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Environmental change, forests and rural communities in three African countries

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Abstract

We used semi-structured interviews to describe how rural subsistence communities living near forests respond to environmental change in three African nations – Cameroon, Equatorial Guinea and Rwanda. We begin by recounting people's perception of environmental change – what are the issues of greatest concern as identified by local communities? Second, we explore people's responses to identified environmental problems (how are people adapting to the identified changes?) and in particular the role of forests in these processes. Finally, we conclude with a discussion of changing land (and in particular, forest) management practices - both real and prospective - in the focal countries, and how their implementation may affect the future adaptation strategies of such communities. We contend that people's current and potential responses and adaptation to environmental change are influenced by the availability and access to forests and forest resources, and the degree to which their livelihood strategies have diversified away from forest dependence. Furthermore, the ways in which these communities are able to continue to use forests to adapt to environmental change will likely be shaped by the implementation of different forest management practices like REDD+.

1. Introduction

The contribution of forests to aspects of human well-being is reflected in estimates that roughly 1.6 billion people depend on forests for part of their livelihood (WB 2004). In particular tropical forests play a considerable role in the livelihoods of the rural poor through their provision of food (Wilkie and Carpenter 1999, Nasi et al. 2008), fuel (UNEP 2006), and medicines (Ndoye et al. 1998, Colfer et al. 2006, Colfer 2008, Sonwa et al. 2012). These provisioning or ecosystem goods often constitute a large percentage of a household's income with fuel wood sometimes forming the single most important component (Cavendish 2000, Angelsen et al. 2011, Belcher et al. 2011). Forests are also considered 'safety nets' for poor households providing goods during times of agricultural shortfalls or other such unpredicted shocks (Sunderlin et al. 2000, Pattanayak and Sills 2001, McSweeney 2003, Takasaki et al. 2004, Belcher 2005, Akinnifesi et al. 2006, Shackleton et al. 2007, WB 2007, Nkem et al. 2010, Vira and Kontoleon 2013). For example, Fisher & Shively (2003) found that rural households in Malawi rely on forest products during food shortages and that such reliance is proportionately higher in poorer households. Reliance on forest products is particularly evident in Africa (Ambrose-Oji 2003, Ndoye and Tieguhong 2004, Ruiz-Perez et al. 2004, Sunderland and Ndoye 2004, Shackleton et al. 2008), home to the second largest remaining intact tropical forest in the world – the Congo Basin (Mayaux et al. 2004, FAO 2005, Hoare 2007).

Although deforestation rates have slowed somewhat in recent years, curbing forest loss remains an issue of global importance based on its contribution to biodiversity conservation, preventing climate induced environmental change, and – as described above, support of people. Although climate impacts are widely distributed they are considered of critical importance for Africa where it is anticipated countries will suffer a disproportionately large share of the negative impacts of global climate change (Slingo et al. 2005, IPCC 2007, UNDP 2007, Fisher et al. 2010). In particular rural people in developing nations are considered vulnerable to environmental changes due to issues of deep poverty, low levels of education and health, lack of technology and infrastructure, and poor food security (Huntingford et al. 2005, Thomas and Twyman 2005). Responses to climate change are generally placed into two broad categories: (1) *mitigation*, activities that result in a reduction in the accumulation of greenhouse gases in the atmosphere and (2) *adaptation*, activities that reduce the vulnerability of societies and ecosystems facing the impacts of

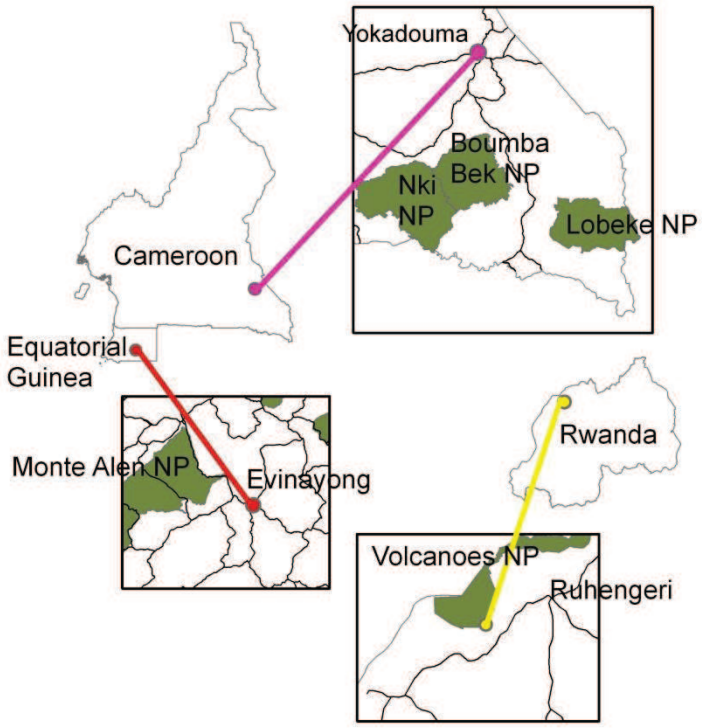
climate change. The bulk of adaptation literature has focussed on the way in which people have responded to natural disasters (likely to increase with climate change) in an effort to describe how rural households might adapt to future climate change. In this paper we follow a similar approach, describing how rural subsistence communities living near forests respond to environmental change in three African nations – Cameroon, Equatorial Guinea and Rwanda. We begin by recounting people's perception of environmental change – what are the issues of greatest concern as identified by local communities? Second, we explore people's responses to identified environmental problems (how are people adapting to the identified changes?) and in particular the role of forests in these processes. Finally, we conclude with a discussion of changing land (and in particular, forest) management practices - both real and prospective - in the focal countries, and how their implementation may affect the future adaptation strategies of such communities.

