-raiding**

For households deriving hazard protection, resources and income sources from forested environments, the spatial proximity of the forest to their homes and properties is evidently an advantage. Yet to varying degrees it exposes households to contact with wildlife. In Kukumankok there was a high degree of concern about danger to humans from forest animals coming into settled clearings, particularly elephants and snakes, and some households in Atom described the killing of livestock by forest-dwelling carnivores. But it was

crop-raiding by herbivores that was most commonly regarded as a problem across the three countries.

Crop-raiding was identified as a high priority issue by 17 of the interviewed households in Cameroon, 27 in Equatorial Guinea and 31 in Rwanda (ie over 60% of all households in the study). The animals identified as raiding crops in Cameroon include hedgehogs, squirrels, rats, monkeys, birds (parrots and partridges), porcupines and duiker. One household also referred to a 'new species':

*'...another type of animal resembling the squirrel which walks on the land and lives in the trunks of trees or in the lairs. It is a new species that we started seeing this year and that we do not really know. They destroy everything they see,'* (Djalobekue, household 02).

In the Equatorial Guinea villages, though crop-raiding is not a new issue, there was some indication that the problem is increasing. Two households in Kukumankok reported changing the types of crops they grow in order to reduce the problem, with one ceasing to plant yams and bananas for this reason, and the other interviewee indicating that she only grows cassava now to reduce problems with wild animals. Many animals are implicated in the crop losses, including elephants and gorillas, but rodents appear to be the most destructive in terms of volume of losses.

Some people have begun to establish traps around their plots to kill the crop raiders, but this appears to be dependent on individual efforts rather than communal activity. A common method is to build a combination of fence and trap around the field called *osap*, a traditional structure consisting of a 50cm-high fence made from bamboo with small holes where traps are placed. Seventeen households describe trapping of some sort with the materials for the traps being obtained from the forest. One household described the futility of such methods against larger animals like elephants and gorillas but it would appear their greatest problem is with much smaller (rodent) animals. Two female-headed households indicated that they did nothing as setting traps is 'man's work' and they lacked the finance to hire someone. Interestingly the nature of bushmeat hunting at Atom is described as changing due in part to the intensity of crop-raiding. For example, one household stated: *'there has been a change in the type of hunting and traps because nowadays I do not hunt for commercial reasons, but to protect my crops'* (Atom, household 09). The setting of traps is primarily a crop-protection measure, but the trapped animals are commonly used as a supplementary source of meat.

In Rwanda, the problem animals were buffalo, monkey and porcupines, entering farmland around the fringes of the Volcanoes National Park. This was regarded as major problem in Masasa, especially, and there was a sense of injustice expressed by several households that they did not receive compensation from the park authorities for their losses. The issue of inadequate compensation schemes for crops losses and animal attacks is a recurrent theme for many communities living around protected areas (Nyhus et al. 2005). One Household in Masasa had quite an interesting ecological perspective on why crop raiding was becoming an increasing problem. The interviewee noted that: *'In the 1970s our agriculture had a high yield even if there were animals coming from the park that were raiding our crops'* (Masasa, household 12). He then continued to explain that, in his view, in 2003 the vegetation in the park started to change because of a change in conservation practice:

*'...before people were allowed to cut dry trees and bamboo, but when they stopped people from cutting those trees and bamboo, it destroyed the equilibrium that was set by the people. Dried bamboo when they fall on the ground do not allow other herbs and grasses to grow. This caused a shortage of grass for animals and they come out of the park and raid our crops.'* (Masasa, household 12).

## **Trade-off 2: Forest coverage versus Land for farming**

Some households in the study expressed a strong desire to see the forest preserved as much as possible, but, for most, a preservation ethic was replaced by perspectives that were much more utilitarian. For many the existence of the forest was not only a source of forest resources but an opportunity to access land. In Cameroon, 23 households indicated that they had increased their land tenure since household formation, and several openly explained that they had acquired new land by clearing the primary forest. In common with shifting cultivation practice, a few households explained that they were working land further from their homes because the productivity of the soil was better and they experienced fewer problems with crop diseases. There was a strong reaction from most interviewees to the idea of placing strict controls on this practice. The response of one household was:

*'We cannot create farms without cutting down trees. It will be very bad if it is forbidden. We will no more have food to eat. Talk to the forest exploiters; they are the problem. What can a poor farmer working with his hands do to this immense forest?'* (Djalobekue, household 06).

