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Forest Livelihoods and Responses to Environmental Change in the Congo Basin: a situational analysis

Nicole Gross-Camp, Roger Few, Adrian Martin

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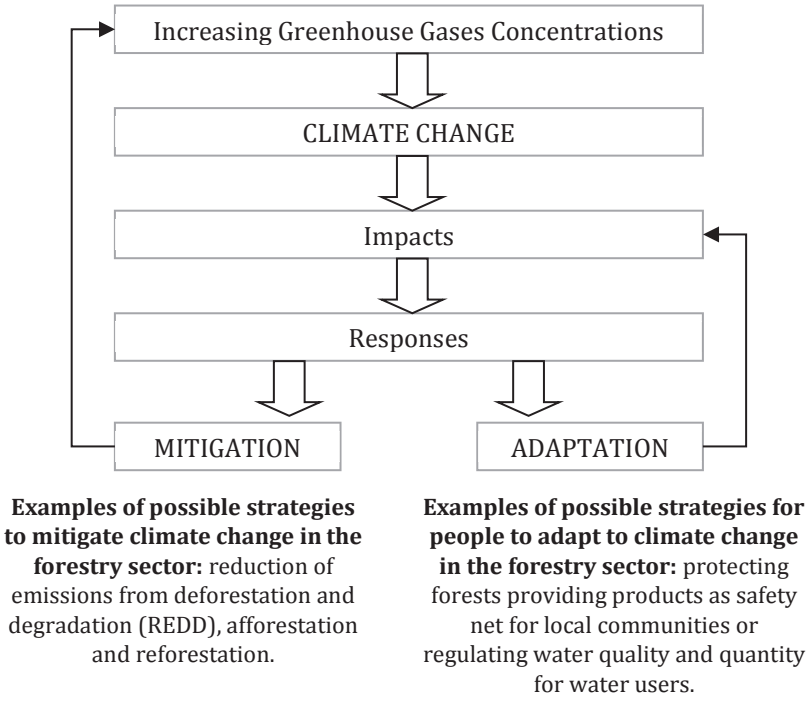
CONTENTS

1. Introduction and background

1.1 COBAM: Congo Basin adaptation and mitigation

The COBAM project was launched in 2010 to investigate the synergies and trade-offs between climate change mitigation and adaptation in forested areas of the Congo Basin.

Figure 1: Difference between mitigation and adaptation



Forest management is expected to contribute towards climate change mitigation through reductions in rates of deforestation and forest degradation and through net contributions to the terrestrial sink for absorbing carbon emissions. At the same time, the protection and enhancement of forest resources is expected to contribute to adaptation to climate change, through provision of coping strategies, including resources and income streams that serve as safety nets in the face of climate related difficulties; and also by reducing the intensity of events such as floods and droughts. REDD+ is an example of a policy intervention that seeks to combine mitigation and adaptation objectives. However, the COBAM research project recognized that there was little understanding of the relationships between forest-based adaption and mitigation, especially in the Congo basin, and that the development of policies such as REDD+ and National Adaptation Programs of Actions (NAPAs) will benefit from new critical research.

1.2 Project aim

The overall aim of this project is therefore to provide policymakers and practitioners with the knowledge and analysis that will help them to implement policies and projects with benefits for adaptation to climate change and reduction of carbon emissions in the forests of the Congo Basin.

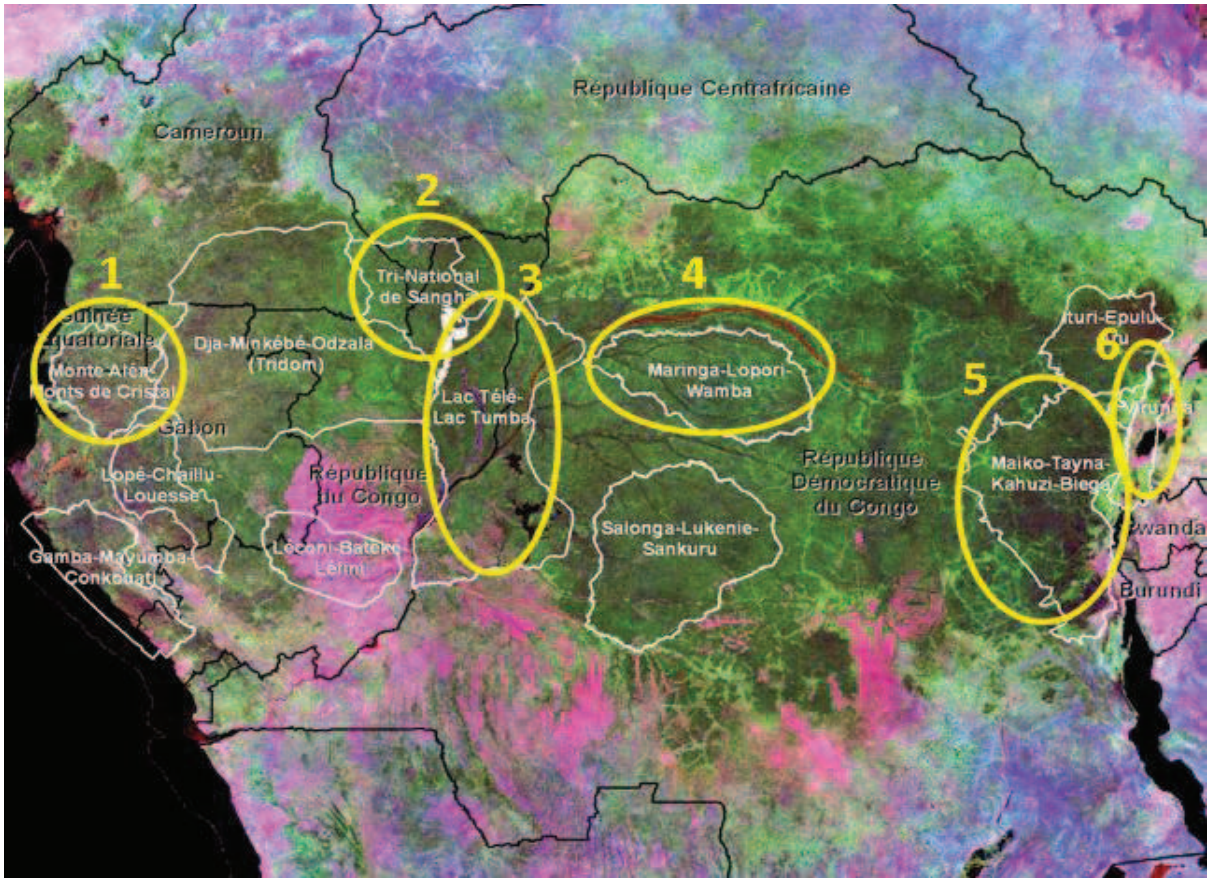
This report focuses on one of the objectives relating to this goal, namely to understand how forests contribute to adaptation to climate-related forms of environmental change. In order to do this we undertook research to establish a) what kinds of environmental change were perceived as most problematic by local people, b) in what ways had households responded to these problems, c) how forests and trees contribute to these responses and d) what are some of the constraints to forest-based adaptation and how might these constraints be affected – positively or negatively - by changes in forest policy and governance.

2. Methods

The COBAM project as a whole focused on the landscapes covered by the Congo Basin Ecosystems Conservation Support Programme (PACEBCo) (see Figure 2). This component of the research selected two villages in each of three landscapes. The Monte-Alan landscape of Equatorial Guinea (landscape 1 in Figure 2) , the Cameroon side of the Tri National de Sangua landscape (Landscape 2), and the Rwanda side of the Virunga landscape (Landscape 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.

Figure 2: The six landscapes selected by the Congo Basin Ecosystems Conservation Support Programme (PACEBCo) shown in the CARPE[1] map



We conducted semi-structured interviews with approximately 20 households in each of the six selected villages (N=121), and a single group interview with community leaders in each village (N=6). Households were randomly selected in Rwanda and Equatorial Guinea where no major ethnographic 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

[1] Central African Regional Program for the Environment, http://carpe.umd.edu/where-carpe-works/paysages

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 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.

3. Results

3.1 Overview of environmental issues: key informant group interviews

3.1.1 Cameroon (Djalobekue and Mang villages)

Environmental problems

The two villages appear quite similar in their prioritising of environmental change, describing high variation in the onset and intensity of the seasons that in turn affects crop and livestock health, water quality, and disease (human). It also appears that very little initiative has been taken by the communities, government or NGOs to modify or adapt to these changes. In Djalobekue, key informants described how the incidence of drought was increasing fire risk, reducing water quality – described as 'dirty' water, and the appearance of caterpillars that were impacting, in particular, cacao pods. Both communities mentioned the government's provision of mosquito nets along with some sensitisation activities which were generally described as 'effective'. Mang suggested that the incidence of malaria reported by the health centre had declined.

Both villages have approached government with their concerns of drought though nothing has been done – namely, Mang approached the farming service presumably as drought was impacting their livestock, and Djalobekue approached the division of agriculture. Mang indicated that the village had discussed emphasising their production of drought resistant crops including cassava and cocoyams, but later

indicated that a shortage of water was highly problematic for cassava production that relies on the use of water for soaking. Mang also mentioned the importance of medicinal plants collected from the forest in aiding disease control.