2. Study sites

The countries in which our study takes place, Cameroon, Equatorial Guinea and Rwanda, were selected for their proximity to the Congo Basin landscape and to capture a variety of forest use and management practices. The Congo Basin covers approximately 228 million hectares (Hoare 2007) and represents 20% of the world's remaining forests (Mayaux et al. 2004). Furthermore these forests are home to roughly 30 million forest-based indigenous people that are largely concentrated around forest peripheries (CBFP 2006). We selected two villages in each country based on their location near to forest and the presence of rural, subsistence-based communities. In Cameroon we also selected sites near officially established community forests. The study sites in each country coincide with three of the regional landscapes prioritized under the Congo Basin Ecosystems Conservation Support Programme (PACEBCo): the Tri-National de la Sangha (TNS) in Cameroon, Monte Alen-Mont Cristal (MAC) in Equatorial Guinea and the Virungas in Rwanda (Figure 1). The villages selected in Rwanda were located adjacent to the strictly protected Volcanoes National Park, home to the highly endangered mountain gorilla. Communities in Equatorial Guinea were similarly located near but not adjacent to the Monte Alen National Park. Human population pressures vary considerably with the highest densities occurring in Rwanda with up to 820 people per km^2 in the Virunga landscape (Cameroon 5 people/ km^2 in the TNS landscape and Equatorial Guinea 16 people/ km^2 country wide). The topographies of the communities in Cameroon and Equatorial Guinea are quite distinct from that of Rwanda, which is

characterised by a steep landscape and dense, montane forest (ASL 680-5120 m). In contrast the TNS and MAC landscapes are predominantly lowland forests ranging from 300 up to 1250m ASL. We selected communities based on our hypothesis that forests would serve or minimally influence people's ability to adapt to environmental change depending on its availability as well as rules of access, i.e. community- versus governmentally-controlled.

Figure 1: Location of respective communities in study countries



3. Methods

We conducted semi-structured interviews with approximately 20 households in two villages in Cameroon, Rwanda and Equatorial Guinea (N=121), and a single group interview with community leaders in each village (N=6). Villages included Djalobekue and Mang, considered part of a group of villages managing the Mpiemog and Morikoualye community forests in eastern Cameroon, and located less than 40 km from the urban centre of Yokadouma. In Rwanda the villages of Kamiro and Masasa were selected, located in the Districts of Burera (Northern Province) and Nyabihu (Western Province), respectively. Lastly, the villages of Atom

and Kukumankok in Equatorial Guinea are located on the eastern side of Monte Alen National Park near the urban centre of Evinayong. Households were randomly selected in Rwanda and Equatorial Guinea where no major ethnic distinctions were present in the sample population, whereas in Cameroon five (of 20) households from the Baka - an indigenous, ethnic minority, were intentionally included from each village. Although there are Batwa peoples (part of the Pygmies people, similar to that of the Cameroonian Baka) in parts of Rwanda, there were no such families in our study villages. Similarly there was little difference in households from the study villages in Equatorial Guinea. Households were from a single ethnic group, Fang, but different clans that were self-described (by the respective leaders of the clans) to have little difference between them. Interviews were conducted by two native speakers of the relevant local language – Kinyarwanda in Rwanda, Fang in Equatorial Guinea and Mbimou in Cameroon, over a period of approximately one month. The fieldwork across the three countries spanned the period July 2012 to March 2013. Two interviewers were trained by senior staff over a period of 4-5 days immediately followed by a period of intensive data collection. Transcripts were then translated into English for analysis. We utilised NVivo v.9.2 (QSR 2011) to help manage, code and analyse transcript content.

Semi-structured interviews of households explored perceptions of access to and availability of land, forest products including firewood, weather patterns (i.e. rainfall and wind storms), temperature, and subjective wellbeing. Typically the head of household was interviewed, spouse of the head, or both. Households were asked to describe the direction and degree of change using the year of their household's formation as a baseline (e.g. marriage or establishment of own house, degree of independence from parents). Once an initial exploration of trends was completed, the respondent was asked to select 1-2 environmental changes or forest-related issues to explore in greater detail. It is in this second section that we attempted to capture people's responses or adaptations to the identified environmental changes as well as any constraints that they may experience. Additionally, respondents were asked a series of questions about forest use and management; we draw on this section of the interview to explore peoples' future options and the ways in which they may be constrained by current initiatives.