It was not surprising, then, when a hypothetical question on the possible reforestation of agricultural land was posed to households in Cameroon it provoked strongly negative responses from most households. In Equatorial Guinea the idea of controlling further deforestation in secondary forest land divided opinions evenly among interviewees, although some households stated that they already leave areas fallow for extended periods of time (2-10 years) or that they would expect to be compensated if they were not allowed to clear. Fairly positive response, however, was expressed about the idea of converting plots to agroforestry in the communities, with all households in Atom expressing support for the idea. But the strength of an underlying concern to rise out of poverty was paramount, and must be recognized. Direct questions about cash crops in the communities in both Cameroon and Equatorial Guinea led to virtually unanimous support for increasing production, on the ground that this would raise incomes, enabling them to improve their lives through the building of better homes, sending their children to school, and purchase of material goods.

In the case of the Rwanda communities, the land issue is quite different, because the national park is strictly protected and rural population density is high. Those that are acquiring land are predominantly doing so through buying land or inheriting increasingly fragmented plots. Households were therefore almost unanimously concerned about any potential expansion of the park and generally felt that even if compensation for land purchase were received, it would fall short of replacing the assets that the households currently possess. Even a policy of reforestation on steeper slopes to protect against soil erosion raised major concerns about production losses.

### **Trade-off 3: Resource conservation v Access to resources**

Controls on the exploitation of forest resources can be a means to ensure they are sustainably managed as well as preserving ecosystem and biodiversity integrity. However, the sustainable management of resources is only meaningful to local people if they retain access to user rights in some sense.

In Rwanda, for the communities around the Volcanoes National Park the tightening of restrictions and/or their enforcement generated livelihood impacts for some households. Change in access to resources was reported as a cost by 13 households interviewed. One villager described the impact:

*'During the past years when there was poverty, we entered into the forest for collecting bamboo and if these were sold we find some money to buy food. We put our*

*beehives into the forest.... Nowadays, all these actions are not allowed to be made in the park.'* (Masasa, household 02).

Loss of the chance to collect firewood in the park was the most common complaint, voiced by 10 households, although there was a greater expression of acceptance of this situation than, for example, the impacts of crop consolidation policy. One household stated: *'we're affected but there's nothing to do, because they are the programs of our government for our common interests.'* (Masasa, household 13). Another householder described having to reduce the number of cattle he owned because, in combination with control on grazing within the park, the government implemented a law that all cattle be confined:

*'Our main activity was to raise cattle. We had 10 cows, 8 goats, 1 sheep and 12 rabbits. Our livestock used to graze in the park and we did not have a problem of feeding them. After, the government policy was to raise livestock in stables and to cultivate grass for them. As we did not have sufficient land, our livestock started to reduce in number'* (Masasa, household 12).

In the sites in Equatorial Guinea and Cameroon, existing restrictions are much weaker and people's access to forest resources is not strongly controlled. Interviewees were therefore asked to speculate how greater restrictions associated with a more rigorous forest conservation and management approach might affect them. The main concern raised in Equatorial Guinea was continued access to bushmeat. Households who spoke against prohibition of hunting stated that they depended heavily on meat for food and income, and were concerned that a prohibition would result in increased crop-raiding activities. However, on balance, slightly more households stated that they were in favour of hunting controls - most households indicated that they did not consume much meat or that they could simply purchase frozen goods instead. Some still wanted compensation for such a loss.