Table 1: Main Environmental problems and responses, Cameroon

Environmental problems	Consequences	Response
Drought/ Scarcity of water	– Increase risk of fire – Reduction in water access (rivers and bore holes drying) and quality ('dirty', mixing with animal faeces, disease transmission) – Death of livestock/ crops – Caterpillar infestation (cacao)	Community informed the agricultural division but no other action was taken (Djalobekue) The government apparently dug a bore hole for Djalobekue but it is no longer functioning. Consideration of crop modification to cassava and cocoyam but not implemented (Mang – see above concerning water and cassava production)
Heavy rains/ Flooding	– Crop rot – Disease transmission (malaria, cholera, measles)	Mosquito nets were distributed and apparently reduced malaria incidence (Cameroon)

Forest management and decision-making

Although neither village is near 'virgin' forest both have access to community managed forests. Djalobekue has two community forests one that is shared between itself and seven additional villages and another that is solely Djalobekue's, whereas Mang shares its forest with two other villages. Community forests are managed by a Common Initiative Group (CIG). In Djalobekue it was said that the CIG is comprised of two representatives from each village that are elected in the general assembly. It appears that these forests are very loosely managed; there is no control over the collection of NTFPs but formal petitions for the cutting of 'big' trees are supposed to be made to the division of forests and wildlife.

Environmental interventions

Both villages state that they have no environmental projects active in their areas.

3.1.2 Equatorial Guinea (Atom and Kukumankok villages)

Environmental problems

The two villages appear to face similar problems with slight differences in the order of prioritisation. Crop raiding and greater inability to predict rain patterns figured high in both villages but with no description of behaviour modification, adaptation or intervention from NGO or governmental organisations.

Table 2: Main Environmental problems and responses, Equatorial Guinea

Environmental problems	Consequences	Response
Low rainfall/ late arrival of rains/ torrential rains	- Death of crops in the fe bikuan - Damage to property	Modification of construction practices using barriers and large bolts. When flooding does occur, villagers assist one another to repair the damage and/ or scoop water out.
Crop raiding	- Not a new issue and one that appears to affect most people - Crops are eaten by forest animals	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.
Wind storms	- Damage to property and crops, e.g. blowing over banana and cassava - Appears to be a new problem increasing in occurrence and intensity	People help one another through repairing damaged property.
Crop pests/ disease	- Death of crops	There is no strategy or modification but Kukumankok indicated that women in particular 'help each other out as they are the ones that plant crops.'
Animal diseases (only Atom)	- Death of chickens in particular - Not a new problem but one that appears to be happening more often (used to be an issue only in the summer)	No response

Forest management and decision-making

Kukumankok described the various types of forests (*afan*) including *bikoro* (singular *ekoro*), *mbut afan,* and *ngom afan.* The term *Afan* generally refers to forest, but it is also associated with a single village with communal limits recognised by other councils. Boundaries are respected meaning that someone from a neighbouring *afan* cannot enter without the permission of the customary council owner. Collection of food in a given *afan* is permitted for any household within the village but cutting of trees is not.

Within the *afan* are *ekoro* that are owned by individual households. Generally *ekoro* are passed along through inheritance although people with large *ekoro* sometimes give to individuals outside of their household. The *ekoro* is created in inactive secondary forest through clearing of trees and is the area where most of a household's foods are produced. Access to *bikoro* is through the individual or household that owns it.

The *mbut afan* is a forest in transition between *bikoro* and *ngom afan* (dense or primary forest). Only yams and cane (sugar) are planted in this kind of forest. Finally, *ngom*

afan is a 'free' forest where everyone has access –this is primary or dense forest. Atom mentioned the role of the government in managing the dense forest (*ngom afan*) in conjunction with the village, indicating that they would prefer greater independence from the government, implying that there may be some conflicts arising from this kind of joint management.

Environmental interventions

Both villages state that they currently have no, nor have they had in the past, any environmental projects in their areas.

3.1.3 Rwanda (Kamiro and Masasa villages)

Environmental problems

The two villages are similar in their prioritisation of environmental change and like Cameroon broadly focus on the impacts of increasing variation and intensity of seasons. Heavy rainfall is considered to most affect people with land near the forests and in valleys. Soil erosion is mentioned though we suspect communities are describing intense rain fall and flash flooding leading to gullying and landslides. The Rwandan Red Cross provided household materials and the Ministry of Disaster Management tiles for roofing to affected communities in Kamiro, with communal work days (*umuganda*[2]) assisting in the repairing of the road. Households that were less affected also took in others that had lost their homes or similar. In Masasa, it does not appear that much was done though a household that lost a child (to drowning?) was supported financially and socially by the community and even called to the District level (though it is not clear what was done for them there). There is also mention of a bridge "being built on that waterway" but it is not clear what impact this has made on the village.

Soil fertility was raised as an issue by Masasa only but implicates the introduction of chemical fertilisers in 1990 as a driver of such change – *It started in 1990, because of the chemical fertilizers when it arrived here. As time passes, the soil become more infertile and requires expanding more fertilizers.*

Table 3: Main Environmental problems and responses, Rwanda

Environmental problems	Consequences	Response
Drought/ Scarcity of water	– Crop loss – Due to governmental land consolidation programme all people were affected (Kamiro)	No support provided.

[2] For a basic definition see: http://www.rgb.rw/main-menu/innovation/umuganda.html

Heavy rains/ Flooding	– Flash flooding and gully formation/ soil erosion – People in valleys and near forests most affected	Red Cross provided household materials, the Ministry of disaster management provided tiles for roofing, communal work repaired the road, and other able households took in others most affected (Kamiro). Only a single household that lost a child (due to drowning?) was supported by the community and District. A bridge was built (Masasa)
Soil Infertility	– Lower and irregular yields	Agronomists encouraging an increase in chemical and/ or organic fertilisers. Use of manure facilitated by confinement of grazing animals. *Girikna munyarwanda* 'One cow, one family' programme targeting poor households with a cow.
Plant disease	– Crop loss – bacterial wilt and potato blight – People with small lands most affected	Use of Dithane (growth stimulant) & Thiodan (an insecticide) for Irish potatoes. Agronomist advises to pull affected plants and rotate crops.

Forest management and decision-making

It was stated that there are government managed woodlots in both villages that require permissions from the Cell, Sector and District (social and development officer) levels in order to cut trees. Kamiro describes the process as cumbersome and indicates that a harvest of timber in one lot impacts the ability to harvest in a neighbouring lot that may be owned by another individual(s). We believe this may be referring the forest rented or leased out by community members from the government, i.e. agricultural areas abutting the PNV.

Masasa indicates that a major problem for the community with the Volcanoes National Park is crop raiding of animals without compensation from authorities, whereas Kamiro describes the collection of several forest resources including wood, water and meat in the park. In particular, Kamiro states that collection of water from the park in the dry season is 'very difficult' and suggests that the park instead purchase water storage tanks for the community. [Note: the International Gorilla Conservation Programme indicated that collection of water from the park is in fact illegal. 'Offenders' are logged by RDB but not prosecuted, which suggests RDB's tolerance of water collection. IGCP has also been building a series of rain water storage tanks (see: http://www.youtube.com/theIGCP) in an effort to meet communities water needs as well as reduce their activity in the park based somewhat on concerns for human-gorilla disease transmission].

Environmental interventions

Each village has some environmental projects working in their area – Masasa has an association called *Turengere Ibidukikije Kabatwa*[3] – Protect the environment Kabatwa and Kamiro describes a tontine, aimed at development and reducing human activity in the park, and Karisimbi Cooperative that is comprised of ex-poachers and designed to improve relations between the community and RDB (management authority), reduce human activity in the park, and report on crops destroyed by wild animals.

Both villages describe digging holes for water capture as something they could do to address environmental problems. Kamiro also mentions planting of grasses and trees and adoption of crop rotation to reduce plant disease. It is difficult to imagine how this would be implemented based on land constraints and heavy reliance on a few crops.

3.2 Material and Subjective Wellbeing

Respondents mentioned the following influencing factors when asked to reflect in general on their material and subjective wellbeing including:

Table 4: Factors expressed as effecting wellbeing

	Cameroon		Rwanda		Equatorial Guinea	
	Djalobekue	Mang	Kamiro	Masasa	Kukumankok	Atom
Health	6	4	3	5	6	3
Livestock		2	6	4		
Land			4	3		
Death of a spouse	1	1	4	6	2	3
Death of child(ren)	3	4				3
Death of other family member	2	4			5	5
Marriage	3	7	2	5	1	7
Children/ family	6	9	3	3	1	12
Material needs (eg food, basic toiletries)	5	1	1	5		
Work/ employment	9	6	1	1	1	6
Crop production/failure	13	15	11	3	1	4
(associated with weather patterns)	3		7			
War			2	10		
Imprisonment of spouse		1	2			1
Government programmes: - **Crop consolidation**			1	1		

[3] This association is composed of people from Kabatwa Sector and is an open membership. Its main activity is to protect the park against people who illegally go inside it reporting this to the management authority, RDB. They also coordinate activities to combat crop raiding by wild animals. RDB supported the association through the revenue sharing scheme associated with the National Parks System by giving them cows. As the sector is big, I think there is Kabatwa 1 in one part and Kabatwa 2 in the other part.