Group interviews were similar to those of the semi-structured interviews but instead of requesting detail of environmental change using an a priori list respondents were asked to add any other environmental events possibly omitted. From this

comprehensive list, the group then selected the top 4 items in order of importance and described in greater detail, e.g. importance of issue identified, the characteristics of the issue – when it began, frequency, etc., and who in the community is affected by it.

4. Results

All communities are characterised by agricultural production predominantly for subsistence with some cash crops including e.g. cocoa (Cameroon and Equatorial Guinea) and pyrethrum (Rwanda). Many households engage in secondary activities such as livestock rearing, fishing, wage labour, and small business. Collection of forest products is largely limited to Cameroon and Equatorial Guinea where access to the forest remains high and relatively unconstrained including for meat, wood, fruits and other materials. In Rwanda, a few households (n=10) described the collection of firewood from the park but indicated that this was increasingly difficult due to enforcement. The average age of a household since its formation across all countries was 27 $\pm$ 1 years, range 5-73, and median of 23 years (Table 1).

Table 1:

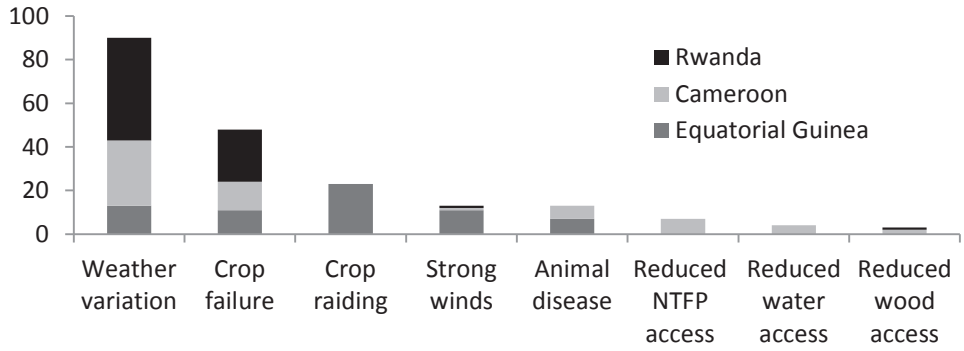
	Number of years since household formation				
	Mean	**SE**	**Maximum**	**Minimum**	**Median**
Cameroon	21	2	65	6	20
Equatorial Guinea	38	3	73	8	36
Rwanda	23	2	63	5	18
All countries	**27**	**1**			**23**

4.1 What are the environmental issues of greatest concern as described by rural households?

There were a total of eight major issues identified by households with two accounting for more than 68% of recorded mentions (n=138 of 202; Figure 2). Households self-selected one to two 'major' issues to discuss in further detail based on a preceding discussion on trends (see methods). Greater uncertainty in predicting and intensity of weather patterns (n=90), and crop failure as a result of pests, plant disease, or reducing soil fertility (n=48) were the most commonly reported environmental challenges facing households in all three countries. It is important to

consider the difference in these issues with the former being an observation whereas the latter (crop failure) is likely a result of changing weather patterns.

Figure 2: Summary of the top environmental issues identified by a household in the semi-structured interviews.



The majority of households described a change in the temperature (65%) and/ or rainfall (43%). Changing weather patterns and in particular temperature and rainfall patterns have been identified by the IPCC (2014) to result in greater vulnerability, e.g. due to its resulting in diminished food production as well as greater health risks from diseases transmitted in food and water. Respondents were asked to characterise the identified change with the bulk of Rwandan households describing an increase in temperature and rainfall, Cameroonian households describing the temperature as colder, with very few comments from Equatorial Guinean households (Figures 3 and 4). Several households also remarked on the variation in weather patterns and in particular changing and less predictable seasons.

> *We are experiencing a change in the seasons; there is rain when it is not usually expected and drought when it is normal to have rain* (Atom, household 01).
>
> *Rains fall during the dry season, and those rains come usually with heavy winds* (Djalobekue, household 04).
>
> *The wet and dry seasons have mixed and their start and end is no longer easily predicted* (Kamiro, household 11).

Figure 3: Household characterisation of the direction of change in temperature (n=79 households).