Interviewees in Cameroon were more solidly against a limitation on hunting, with 32 speaking against it and only 5 in favour. Reasons for opposing such a control included low levels of livestock in the village, bushmeat as a traditional source of nutrition, and loss of opportunity to sell the meat for income generation. Concern was also raised that increased timber concessions in the area would entail greater restrictions on access: *'If the concession is enlarged, we cannot enter everywhere we want to collect what we want'* (Djalobekue, household 05). Two of the Baka households spoke explicitly about their fundamental relationship with the forest, and the cultural impact of being removed from the forest on their family and wellbeing. One simply

stated: *'The forest is our god. The Baka is nothing without the forest. It represents everything for us'* (Mang, household 20).

#### **Trade-off 4: External intervention versus Empowerment**

The final trade-off concerns management regimes and ownership. Strengthened forest management and conservation actions tend to entail greater degree of intervention from the state and non-governmental actors. The interviewees expressed concerns for the implications of ceding greater control over forest resources to external actors.

In the Cameroon sites there was concern expressed especially over the potential expansion of forest concessions in the area, and the inability of villagers to enter forests that are being actively managed by the timber industry. Some anger was expressed about the power of companies to exclude people from forest land – set against a traditional system that allows people to gain ownership of the forest land that they clear and pass it down to future generations. There were allegations of corruption by the village leadership in relation both to the actions of timber companies and the government. One household in Mang stated:

*'The leaders of the village did not know how to defend our interest in front of the government and the whites who are exploiting our forests. They were given money secretly for them to allow the cutting of trees around us. Now we have no wood for our own construction'* (Mang, household 14).

In Equatorial Guinea, households were very positive about the potential for legalization of community-managed forests in their area. The predominant reason for this was utilitarian in that it was seen as a means of preventing companies from claiming forest land without providing compensation to local people. However, even the management of community forests established around the villages in Cameroon raised questions around ownership and transparency. More than half of the interviewed households (22) claimed to have no knowledge of the existence of community forests, bringing into question the extent to which their use and management is broadly community-based. Another 3-4 households in each village described active exclusion from participation in the community forest management.

In Rwanda, concerns over external management of reforested land was a major issue for villagers. It appears that private woodlots in both villages are subject to government control over felling, with permits required from local government. Kamiro interviewees described the process as cumbersome and

indicated that a harvest of timber in one woodlot impacts on the likelihood of gaining permission to harvest in a neighbouring lot that may be owned by another individual. If there were to be reforestation programmes on steep slopes, people who were in favour of this were most concerned as to whether or not they will in fact be the owners of such plantations (as opposed to the government). In the words of one householder: *'If the program obliges us to plant trees in our lands and become owners of them, we will accept but if those trees become the property of the government they will affect us negatively'* (Kamiro, household 03). The same concerns over ownership rights were raised even when interviewees discussed the potential for development of agroforestry in the area.

## CONCLUSION

For people living near to forests in tropical Africa, livelihoods and resilience are commonly linked, at least in part, to forest abundance and diversity (Nkem et al 2013, Bele et al. 2013). Sonwa et al. (2012) categorise the specific threats to vulnerability arising from forest loss and degradation in the Congo Basin: a) loss of NTFPS including food, b) loss of energy source, c) threats to health from loss of medicinal plants and d) changes in water quality and availability. Looking at these concerns the other way round we can see how protection of forests (and forest biodiversity) can contribute to the resilience of human livelihoods, and strengthen adaptation to the impacts of climate change. Key mechanisms through which adaptive advantages might be gained include the potential for forest resources to act as 'safety nets' in the context of climatic strains on agricultural livelihoods and the protection that intact forest ecosystems might provide against landslides, flash floods and other hazards related to extreme weather (Nkem et al 2010, Robledo et al 2012). The former function is associated with a broad conceptualization of adaptation that sees the strengthening of livelihood resilience as a bulwark against increasing climatic stresses.

Most of the authors writing about the potential for synergy, however, recognize that achieving mitigation and adaptation gains presents major challenges (e.g. Locatelli et al. 2010, Robledo et al. 2012, Sonwa et al. 2012). Some see a need to unblock the potential through awareness-raising and improved governance. But others underline that we also need to understand more about the role forests can play in reducing vulnerability and promoting adaptation. We argue that this must mean taking a step back from conceptual argument and using empirical research to critically assess the assumptions on which ideas of synergy are founded.