God	**2**	**1**	**2**	**1**		
House	**3**	**3**		**2**		
Education	**1**	**6**		**1**		
Bride price	**3**	**3**				
Funeral costs	**3**					
Instability of government					**2**	**1**
Money					**1**	**8**

In **Cameroon**, 'employment' often involved employment by the timber extraction industry or collection and sale of NTFPs. Children's deaths were mentioned as an area causing great disturbance to one's wellbeing. An extreme example comes from household D04,

> '*I have passed through so much sadness in my life because of the death of my children. I have only 2 children out of the 14 we gave birth to. So, I always live in tears.*'

Bride price featured in Cameroon only, mentioned in six households including Dja 13, 18 & 19 and Mang 02, 08 & 17, in particular as a major financial obstacle hindering wellbeing. For example, M08

> '*What is disturbing me now is to pay the bride price of my wife. When I will do it, I will be able to concentrate myself and have money to treat my cacao farm.*'

A couple of Cameroonian households made statements indicative of the importance of children (in particular a woman's ability to have children) that are worth highlighting. In M16 the man describes the 'wilful' leaving of his first wife because she was unable to have children. He states,

> '*In 2008 when my first wife left, I was very sad. I loved her so much. It was as if I was dying, and as if I was living my mother's death for the second time.*' He continues to describe how, '*With time, the support and advices of other villagers the situation has improved. I have become more mature and I am living happily with my second wife and my children,*'

suggesting that societal pressures led his first wife to leave and for him to take a second, fertile partner. Respondent M19 describes his subjective wellbeing entirely based on the arrival of his first child,

> '*From 2004 to 2011 I was very unhappy and life had no meaning for me because my wife could not conceive and give us a child. The situation has changed now. I have already 1 child and I am very happy with my household.*'

In **Equatorial Guinea** we only assessed subjective wellbeing. Many respondents described the importance of family and the impact of loss of a family member on

their happiness. Two households described themselves as 'never being satisfied' with their lives. Aging and an increase in responsibility particularly following the death of parents also appears in the transcripts.

In **Rwanda** and particularly Masasa, several households stressed the loss of a spouse often due to war (Kamiro 02, 05, 08 & 12 and Masasa 01, 03 ,04, 10, 19 & 21). For example,

> *'I've never been satisfied with my life. At time of my household formation with my husband, we didn't have any good life/ livelihood apart from take births of our children. After my husband passed away, our livelihood became too bad because I have no longer someone else to help me*,' (K02)

> *'I was most satisfied with my life before the 1994 war because we used to harvest enormous amount of crops and we still had all our things. I was less satisfied with my life after the 1994 because we became poor, and I have lost my husband.'* (m10)

This reflects a more general post-genocide context in Rwanda, in which agricultural productivity is only now starting to get back to pre-1994 levels, and families are looking forward as well as backwards.

> *'I got married in 1981, I lived with my husband who died in 1997, I remained with my children. In 1994 we fled to Congo with our children, and when we returned, a war broke out, and one day the militia infiltrators came to our home, they wanted food, and my husband refused to obey their order, and since he was a local leader he was taken by force and got killed. Since then I suffered but now that my children are grown up I feel happy and secure*.' (M19)

3.3 Socio-environmental histories of change: understanding adaptation behaviour

We explored environmental change in two stages. In this first stage we elicited household observation of changes across a range of resources and conditions. This served as a preparatory stage before seeking to identify those environmental changes that were considered most significant and exploring how households were responding to these. The time period for reporting change was the period since household formation so this varied from household to household. Whilst this makes comparisons more difficult, it enabled histories to begin from a highly memorable and personal starting point, generally the respondent's wedding.

3.3.1 Land access

Changes in access and use of land varied across the three countries as shown in Table 1.

Table 5: Reported changes in amount of farmed land.

	Cameroon (N=40)	Rwanda (N=42)	Equatorial Guinea (N = 39)
Land decreasing	4	12	12
Land no change	5	7	24
Land increasing	23	23	3
Totals	32	42	39

Reasons for decreasing land access also varied across households and countries. In **Cameroon** only four households reported a decrease of land. This was described as a choice for one household (DO5) that was having problems with theft from their farmland and decreased the amount of land for greater control and due to age. But for another, female-led household, loss of land was forced:

> *When [my] husband died they chase me away from the land we had because women cannot inherit their husband's lands. The only land I have now is the one my parents gave me before they died* (M20).

The location of land use was also changing for some, with two Cameroonian households stating that they were working plots further from their homes because soil was better and there were less problems with crop diseases. In **Equatorial Guinea** nearly a third of households reported decline in farmed lands. Of the small number who explained this change, two households indicated that it was primarily due to old age. Six of the households indicated that they are working plots closer to their homes. In **Rwanda** a decrease in land was largely associated with population increase and lack of opportunity to extend farming. In particular, households reported land declines arising from inheritance and division of land to pass down to children. Additional reasons given were need for money due to illness in the family, family migration. As we found in Cameroon, two female led households (both widows) also experienced a sharp decrease in land due to being chased away by in laws (M01). More complex stories also existed, for example:

> *'At the formation of my household we had 10 plots of land. After the death of my husband, one of our neighbours said that my husband gave him 4 plots before he died, and this person took the 4 plots. As I have two married sons, I gave to each 1 plot, and this means that currently, I am remaining with 2 plots'*, (M21).

In both Cameroon and Rwanda a majority of households reported rising land holdings. There is a notable difference in how this expansion is occurring with several households in Cameroon indicating that they simply occupy the 'virgin' forest that no one owns (eg D18), with six households in Dja and 5 in Mang indicating expansion of lands through cutting of the forest. By contrast, in Rwanda people are predominantly buying land or inheriting smaller chunks. In Masasa village for example, 5 households reported land expansion as a result of inheritance and 8 through purchase. Inheritance was also common in Cameroon with 6 households in Dja and 4 in Mang reporting this as a mechanism of land expansion.

3.3.2. Livestock

Table 6: Livestock reduced since household formation

	Cameroon	Rwanda
Livestock decreasing	27	17
Livestock no change	5	5
Livestock increasing	5	18
Totals	37	40

A total of 44 households indicated a decrease in livestock since household formation, Cameroon (Dja 13 and Mang 14) and Rwanda (Kamiro 10 and Masasa 7). In Cameroon, the reasons for the reduction were said to be disease (Dja 13 and Mang 10) and theft (Dja 7 and Mang 5), with other reasons including death due to wildlife (2), need to cover the costs of health care (1), gifts (2), and funeral fees (1).

In Rwanda, reasons stated were war-related loss (5), disease (1), sale to support sick family members (1), theft (1), marriage costs (1), and school fees (1). One household also described having to reduce the number of cattle he had due to the government's implementing a law that all cattle be confined: '*Since our household formation, 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*,' (Masasa12).

<u>Livestock maintained since household formation</u>

There are 10 households that have maintained their numbers of livestock, Cameroon (Dja 3 and Mang 2) and Rwanda (Kamiro 2and Masasa 3). Although these households are described as maintaining their livestock this does not mean there was no churn in stock through time. In Cameroon, for example, some of these households lost animals through disease (4) but other animal populations had increased, offsetting their loss. In Rwanda households described selling surplus animals to purchase land. Three households had never owned livestock.

Livestock increased since household formation

There were 23 households that described an increase in their livestock since household formation, (Cameroon - Dja 2 and Mang 3) and Rwanda - (Kamiro 10 and Masasa 8). Whilst this suggests that perhaps Rwandan households are faring better with livestock, a closer inspection shows that the majority of these households had no livestock at the household formation, Kamiro (8 of 10) and Masasa (5 of 8). Of these households, five were beneficiaries of government or NGO programmes that gave them livestock. In Rwanda the "Gira inka munyarwanda," (One cow per family policy) targets poor households and was reported in four households, although only one of these had no livestock at household formation. The other three lost or were forced to sell their livestock due to insufficient income and were given a cow to help improve their lives. In contrast, only one household in Mang described having no livestock prior to household formation.

3.3.3 Water in dry season (Cameroon and Rwanda only)

We asked respondents how they perceived the change in dry season availability or water over time.

Table 7: Water availability, Cameroon and Rwanda

	Cameroon	Rwanda
Water decreasing	20	5
Water no change	6	24
Water increasing	2	9
Totals	28	38

Water availability decreasing in the dry season

There were a total of 35 households that reported a decrease in water availability, the majority of these in Cameroon (Dja 14 and Mang 16) and a smaller proportion in Rwanda (Kamiro 2 and Masasa 3). In **Cameroon**, water shortage appears to be a continual issue but has reported to be worsening from 2000 on (although the start date for decline varies a lot from household to household – some report 2002, 2004, 2007, 2008, 2011). Households indicate the impacts of this have been declining water quality, increased disease transmission and the need to travel further to find water. There are few causes for this change mentioned other than God and strong sun, and respondents did not report adaptive behaviours, although three households mention the more recent access to a priest's well – see M06, 15, & 16. In **Rwanda,** the few households who report a decline in water during the dry season describe the causes as population growth and limited sites for collection (K12). This in part reflects the local geology of the region, in which much of the water running off the volcanoes

flows underground as it leaves the National Park, before surfacing again at lower altitudes.

Water availability no change

There were 30 households that reported little or no change in the availability of water in the dry season, Cameroon (Dja 5 and Mang 1) and Rwanda (Kamiro 15 and Masasa 9). Four of the households in Dja mentioned a spring that never dries but 2 households described it as very far from their homes. In **Rwanda** it appears a perpetual issue and one that has not changed through time. Households report spending a lot of time searching for water often having to travel very far into the forest or another cell. Eleven households reported collection from the park during this time. Three Rwandan households described some adaptive behaviours with two capturing rain water K06 and M09 and one using water piping as a result of government intervention by RDB (M11).