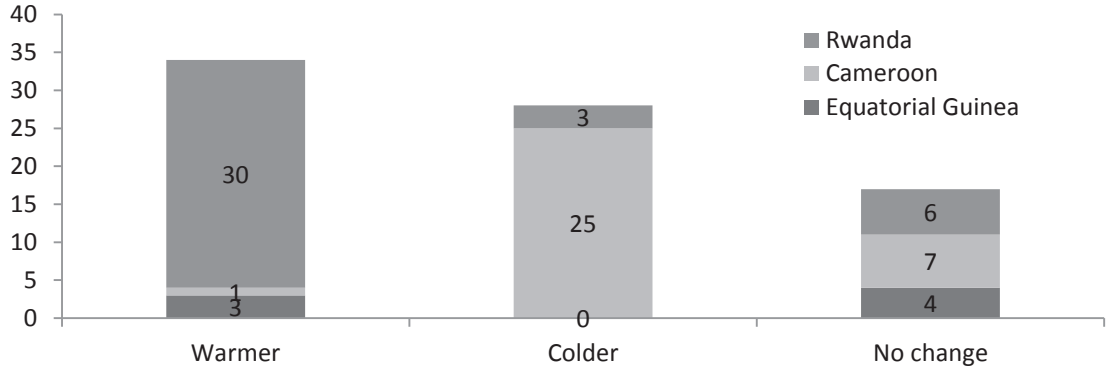
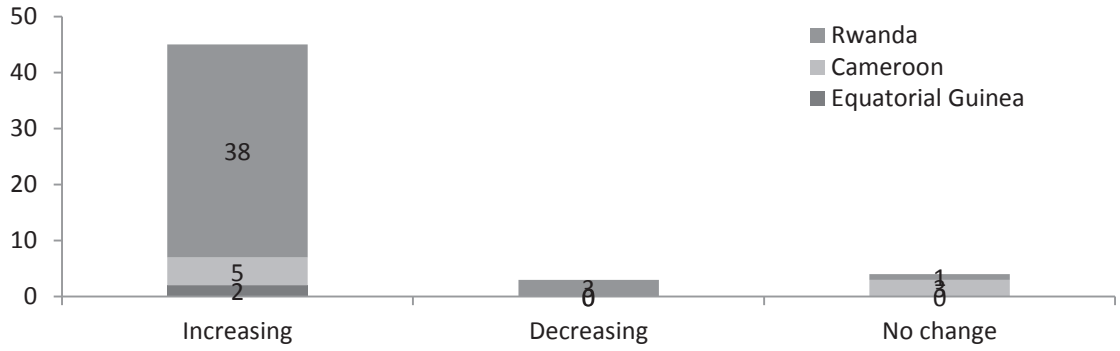


Figure 4: Household characterisation of the direction of change in rainfall (n=52 households).



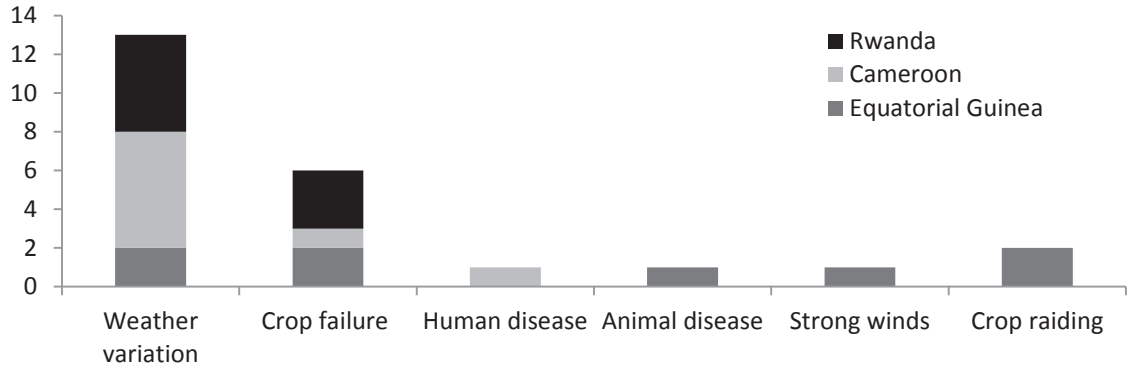
Shifting weather patterns resulted in a disruption of cultivation patterns and ultimately households' ability to produce sufficient quantities of food (ie crop failure).

> *It was when we were sowing corn and peanut. I sowed like everybody, but after that we had a burning sun for three 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).

Cameroon appears to be experiencing the most diverse set of changes compared to the other countries; particularly Rwanda where change is more concentrated in the two most commonly cited issues. In Equatorial Guinea the issue of strong winds, resulting in damage to crops or other property, as well as crop raiding of agricultural fields by forest animals were quite important. In particular, crop raiding appears to be a major concern for the village of Kukumankok where 83% of the 23 mentions were recorded.

The group discussions revealed similar results with all countries describing at least 1 of the top 4 environmental issues of concern in each village being increasing uncertainty in predicting weather patterns, e.g. early/late onset of the rainy/ dry season, and/ or intensity of weather, e.g. 'torrential' rains and 'burning' sun (Figure 5). The second issue mentioned in all but Mang village (Cameroon) was that of crop failure due to pests, disease or reduction in soil fertility. Equatorial Guinea was the only country to describe the issue of crop raiding, expressed as the top issue of concern in Kukumankok and second in Atom, as well as animal disease affecting chickens. In the village of Mang (Cameroon), human disease was selected as the third greatest environmental problem, referring principally to changes in mosquito vector abundance – though the perceived mechanism for this change was not made clear.