The exploratory case studies discussed in this paper, though limited in geographical scope, nevertheless provide illustrative evidence to inform discussions on the role of forests in fostering adaptation for the poor while simultaneously addressing mitigation. Across the study villages in three countries, there are commonly-held perceptions of climatic change, focussing especially on erratic rainfall patterns and increasing unpredictability of the seasons. Whether the perceived climatic variations constitute a genuine climate change trend is open to question, but it is key to note that they not only are perceived to be a trend but are also commonly perceived to have repercussions for the frequency or magnitude of extreme events and for the productivity and susceptibility to disease of crops. These impacts, compounded by other environmental and socio-economic stresses, in turn impact on lives, livelihoods and wellbeing among the households we interviewed.

Villagers also described positive benefit from the existence of forests and forest resources in their surrounding environment. Many villagers directly accessed water, firewood, bamboo, bushmeat, fruits, medicinal plants and other NTFPs from the forests. Forests also constituted a source of land for farming and an opportunity for isolation of animals during epidemics, while tree-planting in the case of the Rwandan sites provided firewood and stabilization of soils. On the face of it, then, in these villages we have a situation in which people are likely to face ongoing climatic stresses and in which forested landscapes are likely to provide continuing forms of hazard protection, sources of income and subsistence and alternative sources of resources.

However, it was also clear that people held complex, and often ambiguous, perspectives on forests, and that the existence of forest and of forest conservation and management practices were also perceived to have negative implications for livelihoods and resilience. Bringing together evidence from the 120 interviews in different zones of the Congo Basin, we can identify four main trade-offs expressed within people's perspectives. First, while the proximity of the forest confers advantages in terms of accessibility to resources, it also constitutes a threat to livelihoods in terms of crop-raiding by wild animals. Second, measures to conserve or extend forest coverage increase abundance of forest resources but constrain availability of land for farming. Third, conservation restrictions can preserve ecosystem integrity but can also restrict the rights of local people to access the resources that might constitute 'safety nets'. Fourth, if strengthened forest management implies greater external intervention then it may lead to a loss of local power and control over forest resources.

The negative implications expressed by villagers will come as no surprise to many working in forest management, and constitute issues that can to some extent be ameliorated through more people-centred approaches to ecosystem management. However, they do bring sharply into relief the potential for assumptions about synergistic mitigation-adaptation gains to be unravelled by on-the-ground socio-environmental realities. Part of this disconnect may come down to a focus on 'forest-dependent communities' in discussions of synergy: 'dependency' by definition implies that conserving forests is supportive for livelihoods, because it conserves ecosystem services for livelihoods. This, conceptually, paves the way for the idea of ecosystem-based adaptation. But it is evident that many, probably most populations, living in close association with forests, do not have a simple form of dependency on forest resources: most such people have access to alternative resource options and differing interests in management of the forests that complicate perspectives and priorities. The idea that their resilience will be strengthened by a forest-based adaptation cannot necessarily be assumed.

Indeed, where broad-based adaptation gains are more likely to be demonstrable is in situations where a compromise between optimal carbon sequestration (and/or biodiversity conservation) and livelihood resilience is inherent in their design. Such attempts at achieving synergies will tend to involve interventions that seek complex forest composition (rather than carbon monocultures) and ones that adopt landscape scale planning to include relationships between forests and agriculture (D'Amato et al 2012; Harvey et al. 2014).

The findings of the research highlight the need to understand both the limits of synergy, and the constraints and trade-offs for rural livelihoods that may be associated with a forest conservation agenda driven by the additional impetus of carbon sequestration. The search for synergy may be conceptually laudable, but if forest management actions do not take account of on-the-ground contexts of constraints and social trade-offs then the result of those actions risks undermining wider livelihood resilience and ultimately the chances for adaptation of those most vulnerable to climate change.

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