Water availability increasing

Eleven households reported an improvement in water availability, Cameroon (Mang only 2) and Rwanda (Kamiro 1 and Masasa 8). In Cameroon, the Mang households reported an improvement based on a new well dug by the State. In Rwanda, 6 of the households described a piping system (as above) that made water more accessible and 2 reported construction of water storage by plastic sheets, M10 & 12.

3.3.4. Firewood (combined with construction wood in Cameroon only – not asked in Equatorial Guinea)

Table 8: Firewood availability, Cameroon and Rwanda

	Cameroon	Rwanda
Firewood decreasing	32	16
Firewood no change	6	16
Firewood increasing	0	3
Totals	38	35

Firewood decreasing in availability

A total of 48 households described firewood as decreasing in accessibility, Cameroon (Dja 15 and Mang 17) and Rwanda (Kamiro 6 and Masasa 10). In **Cameroon**, the causes of such a shortage are predominantly cited as population growth (12) and the cutting of forest for farm creation (17), resulting in much greater distances to find wood (18). One household in Dja described the influence of a company closing, job loss and surge in the local population,

'*Before 2002 many youths were working in forest exploitation companies. In 2002 the companies stopped functioning and many youths who were staying and working there came back massively to live in the village. They then cut a lot of wood to build their houses. Since that period to have wood became so difficult and we now have to go very far in the forest to find it*' (D14).

Another household in Mang, described poor governance,

'*It is now difficult because 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 less wood for our own construction*' and implies corruption, '*This option* [villagers use of 'waste' wood in forest concessions to build] *has never been taken into consideration because the site's chiefs usually give money to the village chiefs so that they can keep quiet and let things continue the way they are now*' (M14).

In **Rwanda** several households attributed the decline in wood directly to greater restrictions to the park, Kamiro (2) and Masasa (8) – leading to greater pressure to purchase wood (4 and 5, respectively). Other reasons cited for the decline were population growth (1), charcoal production (1), and decreasing access to waste wood

'*Firewood got harder and harder to find, because before she would collect what she needed from other people's forest but nowadays no one lets her do that anymore,*' M01.

People also describe a sort of escalating problem beginning with restricted access to the park, need to purchase wood, lack of plantation wood and an increase in the cost of wood. For example,

'*Access to firewood is now harder, because a long time ago they used to fetch firewood from the park, and even the price of a tree was very low, just 2000fr, but now it costs 5000fr, and a mature one for timber costs 30,000fr,*' (M09).

<u>Firewood no change in availability</u>

Twenty-two households reported no change in the availability of firewood, Cameroon (Dja 5 and Mang 1) and Rwanda (Kamiro 8 and Masasa 8). There is a stark contrast between the reasons given by country with the majority of Rwandans stating that 'they have their own forests' (Kamiro 7 and Masasa 6), meaning that they use fuelwood plantations on private lands, whereas Cameroonians describe continued access to the natural forest even if it requires travelling a little bit further. One household in Masasa (02) stated that in 1974 they collected wood in the park but

now (2012) they have their own woodlots, suggesting that perhaps there was a period of difficulty but it has subsequently passed.

Firewood increased in availability

Only 3 households reported an increase in firewood availability – all in Rwanda, Kamiro 2 and Masasa 1. In Kamiro households reported that they had recently purchased forested land and the other that their forest was reaching maturity. In Masasa the household attributed the increased availability of wood to the decreased demand for wood due to an improved (more fuel efficient) stove.

3.3.5 NTFPs availability and use (Cameroon and Equatorial Guinea only)

Table 9: NTFP availability, Cameroon and Equatorial Guinea

	Cameroon	Equatorial Guinea
NTFPs decreasing	35	8
NTFPs no change	0	11
NTFP highly variable	0	8

There were 43 households that stated a decrease in NTFP availability – Cameroon (Dja 17 and Mang 16) and Equatorial Guinea (Kuku 7 and Atom 1). In **Cameroon**, the predominant reason appeared to be an unreliable production, ie some years the crop would be produced whilst in others it would not. The creation of farmland (5), God (2), sorcerers (1), climate change (1), being sold too much (10), outsider demand (4) and even competition with forest animals (3) were also cited. NTFPs in Cameroon include bush mango (18 households), caterpillers (4), djansang (3), djembe (9) and koko (35). Koko, *Gnetum africanum*, is a forest liana that apparently forms a large component of the diet in Cameroon. In **Equatorial Guinea**, there is a tie between NTFP availability decreasing (or being highly variable) and 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.

Medicinal plant use occurs in all countries – Cameroon (Dja 7 and Mang 10), Rwanda (Kamiro 14 and Masasa 14), and Equatorial Guinea (Atom 1 and Kuku 9), though many households in **Rwanda** indicate that the plants are cultivated around the home and less relied upon now that access to health care has improved.

3.3.6 Bushmeat (Cameroon & Equatorial Guinea only)

Table 10: Bushmeat availability, Cameroon and Equatorial Guinea

	Cameroon	Equatorial Guinea
Bushmeat decreasing	32	22
Bushmeat no change	0	10

In **Cameroon** a total of 32 households described a change in bushmeat access all of which indicated a decreasing trend – Dja 14 and Mang 18. The main reasons given for such a decline were a combination of population increase, the use of guns in hunting (14), and a shift from hunting for household consumption to hunting for sale (10) in particular by outsiders (10). Such changes in hunting practices are described by the following four households:

> '*People are killing too many animals now. Everybody in the village do hunting. It is no more the responsibility of household heads as before. More to that, people also come from town to kill great quantities of animals and carry them along' (D20)*
>
> '*The population has increased and people are hunting more. I remember that when we were kids only parent were going hunting. Today even youths set traps' (M03)*
>
> '*Before the youths were not setting traps. Hunting was reserved to parents. Today everybody hunt; the young as well as the old. There is also the arrival of weapons' (M10)*
>
> '*Before we were not many in the village and people were using local means to hunt and according to the needs of the family. Since the year 2000 till today some people have even abandoned farming just to hunt and sell. Now people hunt days and nights to eat en sell. How will the meat not reduce with all that?' (M18)*

In **Equatorial Guinea,** twenty-two households described bushmeat access as declining, with loss or notable decrease in several species including the giraffe and duiker species, as well as other names in Fang (including nvin, viong, nkeba, ndjip, ebio, mibiri, sho, mieing and nkaa). Five households described the decrease as a result of overhunting and general increase in hunting activities. Five households also described an increase in the distance needed to travel in order to find animals. Interestingly the nature of hunting is described as changing due to the intensity of crop-raiding. For example,

> '*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*' (A09)
> '*Previously it was available but nowadays it is not because the 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*.' (A12)

3.3.7 Rainfall

Table 11. Perceived changes in rainfall

	Cameroon		Rwanda		Equatorial Guinea	
	Djalobekue	Mang	Kamiro	Masasa	Kukumankok	Atom
*Mixing of seasons/ unpredictable	16	20	14	10	15	18
No change	3	0	0	0	2	3
Decreasing rain	2	4	0	3	0	0
Increasing rain 'shorter but more intense/ heavy'	3	8	19	16		

* Mixing of seasons or unpredictability of rainfall was often cited in addition to a general statement on rainfall, e.g. rainfall is falling more intensely but is generally unpredictable. For this reason, totals in this table are not possible as rows are not mutually exclusive.

Broadly speaking, rainfall is reported to be less predictable and falling in more intense bouts but for shorter periods in all countries. It would also appear that there is a general agreement that this trend towards shorter, more intense, and less predictable rains became noticeable in the last few years. One household in **Cameroon** indicated an inability to utilize wildlife signs for planting purposes suggesting disruptions to ecological processes.

> '*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,'* (D08).

In **Rwanda**, two major events are highlighted in the transcripts: 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 potato harvests. The unpredictability of the rains (and dry periods) has similar consequences in the respective countries including disruption to planting, the need for multiple sowings (due to crop failures or heavy erosion), reduced crop yields and destruction of property; problems due to erosion was more intense in Rwanda. For example:

> *'It rained very heavily and extended the normal period. We had to add more and more dithan* [Dithane is a growth stimulant] *a chemical we add in the rain season to harden the leaves so that they don't get damaged by the rain. However the rain was very intense and 4 of my plots were badly destroyed by the water from a freshly formed ravine. Farms of sorghum and tea in Byangabo were flooded and now the area is a lake. . . The rain eroded my farms, and broke the wall of my home,'* (K15).

'Most of the time now, the raining season extends and occupies 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,' (D11).

3.3.8 Temperature

Table 12: Perceived changes in temperature

	Cameroon		Rwanda		Equatorial Guinea	
	Djalobekue	Mang	Kamiro	Masasa	Kukmankok	Atom
Temperature increasing	1	1	15	16	15	12
Temperature no change	3	4	2	2	4	8
Temperature decreasing	14	10	3	2	0	0
TOTALS	**18**	**15**	**20**	**20**	**19**	**20**

Temperature increasing

In Rwanda and Equatorial Guinea, 74% and 69% respectively felt that temperatures had been steadily increasing; this compares to only two households in Cameroon. There was considerable variation in households perceptions of *when* this change began with no clear consensus; households stated the change began as early as 1976 and as late as 2011 in Rwanda, and between 1995 and 2013 in Equatorial Guinea. One Rwandan household commented on a change in temperature patterns:

'The temperature has increased, because children no longer put on sweaters. However the summers are cooler than before. They can't remember well when it all started changing' (M09)

A similar pattern is echoed in more households in Cameroon (see below in 'Temperature decreasing'). Three Rwandan households and one Cameroonian (D15) indicated that this increase in temperature is the result of forest loss with one also stating its effect on increasing disease prevalence.