Figure 5: Summary of the major environmental issues identified by group discussants.



4.2 How are people adapting to the identified environmental issues and what role does the forest play in these strategies?

Here we focus on household's response(s) to the environmental issues described above in particular comparing the ways in which households from different countries respond and the role that the forest plays in their responses.

As predominantly subsistence communities much of the discussion with groups and individual households revolved around a reduction in crop production and their efforts to reduce such loss. Historically households have coped with fluctuations in food production by planting different crop varieties, shifting sowing-harvesting

times, adding or modifying chemical and organic inputs, diversifying income to compensate for losses and most dramatically migrating to 'better' areas (see for discussion Maddison 2006, Thomas et al. 2007).

Perhaps because of greater constraints on land and in particular access to forested land, Rwandans described the greatest diversity of adaptations (Table 2). Increasing chemical and organic inputs was described by 71% of Rwandan households as a means of combatting plant disease and increasing yield. Responses suggest that households were acting largely in response to suggestions made by governmental agronomists or copying neighbours but generally lacked an understanding of the properties and uses of respective inputs. For example, several households described the use of fertilisers to combat pests. Rwandans also described considerable efforts to create waterways to channel rain water away from houses, to reduce potential damage to crops as well as to store water for later use.

> *We have tried to do communal activities of bringing back the soil in place that were damaged, we dug holes in our fields, we made stones fences around our fields and we have planted some plants that fight against erosion* (Kamiro, household 12).

The steep topography of the country is worth reiterating and likely drives the presence of this coping strategy in Rwanda as compared to Cameroon and Equatorial Guinea. Furthermore Rwanda was the only country to describe assistance from governmental initiatives or local cooperatives, or taking a government supported loan to purchase materials to cultivate a second time. The presence of informal institutions in Rwanda contrasts greatly with other countries; cooperatives and communal work (*umuganda*) were mentioned in over half (57%) of the Rwandan households as assisting, supporting or enabling adaptive strategies, with no mention of such organisations in Cameroon or Equatorial Guinea.

Table 2: Household responses to identified environmental changes.

	Cameroon	Rwanda	Equatorial Guinea
Use of inputs fertilisers or pesticides		X	
Erosion control (ie digging holes or planting trees or grass)		X	
Water storage		X	
Clear new plot (in forest)	X		X
Altering planting schedule	X	X	
Renting/ selling assets (eg land and livestock)	X	X	
Sharing surplus with neighbours		X	
Employment (farm labour)		X	
Small loans/ organisational support		X	
Reduce expenditures	X	X	

In contrast to Rwanda, the dominant coping strategy in Cameroon and Equatorial Guinea was the clearing of new land; this is quite simply not an option in the densely populated and highly constrained landscape of Rwanda. Rwandan households still recognise the indirect value of the forest, but differ rather significantly in their ability to directly benefit from it, as in the case of Cameroon and Equatorial Guinea. For example, there is a strong recognition of the importance of forest in preventing or reducing soil erosion, providing income through a revenue sharing program, regulation of temperature and rainfall, and provision of water during the dry season.

> *It* [the forest] *has benefit to protect us* [from] *the soil erosion because if the forest is not there, water destroys our crops and homes,* (Masasa, household 06).

> *It has always been hard to find water in the dry season, we fetch from the forest [Volcanoes National Park]* (Kamiro, household 13).

Household's use of forest products, regardless of environmental shocks, is widespread in Cameroon and Equatorial Guinea (78 and 100%). There was no indication that households utilise the forest differently during times of environmental stress with the exception of being able to clear land for agricultural production. Interestingly, however, the ability to find and access these resources is perceived to be reducing. All but a single household in Cameroon described a reduction in wild meat with 85% describing a reduction in non-timber forest

products (NTFPs) due to changes in human behaviour and population density, but also environmental change.

> *It* [the reduction in wild meat] *is caused by the hunting with guns. And also, in the past we were killing animals just for consumption; today, they kill them to sell* (Djalobekue, household 08).

> [NTFPs are reducing] *[b]ecause trees are producing less than before. There are years that they produce nothing. It is because of the perturbation of seasons and the strong winds. They produce well and when the wind comes all the fruits fall* (Mang, household 03).

> *It* [NTFP collection] *is more difficult to find now. One has to go very far in the forest to harvest them. The situation is gradually getting worse. Before nobody was interested in NTFP and we were not using them much in the village. Now that they are sold* [commercially], *everybody is interested in them and everybody is harvesting them in great quantities. That is the why they are more and more rare* (Mang, household 13).

Similar sentiments were echoed from Equatorial Guinean households where 56% of households described a reduction of wild meat, specifically of larger, hunter-preferred animals like duikers. The decline in these species is paralleled with a perceived increase in crop loss due to raiding by smaller species as well as a shift in hunting practices (described in greater detail below).

Despite the benefits of the forest, people equally indicated that it had costs. For example, crop loss due to raiding activities of animals from the forest was raised by households in all countries, including 43% in Cameroon, 59% in Equatorial Guinea, and 79% in Rwanda[1]. Similar to the decreases in meat and NTFP access, increasing incidences of crop raiding are considered to be the result of overhunting and clearing of the forest for agricultural production.

[1] The percentages reported here differ from those reported earlier where households were asked to describe 1-2 of the most important environmental issues concerning them. Here we report people's response to a question concerning the value, both positive and negative, of the forest to their household.

> *The cause* [of increased crop raiding incidence] *is the fact that there has been a lot of hunting and exploitation of the forest in that area* (Atom, household 01).

> *To see animals* [to hunt] *one has to go beyond 50 km. But rodents can be found beside the farms, approximately 2 km from the village* (Djalobekue, household 09).

Although not directly the result of climatic change, it is likely that these more localised anthropogenic pressures will further intensify the impacts of environmental change and, subsequently, rural communities' ability to cope with such change. In Equatorial Guinea, for example, households described the need to travel much further into the forest to find wild meat, spending more time away from home, whilst also balancing the need to protect their crops from raiding (forest) animals. Notably several households described a shift in their hunting practices to accommodate these changes by creating a series of small animal traps around their fields that are then consumed or sold.

> *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).

> *[T]he only hunting that I carry out is to protect my crops. This change has been gradual as there are not very many animals left, this is due to various slaughters which have caused various species to become extinct, therefore I prefer to just make traps around my plots* Atom, household 12).

Finally, people in Cameroon and Equatorial Guinea seem to have a much stronger relationship with the forest being more explicit in their value of the forest. For example a household in Cameroon described the forest as '*the mother of everything*' with another stating, '*If you take out the forest, we will die. I do not know how to explain this to you. We draw all from the forest, even the moral satisfaction'* (Djalobekue, household 02). Similarly, households in Equatorial Guinea explained, '*everything I have is from the forest'* (Atom, household 12) and '*my life is in the forest, I cannot live without it*' (Atom, household 19). In particular, the relationship of the forest appeared strongest in the Baka households where one respondent explained, '*When we live out of the forest, everything goes wrong for us*' (Djalobekue, household 14) and another that '*The forest is our god. The Baka is nothing without the forest. It represents everything for us*' (Mang, household 20).

4.3 How are land (and in particular, forest) management practices changing? And, how does the implementation of such practices influence communities' adaptation strategies?

Understanding current forest management practices are likely pertinent in considering the context in which potential future adaptations may occur. Similarly such an understanding may lend insight into the constraints or support that households may experience in their efforts to adapt. Forest management differs profoundly in Rwanda as compared to that of Cameroon and Equatorial Guinea based on the simple fact that communities live next to a protected area that prohibits all human activity. Rwandan households are broadly aware of the authority responsible for the forest's management (RDB) and generally accept and tolerate the authority. Despite household's acceptance of such restrictions there is evidence that this management is relatively 'new' with some household's describing former use of the park and an indication that this has affected income and food security.

> *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)

A further two households described the loss of land during the park's creation with one recounting a more penetrating loss:

> *There at the entrance of the park; it was the land of the community; RDB* [governmental management authority] *took 6 meters of our lands when they constructed that entrance. It seems that those 6 meters for all lands of the community are too much. We had enough harvest on that land, but nowadays it's no longer the case… [Park] guards say that trees are the property of the community, but if someone is caught there collecting grasses of the livestock or firewood, she is automatically getting punishments. We have not access on those resources, but they always say that these are your property. They don't remember that time when they took our lands; I'm telling you the truth, no one among the community is paid for those activities* (Masasa, household 08).

This statement is indicative of Rwandan's former use of the forest and perhaps more critically, is insightful into present day perceptions of the park and its associated

management authority that influences and (or) constrains people's responses to environmental induced change. Land confiscation by the Rwandan government in park formation and its associated impacts is explicitly acknowledged in the country's Biodiversity Policy (GoR 2011) that states,

> *In the creation of protected areas many communities were forcibly removed without adequate compensation. Furthermore, a "fences and fines" approach resulted in people being denied access to resources upon which they depended. Aggravating these circumstances is the fact that protected areas have remained inaccessible to the majority of the people, and are perceived to provide few benefits to them. These imbalances are well recognized, and are in some instances being redressed by conservation and other agencies.*

In particular the Batwa were negatively impacted by Rwandan park formation and, to date, have received little if any compensation or recognition for their displacement. Although our interviews did not capture any members of this population, we consider the repercussions of such treatment on the Batwa's ability to adapt to be rather significant as has been suggested by other studies on Pygmies people (e.g. Nkem et al. 2013 Baka, Bagyeli or Bakola and Medzan in Cameroon) and will return to such later in the discussion.