'The temperature has increased significantly. 30 years back this region was very cold and there were no diseases, because there were more forests. These days it is warmer and malaria increased.' (K19)

Temperature no change

Eleven households (Cameroon 7 and Rwanda 4) stated no perception of change in temperatures.

Temperature decreasing

The majority of households in Cameroon felt that temperatures have been getting progressively colder (60%) in contrast to only 5 households in Rwanda (12 households). Similar to Rwanda, there was considerable variation in Cameroonian household's perceptions as to when this trend began, spanning from 2000 to 2010 years ago. Households considered this change as disruptive to certain practices including the drying of cassava (D12 & D13), increasing disease prevalence (3 households), and preventing households from entering the forest in the morning (4 households).

> *'It is giving much fever to our children and us. We cannot go out very early in the morning or in the evening to look for what we need for the household. The entire village is suffering from that situation,'* (D18).

> *The temperature has changed a lot. At times everybody go to sit under the sun because of the cold in our houses. Even under the sun, the wind blows and we feel cold. We cannot understand what is happening now. It is colder than before. The situation is worst early in the morning, above all for us to go very early in the forest to collect products and check our traps,'* (D13).

Three additional households in Cameroon qualified the changes in more detail suggesting that there is greater daily fluctuation in temperatures than a simple 'increase' or 'decrease' comment explains. For example,

> '*Now it is very cold in the night and very hot during the day during the whole year. Periods of heat are longer. And generally it is either very hot or very cold. We cannot understand anything again,'* (MA11).

> '*Temperatures are funny now. When it is cold we are forced to remain beside the fire because the cold is excessive. When the heat comes it is extremely hot and we are forced to run to the forest. There is no good side. 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,'* (MA20).

3.3.9 Wind (Equatorial Guinea only)

A total of 25 households described the winds (often associated with severe storms) as increasing in intensity as early as 1990 and early 2012. Twelve households described no change.

3.4 Exploring Adaptive Behaviours

Having reviewed this wide range of changes perceived by respondents we then asked them to select two environmental issues that they considered most important. These were then pursued in more detail in the remainder of the interviews. The table below summarises the issues selected and frequency of selection across the six sites.

Clearly the perceived change in weather patterns is of widespread concern for all countries and their respective villages but it is noticeable that a more diverse set of issues comes up in Cameroon as compared to Rwanda and Equatorial Guinea. With few exceptions, Rwanda focussed on two environmental change issues – crop failure and changing weather patterns. This is perhaps not surprising given the lack of access to forests in Rwanda and the corresponding dependence on farmland resources.

Table 13: Environmental problems selected as most important

	Cameroon		Rwanda		Equatorial Guinea	
	Djalobekue	Mang	Kamiro	Masasa	Atom	Kukumanok
Crop failure (due to pests or weather), reduced soil fertility (as evidenced by a harvest)	5	8	14	10	7	4
Animal disease	4	2			3	4
Change in weather patterns, mixing of seasons, drought/ heavy/ late rains	9	14	25	22	13	
Reduction in NTFP access (D11/Mang11)	4	3				
Change in temperature	5	2				
Reduction in water access	3	1				
Strong winds	1			1	7	4
Landslide (K5)			1			
Reduction in wood access		2		1		
Changes in vegetation (Masasa12)				1		
Crop raiding					3	20

In **Cameroon**, the mixing of seasons/ change in weather patterns is said to be resulting in a reduction in crop production and ultimately, hunger and income loss. Some households have tried replanting but without success. '*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*, Dja09.' Income loss seemed to be compounded by an increased difficulty in accessing the urban market due to the road becoming impassable, and a cascade of 'tightening the belt' activities such as stopping children attending schools (due to lack of school fees).

A reduction in crop productivity was responded to by several households by abandoning the parcel and 'clearing' elsewhere; though household's were not explicit in *where* they would clear, we strongly suspect that this was a direct reference to clearing of the forest. Plant diseases were said to be a particular problems for cassava and cacao, resulting in a reduction in crop productivity and harvest. Households stated that they shifted their diet eating more yams, but that this decline generally resulted in a loss of income and the need to reduce expenditures on household items and children's school fees. Like that of reduction in crop productivity, households identified shifting their cultivation elsewhere as a potential means of reducing such loss.

> *'When time comes to harvest cassava, tubers are thin, with small animals stuck on them. At a certain moment leaves are twisted and the stems dry up. I do not know what causes this disease. I soak cassava tubers and I sell lit to send my children to school. This year 2 of my children did not go to school. It disturbed me a lot to see my children not attend school. I did not carry out any action, and nobody did it. What we should I done was to abandon the parcel and farm elsewhere. It is what I will do during this coming cultivation season*, D06'

A reduction in NTFPs (including bushmeat) access was attributed to clearing of forest for new agricultural land and concurrent increase in demand for sale of such products. People stated that they were having to travel much further to find NTFPs and felt that they were competing with more people to do so as well as the animals. One household stated that such a reduction was particularly difficult during lean times, suggesting that access to forest products is a kind of food insurance.

Animal diseases, in particular for chickens and pigs, were identified as a problem of increasing importance in Cameroon with animals dying resulting in a loss of income and repercussion of children being taken out of school, inability to pay for regular household items, etc. The *potential* response identified by most households was to 'send the animals to the forest during epidemics' or a hut – essentially to isolate them (note that such a strategy has been used historically in Rwanda, e.g. in response to Rinderpest in the 1920s, but is no longer a legal option). Households described no response to decreased access to water but stated that it resulted in consumption of 'dirty' water and an increase in disease transmission.

In **Rwanda**, as in Cameroon, the mixing of the seasons was seen to result in a loss of crops and hunger. Some households altered their planting schedules, planting multiple times, but with no success. The impact of such a change varied depending on the nature of the change – in increasingly wet times, soil erosion was identified often associated with property and or crop loss. People responded to such loss by digging pits and creating waterways to channel the water off of their fields and

away from their homes (K01). Planting trees was also indicated as a means of reducing erosion. Households said that they came up with such an idea through neighbours and were constrained by their labour. Households that reported property loss stated that they sold or were renting a portion of their land to try and make up for their financial losses. Many households are not responding in any meaningful way with one stating that 'controlling the rain is out of our hands,' K03.

Additional responses to crop loss (as a result of the mixing of seasons) included neighbours sharing surplus with households that received less (K02), increasing manure input (M21), diversification of livelihoods by working on other peoples lands (K04) or production of sorghum beer (K06), selling land (K04), purchase of plastic sheeting to create water storage (M17), and taking of a loan from SACCO to re-cultivate land (M18 – the respondent stated that this was supported by the government). One major constraint on adaptation was financial, for example in the above cases, difficulty in the purchase of plastic sheets and new seeds. Some households described possible solutions to crop loss as agroforestry (M17), though with limited explanation.

Plant diseases were often described as being triggered by the mixing of season and in this regard may be seen as a 'result' of the mixing of seasons. Ultimately disease resulted in a reduction in harvest and hunger. Households responded by increasing pesticide application and changing the species of potato being cultivated (M18 & K04). Pesticide application was ineffective. In addition to financial constraints mentioned above, the greatest constraint identified in this context was the lack of knowledge concerning fertilizer and pesticide application. The following is an demonstrative example of how households are affected by and subsequently respond to the change and seasons and its impact on their crop production:

> (M18 our summary) Heavy rains in 2012 resulted in crop failure. She took a loan from SACCO to buy seeds and fertiliser to replant her failed fields. This loan was facilitated by the government. She has not yet harvested so it is difficult to say whether her response was 'effective.' She also changed the species of potato that she was cultivating in large part because she '*saw our neighbours who were planting those other species and they were not being contaminated by the bacterial wilt, and we decided to try it also*.' She was also told by the agronomist that the fertiliser she was using (Di-Ammonium Phosphate) was not for potatoes but for maize and suggested that she change to NPK. '*When we changed, it made the bacterial wilt to diminish considerably*.'

The woman's use of DAP is indicative of a general lack of knowledge in how to utilise fertilisers as DAP, when applied as plant food, temporarily increases the soil

pH, but over a long term the treated ground becomes more acidic than before upon nitrification of the ammonium[4](IPNI).

In **Equatorial Guinea** the greatest environmental problem raised in Kukumankok – mentioned by 15 households - was crop raiding by all sorts of animals but particularly marmots (groundhogs). Peoples' response is overwhelmingly to build a combination of fence and trap around the field called *osap*, a traditional trap that is made using a 0.5m high fence made from bamboo leaving little holes where they place traps (KU05). 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. Noise is also described as a defence against crop raiding and plying animals with alcohol to make them drunk and easier to kill. Two female-headed households indicated that they did nothing as setting traps is 'man's work' and they were also constrained by lack of money to do hire someone, KU01 and KU20.

Other concerns included crop disease, believed by one household to be a result of low soil fertility. The only reported response to this was to move location. Wind (and lightning) was interestingly believed to be the result of large quantities of gold in the village that attracted the lightening. These cause death and property damage and the only response reported was to stay at home. Animal disease was described as affecting chickens that were treated with antibiotics or traditional medicines, the latter of which is said to be 'no longer effective.'

3.5 Forest Livelihoods and Policy

The data for this section came from a continuation of the household interviews with the same interviewees. Here the concentration is on people's perspectives (positive and negative) on natural resources and ecosystems, on current forest management and on potential future management.

Forest Benefits and Costs

Examining the things that people described as benefits and costs of the forest revealed the following trends:

Support of livelihoods was reported in Cameroon (Dja 19 and Mang 12), Rwanda (Kamiro 5 and Masasa 2), and Equatorial Guinea (all households – 20 Atom and 19

[4] IPNI. "Nutrient source specifics: Diammonium Phosphate." Nutrient Source Specifics No. 17 Retrieved 07 Aug 2013, from www.ipni.net/specifics.

Kukumankok). All households in Rwanda were beekeepers and referred to the importance of keeping their hives near the park. A few of these attribute the park with this honey production (Kamiro K10, K11 and K15). In contrast, Cameroonian and Equatorial Guinea households described collection of multiple NTFPs that contributed to household income including djembe, koko, bush mangos, and djansang in Cameroon and bushmeat, fish, wild fruits, and melongo (basket weaving material) in Equatorial Guinea. An interesting note in Equatorial Guinea is that 'hunting' appears to be largely done by setting traps around cultivated areas in the forest [the *ekoro* – secondary forest where cultivation is done] as opposed to setting traps in the primary forest. This appears to be a recent change in hunting practices (see Bushmeat under Stage 2 Trends).

25 households in Cameroon benefit from the sale of surplus NTFPs collected from the forest including bushmeat, bush mango, fish, koko, caterpillars, djembe, and djansang. Similarly all 39 households in Equatorial Guinea describe the sale of surplus items in particular bushmeat, fish, palm oil and wild fruits. For example, in Atom household A09 states

> '*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*.' (A09)

Cropraiding appears to be an issue in all countries – Cameroon (Dja 9 and Mang 8), Rwanda (Kamiro 12 and Masasa 19), and Equatorial Guinea (Atom 7) though much higher proportionately in Rwanda. The main animals in Cameroon identified include hedgehogs, squirrels, rats, monkeys, birds (parrots and partridges), porcupines, 'doe' (duiker?) and a 'new species'. '*There are hedgehogs and 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*,' (D02). In Rwanda the problem animals were limited to buffalo, monkey and porcupines. Several households indicated that they expected or wanted RDB to compensate them for their loss. Two other households said that cropraiding happened but was not a big problem, M03 and K03.

Household Masasa M12 had quite an interesting perspective on why crop raiding is becoming an increasing problem that warrants consideration. The respondent's answer is also indicative of the age of the household and kind of difference in information yielded from more mature households. The household states that,

> '*In the 1970s our agriculture had a high yield even if there were animals coming from the park that were raiding our crops. These animals were especially elephants and hyenas* [jackal?].' (M12)

He then continues that in 2003 the vegetation in the park started to change,

> '*mainly due to the fact that 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 they do not allow other herbs and grasses to grow. This caused a shortage of grass for animals and the last come out the park and raid on our crops*.'

In Equatorial Guinea crop raiding was reported as a problem in Atom, with an additional 4 households describing the killing of livestock by forest animals. In contrast Kukumankok was heavily concerned about human attack from animals particularly elephants and snakes. The lack of reference in this section of the interviews in Kukumankok to crop raiding is surprising given that all households reported crop raiding as a major environmental issue in the previous section.

Cultural value

In Cameroon this was widely reported, Dja 11 and Mang 9 households. Descriptions of the forest value included – freshness, tranquillity, place to rest and think, refuge and relaxation. One household described the forest as, '*the mother of everything*,' (M11). Four households struggled to find the words but were adamant of its value (D02, D10, D19 and M06. For example,

> '*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*,' (D02).

Two Baka households were quite a bit more explicit in their relationship with the forest with D14 describing in considerable detail the impact of being removed from the forest on their household and culture, D14. The other simply stated,

> '*The forest is our god. The Baka is nothing without the forest. It represents everything for us*,' (M20).

E. Guineans describe the forest as '*everything I have is from the forest*' (A12), '*my life is in the forest, I cannot live without it*' (A19), '*whole life depends on the forest*' (K04). Two households describe it as a place to go for 'solitude' (K11 & 14). Another states that '*it is not good to waste the forest*' (A16) implying that some do and begging the question of what 'waste' looks like. There is also recognition of the forests' importance for future generations, i.e. '*forest is important for us because the lives of our children depend on it*' (A02 & 11). Finally, there is a strong acknowledgement of the forests' role as an environmental buffer against wind, extreme temperatures, provision of shade, and erosion control. For example in Kukumankok 11 '*The forest*

protects him from strong winds, sometimes when he wants to be alone he spends time in the forest, it gives him shade and fresh air.'

In Equatorial Guinea one household made a striking comment about the forest as a fearful place because people can use it to hurt [kill] others. K20 stated '*Forests frighten them as many people use it to kill others, when you go to the forest for your activities, there may be someone watching you waiting to hurt you*.'

In **Rwanda** the cultural value was emphasised less although not absent altogether. '*It looks well, it attracted the tourists and they remain something in Rwanda (money) and even if they didn't remain something; for me it's also wonderful to see it around our community'* (Kamiro 01).

Current forest governance

Cameroon

Control of forests near village

There is general agreement that forest is controlled by the one that first exploited it or inherited the land from grandparents. Families manage their own land and freely access resources from that land.

Controls of community forest

There is a high proportion that claim ignorance of the community forests (Dja 10 and Mang 12) responding with statements like, '*I have not heard of the community forest. What is it?*' suggesting that their use and control is not truly community-based. Some households were able to describe some aspect of the community forest – Dja 02, 09, 12, 13 & 14 and in Mang 11, 12, 14, 15, 16 & 18.
There are also some households in each village that described active exclusion from participation in the community forest including Dja 10, 15, 16 & 17 and in Mang 02, 07 & 16.

One Baka household (MA20) reveals a rather harsh exclusion from forest access that has severe livelihood repercussions,

> '*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 what is government authorities, forest guards, forest exploiters. In brief it refers to those who 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, 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.'

Of the households that were able to explain something about the community forest or described exclusion from participation in the community forest, there is a mix of perspectives. In Dja two of the households had no opinion one way or the other on the community forest whereas the remaining three (12-14) all deemed it as 'fair' and 'running well.' In contrast those that described exclusion from the process described it as not fair (15-17) with one (rich, D10) household stating that, '*Those things [about the community forest] concern only those who live at the centre of the village. They have never told us anything or invited us to any meeting*.'

In Mang, four of those familiar with the community forest described it as not fair (11, 12, 15 & 16) and two as fair (14 & 18). For example, MA16 (poor household) stated,

'*It is unfair because the revenues are not profiting to the village and its inhabitants. The government and the community forest managers are eating alone. I think we can improve things by rendering the community forest profitable for all*.'

Those that described being excluded from the community forest had no apparent stance (07) or felt it was not fair (02 & 16).

Equatorial Guinea

Control of forests (afan) around the village

There appears to be a slight difference in perspective between villages, with 12 households in Atom stating that no one controls this area, whereas the village council is perceived to manage the forest in Kukumankok (18).

Rules of access to the dense forests (ngom afan)

There is broad agreement between the villages that ngom afan is generally freely accessible to villagers from a defined area but outsiders must receive the permissions from the village council/ elders/ president. Several households in Kukumankok suggest that each tribe (clan) has a corresponding section of the forest. K08 & 19 state that this does NOT apply to fishing or hunting, which are freely allowed to members of the village. From our understanding this would mean that the largest tribes have control over the largest amount of forest. Kukumankok 18 states that this also applies to the rivers too (K19 contradicts this), and that the minority tribes can '*go to any part of the forest to carry out their activities*,' suggesting that the minority tribes do not actually have any (exclusive) claim to a section of forest.

Rules of access to secondary forests

As in ngom afan there is broad agreement that the ekoro are privately 'owned' by a household whose permissions must be obtained prior to entering – though again, this seemed not to apply to hunting and fishing. Responses suggest that people like the rules and that they help to maintain order as well as conserve resources for the future. For example in Kukumankok, K12

> '*These rules and restrictions are positive. Their way of life would be different, only the cleverest people would survive*,'

suggesting that rules are a mechanism of levelling the playing field, making it 'fair' for everyone.

> '*This is a good thing for him because they guarantee the preservation of some important resources in the forest, and they have existed for a long time. If these restrictions did not exist their lives would change culturally as they are cultural restrictions, there would be no order either.' (K14)*

Lastly, there is evidence of a plentiful resource in Atom, A05 '*They* [rules] *do not affect me at all because we still have a lot of forests spare and if anyone uses it, you can go to another place.'* This may refer to how people obtain ekoro – most commonly ekoro is inherited but there are indications that, if you do not have ekoro, you may go to an area of forest to 'clear' or 'weed' it, making it your own.

Rwanda

National park management

Households generally understand that it is RDB (ORTPN) that manages the park though they are sometimes unable to state the actual name. Guards are often referred to as well as local authorities.