Turning to our other study sites, Cameroon and Equatorial Guinea appear to have similar de facto management practices whereby the forest is informally managed by village or clan leaders. Primary and secondary forests are further distinguished with the latter being informally owned through family inheritance or based on initial efforts to 'clear' the plot to enable the production of food crops. Access to the primary forest is very loosely regulated with peoples' access being tied to their village. In Cameroon we also inquired about the management of the community forests (CF) affiliated with each village. The Mpiemong CF is 5500 ha in size and shared between four villages including Mang. The Morikoualye CF is 5000 ha in size and shared between seven villages including Djalobekue. These areas are legally recognised by the Cameroonian government and yet over half of respondents were unaware or unable to describe what the community forest is. In fact only 28% of interviewed households understood that there was a community forest with 18% describing active exclusion in their participation in the forest. In particular a Baka household described broader limitations on access to the forest that suggests 'free access' does not exist for all village occupants.

> *People from the village and the whites prevent us from having access to resources in the virgin forest.* [Whites for the Bakas refer to all those that are neither Bakas nor from the village.] *The fact is that we are prevented from entering the forest to collect the products that we can sell to live here in the village. Without that law* [suggesting active removal from their preferred home in the forest]*, no Baka would have been found here in the village. We would have been all in the forest. So with that law, we are chased away from the milieu where we live with ease. I have no idea of what you call community forest. I do not really know what it is* (Mang, household 20).

The present structure of management practice – formal in Rwandan and informal in Cameroon and Equatorial Guinea may be modified under new management practices with the potential to exacerbate or reduce some of the inequitable access currently experienced by the Baka and loss of land in Rwanda.

Finally we explored current land use management practices and the degree to which changes in such practices would be received by households. In Cameroon and Equatorial Guinea there is generally good access by households to the forest and its associated products. There are also several logging concessions where management and access differs, though hunting remains possible. We asked households how they would be affected by an expansion of these concessions to which there was an almost unanimous positive response in Equatorial Guinea, with Cameroon being more divided – 35% responded positively in contrast to 60% negative. Equatorial Guineans responded positively with the exception of two households based on the expectation that they (or someone in their household) would receive employment and subsequent increase in income and quality of life. The two households that responded negatively cautioned against short-term benefits and long term, negative consequences:

> *Even if young people got jobs I do not support it* [expansion of the logging concessions] *because young people do not realise 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)

> *It would not be good, I hate exploitation, it causes a rise in heat.* (Kukumankok, household 19)

In Cameroon similar concerns were echoed if logging concessions were expanded citing a loss of available land, and loss of forests and associated resources for the present and future generations. People in support of logging concession expansion stated their promise to increase jobs, income and thus, material well-being. Such responses suggest that households are responding to an interest in obtaining greater financial security but tempered by their concern for maintaining their access to land and in particular, forests, and likely represents a trade-off that may become more divisive as forests decrease and (or) become less accessible to locals, e.g. due to increased management, protection or programmes like REDD+.

In Rwanda there are no logging concessions in or around the park, though there are a multitude of activities in the area to reduce soil erosion and efforts to increase agricultural efficiency. Recall that Rwanda's landscape differs from that of Equatorial Guinea and Cameroon in its being at higher altitudes with more variable topography. Soil erosion is a major issue over much of the Rwandan landscape as is agricultural efficiency on plots that are, on average, less than 0.76 hectares per household (ROR 2010).We focused in particular on the conversion of farmland to agroforestry and governmental control of crops being planted based on the potential and demonstrated impacts of these activities on household's ability to adapt to environmental change.

The majority of households felt that agroforestry would help their households based on its ability to reduce soil erosion, creation of a natural wind block for sensitive crops, lack of impact on crop production, and utility of wood source. The few that were less confident in agroforesty's utility were concerned about the compatibility of trees with their crops, worried that the trees remained the property of the community (as opposed to the government, see quote from Rwanda Masasa 08 above describing loss of access to 'public' trees), preference to plant grass that similarly reduced soil erosion and provided fodder for livestock, and concern that land size constraints would make it difficult to meet household food needs (i.e. competing space of trees and food crops).

In 2007 the government of Rwanda initiated the Crop Intensification Programme (CIP; MINAGRI 2008) that mandates the types of crops that may be grown in a given region and growing season (there are two main growing seasons in the year). There are a total of six approved crops through the CIP including wheat, rice, potatoes,

beans, maize and cassava; these crops comprised only 30% of the total national production in 2008 (NISR 2010) representing a severe reduction in the kinds of crops households are able to produce. In addition the way in which household's plant crops has been changed from a mixed- to mono-cropping culture. Fifty-seven percent (n=24) of Rwandan households reported that this programme resulted in hardship, predominantly hunger due to smaller crop yields, increased reliance on the production of a single crop and consequences of its failure. Furthermore even the people that 'accepted' the programme did so with serious reservations.