The use of the park (or restrictions on use) are also generally understood and accepted. When asked how their livelihoods would be affected if such restrictions did not exist responses were relatively uniform, perhaps reflecting messages from local authorities or RDB. For example,

> '*It would become desert, the rain or sun might destroy many things. This forest is considered as the source of rain here in our village and it provides the moisture'* (K04)

> (K12) *'I can't say that these restrictions affect the community, because if the restrictions did not apply, the forest could no longer be here (desert), without any trees and the loss of different species of animal.' (K12)*

It is clear, however, that this relationship is 'new' and certainly has impacted some households.

> '*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 and make cloture. Nowadays, all these actions are not allowed to be made into the park.' (M02)*

The resources lost were predominantly wood (14) with two households reported loss of bamboo. One household reported the loss of land,

> *'There at the entrance of the park; it was the land of the community; RDB 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. They have planted trees and sometimes we say that those trees are the property of CARE, guards say that trees are the property of the community, but if someone is caught there by 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',* (M08)

One longer standing household reported a shift in wood use that suggested a period of difficulty but that access is better now: *'1974:*

> *Firewood had become more accessible because we collected into the park. 2012: 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.'* (M02)

Water collection in the park is mentioned by a handful of households in Kamiro and Masasa (7 and 5, respectively) though it appears that households would prefer not to collect in the park due to distance travelled and difficulties of doing so, i.e. need to be accompanied by RDB.

<u>Control of non-forest lands</u>

By far the most commonly mentioned programme was the crop consolidation that mandates planting of certain species. Near the PNV this appears to be tied into and exacerbated by land tenure issues (see quote from M20 below). Eleven households in Kamiro and 13 in Masasa explicitly described hardship arising from crop consolidation programmes [we would emphasis the significance of this based on experience of working in the country - Rwandan's great reluctance to criticise anything coming from above].

'There are some impacts we're facing including the land consolidation program which requires to plant one crop. The few past years, we planted maize, beans and Irish potatoes on the same farm and when we harvest Irish potatoes, the maize and beans grow well. Supposing that the maize could be destroyed by climate conditions but you get the yield of the remaining crops. No one can change the regulations established by the government but this program of land consolidation is not fair for the community,' (K14)

'*I can't lie, it makes us hungry*.' (K17)

One particular issue arises from land that was identified for growing pyrethrum.

'*These lands were the property of SOPYRWA, but nowadays it's the property of the government. SOPYRWA took these lands for 20 years, after the expiration of this period; the lands became once again the property of the government. We rent these lands with the government for 99 years, but after these years, it will be the property of the government*.' (M20)

Households spoke most directly to the requirements of planting pyrethrum, specifically that it takes a long time to mature, the yield is reducing and subsequently income generated by it and, most critically – it is not edible and 'creating hunger' in many households.

Control of tree cutting appears to have changed recently with cutting formerly being organised by landowners, whereas now the local authority must give permission and only for 'mature' trees.

'*There regulations don't allow the community to make charcoals but due the problem of hunger in this area, it's very impossible. If they make charcoals, the trees are quickly reduced and the cost of firewood increase due to the loss of trees. The community is still working these actions but it's not allowed because is the regulation established by the government. We have regularly meeting with our authorities in order to inform the community all established regulations*.' (K16)

'They want to limit the community for their actions to make charcoals and if they continue like this, there will no any tree stay in the country. We're still facing hunger in this village, the reason why we regularly collect some trees in our woodlot.'

Unlike crop consolidation, control of tree cutting appears to be more broadly accepted with only a few mentions of the apparent difficulties this has presented, e.g. M13 [in response to livelihood impacts due to regulation of tree cutting] '*We're affected but there's nothing to do, because they are the programs of our government for our common interests.'*

Potential forest policies and interventions

We analysed responses to determine whether particular management objectives and interventions were thought to lead to positive or negative impacts for the household. The interventions considered included increase in cash crop production, increase in mining and timber concessions, and prohibition of hunting. The particular objectives that we asked about in each country were based on previous scoping studies, discussions with key informants and literature reviews, to identify feasible policy directions. For example in Rwanda, at the time of interviews, there was an ongoing consultation about expanding the national park area, and existing national policy to increase forest cover on steep lands.

Whilst we took a broad approach to identifying these possible policy directions, we are of course most interested in those interventions that are oriented towards, or at least justified in terms of, government responses to climate change, both for mitigation and adaptation. This again gives us some insights into the complexity surrounding assumptions that adaptation and mitigation work in synergy to support the needs of the rural poor.

Cameroon

<u>Increased production of cash crops (coffee, cacao, palmoil)?</u>

Both villages were unanimous in their positive support of such a management plan , Djalobekue 19 and Mang 20 households. The main reasons for this cited were an anticipated increase in income that would directly increase material wealth and ability to send children to school, agricultural expansion, and job creation.

<u>Expansion of mining concessions</u>

Dja (11 positive, 8 negative) and Mang (8 positive, 11 negative) with relatively even distribution amongst household categories. Negative reasons cited were a concern for the loss of access to forest resources and subsequent decline in material wealth, lack of concern of the outsiders (associated with mining expansion) for the village's needs and wellbeing, a decrease in agricultural land, potential for outsiders to 'chase' the villagers from their land, and mining's temporal nature.

> *'Agriculture will stop; it is an activity that remains even when you die and your children will continue in your parcels. The experience has demonstrated that mining is a non lasting activity. After it there will be hunger in the village, and people will remain poor,'* (Dja 03)

Positive reasons cited were based on perceived opportunities to sell products and increase material wealth, and ability to send children to school.

Expansion of forest concessions

Dja (9 positive, 10 negative) and Mang (5 positive, 14 negative and 1 no response). Negative reasons cited included the potential risk of famine sometimes associated to a decrease in the availability of land, the loss of forest and land for future generations, concern over forest concessions on NTFPs specifically caterpillars.

> '*It [expanding forest concessions] will reduce our lands. Our children will neither have forests nor lands* (Mang 16)
> *The forest exploitation destroys the forest and causes a lot of difficulties for us. The trees producing caterpillars will disappear. With the coming of exploiters we cannot enter in the areas where they are working again. If the concession is enlarged, we cannot enter everywhere we want to collect what we want,'* (Dja 05)

Positive reasons included a potential increase in jobs and subsequent increase in money (material wealth) and better living conditions.

> '*It will be a very good thing for us. We like to live in shadowed areas. So if they ask not to cut trees again, it will create better life conditions for us,'* (Mang 20, Baka household)

Enforced reforestation of farmland

Not surprisingly, most households responded negatively to reforestation of farmlands based on the concern that this would compete with their current practices of agricultural production.

Prohibited deforestation in village (forest) land

Similarly most households responded negatively based on the concern that if they were not allowed to cut the trees, their crops would not grow. One household stated that they [the villagers] were not the problem,

> '*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?'* (Dja 06).

Positive reasons were based on the protection from the sun and potential to benefit from fruits produced by such trees.

Encouraged migration of people to other areas

Assisted migration was approximately 2/3 negative and 1/3 positive. Negative reasons cited including concerns of overcrowding and the creation of conflicts and

limited resources, that the newcomers would 'steal our wives,' the newcomers would lack respect for the original 'locals,' and also bring new diseases. Positive reasons included the potential for development opportunities and the ability of the newcomers to teach [the villagers] new things.

Prohibited hunting in forest concessions

Both villagers were predominantly negative concerning a limitation of hunting in the forest concessions with Dja (4 positive, 1 in between, 14 negative) and Mang (1 positive, 1 in between and 18 negative) Negative reasons included the need for meat and lack of livestock (ie cows) in the village, traditional source of protein, and inability to sell the meat for revenue generation. Positive reasons included the ability to find other food sources, that wild animal populations will increase and increase the number of animals that the household could trap on their [private] farmland, desire for species survival and a need to decrease the pressure of commercial hunting.

> '*It is good [to prohibit hunting in forest concessions]. Many children are born now and we have to give them the chance of seeing gorillas and other species in the future. What is bad is that many animals are killed for commercialisaion. If things continue like that, the animals will finish. I encourage such ban,'* (Dja 6)

> '*It is more or less good [if hunting in forest concesssions was banned]. The animals are disappearing because of the excessive poaching, and our children will not have the chance to know some species. It is not also good because meat is part of our meals,'* (Mang 10)

Equatorial Guinea

Increased production of cash crops

Both villages are unanimous in their support of this largely out of the anticipation of income that would result enabling them to improve their lives through the building of better homes, sending their children to school, and purchase of material goods. One household in Atom indicated that he would 'stop hunting' implying that hunting is a supplementary income activity.

Expansion of forest concessions

Villages were almost unanimous in their support of this with the exception of two households (see below) based on the expectation that they (or their spouses) would receive employment and increase their income.

'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.' (A09)

'It would not be good, I hate exploitation, it causes a rise in heat.' (K19)

Forest law change to enable community-managed forests

People were unanimously in agreement with the creation of a community forest predominantly because it would prevent companies from coming in without compensating them.

Conversion of farmland to agroforestry

Atom households were all positive in their support for agroforestry, though with a few households poorly understanding the question. There was a division in support in Kukumankok which we suspect may be a result of different interviewer interpretation of the question. There was one response in particular that was very against agroforestry (K07).

Prohibited deforestation in secondary forest (bikoro) land

Villages were relatively divided in their support (or acceptance) or a prohibition of deforestation in bikoro with some households stating that they already leave these areas fallow for extended periods of time (~2-10 years) or that they would expect to be compensated to do this.

Prohibited hunting in the forest (afan)

Surprisingly there was a similar division in people's support on a prohibition of hunting with slightly more stating that they were for rather than against it. Most households indicated that they did not consume much meat or that they could simply purchase frozen goods instead. Others still wanted compensation for such a loss. Households against this prohibition stated that they depending heavily on meat for food and income, and were concerned that a prohibition would result in increased crop raiding activities.

Rwanda

Expansion of the national park?

Households almost unanimously were against the expansion of the park or 'for' its expansion with serious caveats – specifically, people seem to accept the expansion of the park because it is the government that would mandate it.

'How could we refuse the regulations established by the government? They know very well where we will stay after leaving from this area. We will accept because we can't refuse the programs comes from the government.' (K20)

Several households describe the potential negative impact such a loss would instigate (K09-11) and general likelihood that even if compensation were received, it would fall short of what the household currently possess. For example,

'*We as the community is living in surrounding zones of the park, we will be facing the problems. For example my brothers that have lands near the forest will face problem of the loss of their material wellbeing including land'. (M15)*

Furthermore, respondents did not see how financial compensation could offset the costs of park expansion:

'It will be a big problem on my side because I can receive that money and they didn't help me to find other materials including houses, lands, etc or the new household comes uncomfortable for my family comparing to this one.'

Although two households described greater faith in the government to ensure they were not harmed, describing the government as a 'parent' that 'will find us food and other places for surviving,' (M10 and M19).

<u>Enforced reforestation of farmland on steep slopes</u>

Most people accept the idea with caveats (only three households explicitly reject the idea)**.** Households seem most concerned as to whether or not they will in fact be the owners of such plantations (as opposed to the government),

'*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,'* (K03)

They claim the utility of these peripheral lands in times of poor crop production,

'*On one hand this program could be better; but on other hand it affects the community because when it doesn't rain, the community uses these lands for getting their livelihood,'* (M16).

There are also concerns over land limitation and impact on food production,

'*We accept the program for protecting our lands, but the community may have problems mainly those who have only one plot of land because they prefer to plant Irish potatoes instead of forest which will take long time and causes the hunger to our families,'* (K10).

Many households that did not have an issue with the programme stated that it was in fact something that they were already doing,

> *'We don't have any problem about reforestation on steep slopes, because we normally make these activities without being pushed by regulations,'* (K15).

Conversion of cropland to agroforestry

The vast majority of households agreed with agroforesty outright or with few caveats, 23 and 18, respectively. Only one household (M05) explicitly did not want agroforestry because he felt it would be better to plant grasses that would provide soil erosion control and provide fodder for his livestock. Households that agreed outright felt that agroforestry was good because it reduced soil erosion and did not affect their crops. Other reasons included that the branches and wood were useful and trees provided a nice wind block (one household). The mixed responses were less sure about the potential compatibility of the trees with their crops and were concerned that the trees were the property of the community – as opposed to the government. One household indicated that although he wanted to implement agroforestry he lacked the knowledge how to cultivate the tree seedlings. An additional house described a paucity of land to plant on and be able to grow enough food crops.

Consolidation of fragmented landholdings (and control of crop plantation)

NOTE: People freely mix the consolidation of fragmented lands to that of the programmes controlling the types of crops planted on such lands.

Seventeen households expressed strong concerns over the ability of households to produce enough crop foods based on the current programmes that mandate the planting of certain species (11 Kamiro and 6 Masasa). Many households lamented the loss of the ability to mix crops and desire to return to this method. Approximately 12 households indicated that they had 'no problems' with the consolidation of fragmented lands but comments made in other parts of their interviews suggest otherwise (1 Kamiro and 11 Masasa).The difference in villages suggests that there may be something else going on here – was this programme implemented in Masasa earlier allowing people more time to adapt to its repercussions?

For example, in M18 the respondent states that the consolidation of fragmented landholdings is 'very important' and 'doesn't cause problems,' but that,

'*Land use consolidation can cause the hunger, because the harvest finishes at the same moment for all the population. During the past years, we cultivated without using that program and if someone suffered the hunger because the harvest has been yet finished; she/ he could be helped by other population. It will better if they did not establish those regulations.*' (See also M08 and M11)

Even those households that 'accept' crop consolidation do 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,*' (K09).

A couple of households indicated that this programme was particularly difficult for family's that had small amounts of land or children that would inherit some land. For example,

'*We accept that program, for example from starting down there all plots are planted pyrethrum, means that during the following season we must start here near household by planting pyrethrum. The main problem is when someone has a lot of children. If this person has the 9th plot which must receive pyrethrum, he/she must automatically search how to find (rent) other plot for planting Irish potatoes. But as you have understood; it causes problems because if he/she doesn't have means to rent other plot, he/she will buy Irish potatoes,*' (M10, See also M04).

<u>Terracing of farmland</u>

There appears to be a slight difference in response to this question in Kamiro from Masasa households with Kamiro tending to be more positive and Masasa more negative. Households in Kamiro responded positively with a handful of households (6) stating that such techniques were helpful in reducing soil erosion, whereas the households that responded negatively stated that it was because the ground was not suitable (too stony, 3 households) or that rainfall was excessive and would simply wash away the terracing (2 hs).

'*Terracing can't happen here in our village because the soil is not appropriate for terracing techniques.*' (K10)

In Masasa, households responded negatively due to insufficient land (3) and their being a lack of steep slopes and thus need for terracing (12 households). Households also described the current use of pits to control for soil erosion problems, e.g. in M08,

'*Terracing can't happen because there are no lands with high steep slopes; we dig holes and pits alongside the farms for fighting soil erosion.*'

Resettlement of people living close to ravines

Our sense is that no households that may be directly affected by resettlement were actually interviewed, which may impact on people's responses. Households generally agreed that resettlement was necessary if the loss of life or property were high. Only one household flagged a potential complication:

> '*You have seen there the caves of water, this situation happened when it rained intensely. The water came from the forest and created the waterways here. It was a simple ways used by the community but finally destroyed our farms. Regarding the resettlement of people close to ravines; how those persons must be resettled every time the problem occurs? It's very difficult, because we have many waterways in our village,'* (K19).

4. Concluding Remarks

Whilst there is an abundance of information contained within this synthesis report, we wish to highlight a few aspects of the data that may be broadly helpful in understanding how environmental changes are affecting communities and their responses to such change.

- The value of the relationship with the forest seems to differ dramatically in Cameroon and Equatorial Guinea from that of the household's interviewed in Rwanda. There appears to be a much stronger, more direct connection with the forest in particular for the Baka peoples. The research sites in Rwanda did not contain communities of ethnically related Batwa people whose cultural attachments to forests may overlap with the Baka.

- The level of economic dependence on forests also varies considerable across countries, sites and households, depending not only on forest resources, but also on policy and governance contexts and on cultures, local institutions and livelihood preferences.

- Countries are similar in their concern with erratic, unpredictable weather patterns that ultimately lead to food insecurity. Communities vary in their responses to environmental change with a greater reliance on the forest and associated resources in Cameroon and Equatorial Guinea. In large part this difference is based on the protected status of the forest and lack of access in Rwanda; the communities live adjacent to the Volcanoes National Park. In contrast, communities in Cameroon and Equatorial Guinea retain customary rights to the forest, clearing land if needed, and collecting (and often selling) NTFPs to fulfil household's needs.

- In Rwanda households displayed the greatest diversity of adaptive behaviours to environmental change. This appears to be partly due to greater restrictions on forest access, but also due to the higher levels of social organisation, including government intervention. Over half of the household's interviewed described informal institutions (i.e. cooperatives) and communal work (*umuganda* – occurring the third Saturday of each month) as assisting, supporting or enabling adaptive strategies, with no mention of such organisations in Cameroon or Equatorial Guinea.

- The constraints to adaptation to environmental change, including perceived trends in weather conditions, are varied. However, two stood out in our interviews, namely financial capital and knowledge about innovative agricultural practices. In Cameroon and Equatorial guinea there was a tendency to see adaptation as something pursued at the household level whereas in Rwanda there was a greater sense of dependence on government intervention.

- We also observe more subtle constraints. For example, female headed households in Equatorial Guinea were not responding to increased crop loss from wild animals because the construction of fences of traps was seen as men's work and they could not afford to pay men to do this for them. Thus, local institutions (of gender) combine with financial constraints to restrict adaptive response to livelihood stresses.

- The same subtlety in constraints can be said about access to forests for NTFP collection, not only for commercial sales but for subsistence, including for coping in times of poor crop yields. Forests are seen by some as dangerous places in which e.g. fear of witchcraft feature in decisions about access. Again, there is a financial element to this because wealthier people are more likely to be able to take actions to ward against such dangers as these can inolve financial outlay on gifts/offerings and ceremonies.

- There are a number of actual and prospective forest policy interventions that are related to climate mitigation and adaptation, even without considering REDD+ itself which remains less imminent in the particular sites we worked in. For example, forms of agroforestry were being promoted or considered in all countries, as well as efforts to reduce deforestation and biodiversity loss.

- Forest management and conservation activities (current and planned) may contribute to livelihoods, but the linkage is not necessarily evident and such activities can in some cases have negative consequences for local people, in terms of access to resources and income losses. These preliminary findings

make a clear initial case that simplistic assumptions of connections between mitigation, adaptation and local wellbeing may not hold out in practice, and such assumptions alone are not a robust basis to justify policies such as REDD+. Better understanding of this complexity is an objective for the next phase of data analysis.