> *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).

People's reservations are perhaps well founded given that the government reserves the right '*to repossess the land if the owner or holder of the land rights has failed to use it in accordance with the law*,' (ROR 2004) and will surely influence what and how people plant in the foreseeable future.

5. Discussion

Our results corroborate the findings of many other studies from developing nations and more specifically sub-Saharan Africa that indicate households are struggling with environmental change impacts and in particular more erratic and intense weather patterns that directly affect crop yields and cause hunger (Maddison 2006, Fisher et al. 2010, Nkem et al. 2010, Sonwa et al. 2012, Nkem et al. 2013). Households in our study sites were relatively limited in their response to environmental induced changes, predominantly responding to short term shocks (e.g. drought/ flood events or crop pest outbreaks) and being more reactive than strategic (see for discussion of this tendency Ellis 2000, Smit 2000, Wunder et al. 2014). Rwanda appears to have a richer suite of responses perhaps in part driven by the loss of access to the forest and source of coping strategies, and greater governmental intervention and guidance. How these households will adapt to future increasingly more common environmental change remains to be seen, however, we offer a few insights based on our research.

A major distinguishing characteristic between the study countries is access to forest and its associated products. In Cameroon and Equatorial Guinea, households have a

more direct relationship with the forest, clearing it to create agricultural lands, collecting NTFPs, and a deep value or connection to the forest particularly reflected by the Baka households. In contrast, Rwandans are more distant or indirect users, recognising the forest's value in regulating climate and provision of water during the dry season, but otherwise restricted in their ability to obtain other items or access it. Furthermore, our interactions with Rwandans and familiarity with its history suggests that this mentality and emotional divorce from the forest is relatively recent with deep wounds only being superficially 'healed.' Specifically, in the 1990s the formation of the Volcanoes National Park resulted in a dramatic reduction in access to the forest for thousands of people and in particular forced displacement of households, many of which were Batwa. These households were moved without consultation or compensation (Huggins 2009). There were no Batwa households represented within our sample, though displacement was raised by two non-Batwa households and is indicative of the tensions between those that were displaced, the current park authority, and the effect on their livelihoods. Similarly, the content of the Baka's response in Cameroon to the value of the forest and suggestion of active discrimination by non-Baka (i.e. exclusion from the community forest), suggests that the ethnic minorities in these regions may face particular challenges, above and beyond that of non-Pygmies people, in adaptation to environmental change. Insecurity of land tenure, marginalization and disempowerment are likely to inhibit the capabilities to make active decisions on land use and livelihoods that underlie the idea of adaptive capacity (Ribot 2010, McDowell and Hess 2012).

Cameroon and Equatorial Guinea are also distinct from Rwanda in their recognition of community forests. There are no such forests currently present in Equatorial Guinea although the government has established a law recognising communities' rights to manage forest through the creation of a title '*bosques comunales.'* The benefits of these areas and ability to support communities' adaptive capacity are not yet clear but may be a vital step in ensuring that local people are able to capture benefits from programmes like REDD+.

Overall our data suggests that the forest *can* be both a short term coping mechanism (e.g. during crises of crop failure, clearing of new agricultural lands) and long term insurance (e.g. regulation of climate) against the impacts of environmental change. The degree to which this is possible appears to be driven by the availability and access to forest, as well as the rate of forest degradation and deforestation. Equally important there are likely to be trade-offs that may strain people's future ability to

adapt. For example, Equatorial Guinean households described a shift in hunting practices from the hunting of large ungulates and primates to one that traps predominantly smaller rodent species around agricultural fields. The implication is that former hunting practices of larger animals are no longer possible due to a decline in these species. Furthermore, people implied that crop raiding had become worse and so trapping around plots served a dual purpose – to prevent crop loss and as a meat source. Although beyond the scope of our study, the decrease in the size and type of animals being hunted is likely indicative of species depletion due to intensive hunting practices (Fa et al. 2000), the longer term impacts of which we have only a cursory ecological understanding.

Finally, our study demonstrates the difficulties of generalization about the potential role of forests in supporting adaptation and the importance of context in predicting forest's ability to contribute or constrain people's ability to adapt to environmental change. Rwanda is a country with very little remaining forest cover, a relatively recent history of forced exclusion from these forests, and increasing centralisation of agricultural production, i.e. CIP. In contrast, Cameroon and Equatorial Guinea have large tracts of forest under customary management, increasing trend of community managed forests, presence of extractive industries (i.e. timber and mining), and relatively little intervention or support from formal institutions. The interplay of these factors affects people's ability to adapt and perhaps most critically determines the role that the forest plays in this process. In particular the management of forests under REDD+ could have devastating consequences for rural communities if for example their management shifted to central control or the privileged few as is implied in the few people that were aware of community forests in Cameroon.

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