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ANALYSIS OF THE RATE OF DEFORESTATION IN POST-CONFLICT AREAS IN THE DRC: CASE OF COMMUNITY FORESTS AROUND KAHUZI-BIEGA NATIONAL PARK IN KABARE NORTH

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Abstract

This study was carried out in the context of knowing the rate of deforestation in post-conflict areas in the DRC and particularly in the community forests surrounding the Kahuzi-Bièga National Park in the north of the Kabare territory. The population of this part lives mainly on agricultural activities and uses firewood for cooking food. Before cooking food, building a house … there must be a tree or even several trees to cut down, which increasingly accentuates deforestation in this part.

However, deforestation and deforestation is increasing in the PNKB and in most of the settlements surrounding it, as the population increases or moves. Admittedly, groups have taken advantage of the war and community conflicts to illegally exploit wood resources, especially in the PNKB and its surroundings, and the influx of refugees has caused serious ecological problems in the northern part of Kabare territory. The first devastations of the war would have hit the Kahuzi Bièga National Park with the massive influx of Rwandan refugees in 1994. As causes of deforestation, let's say that the construction of houses, the search for firewood and embers occupy the first place because man has always needed to shelter and cook food or even to heat himself, unfortunately in the northern part of the territory of Kabare, to meet food needs, we often use firewood and embers because the stoves are less used in this part but rather braziers and the traditional fashion. Despite the possession of afforestation by 100% of our respondents, the rate of deforestation in the latter is 22.47%.

Introduction

The African Great Lakes region faces multiple challenges related to the sustainable management of available natural resources. This problem could be read through various factors and impacts of the conflicts observed: natural disasters, social conflicts, and extreme poverty observable both at the level of individuals and of entire communities (Bajope B. et al, 2013). Currently, the most serious conservation problem that arises particularly in the eastern part of the DRC is probably linked to demographics coupled with poverty where human activities are essentially linked to the direct exploitation of direct natural resources for the satisfaction of basic needs in an environment where processing technology is still rudimentary and individual living space is too small (International Alert, 2009).

The annual rate of deforestation would be 0.4 to 0.6% in Central Africa and the forest would still cover more than half of its initial surface. Congo Basin countries are still at the first stage of the forest transition, with a CEFD (high forest cover-low deforestation) profile without irremediable threat (Jacquemot, 2018).

In the DRC, after several decades of war, the economy is recovering and the state is gradually being rebuilt. But this peace remains fragile, the institutions are in tatters, and the control mechanisms do not work. Emergencies tug at all sectors. The natural heritage of the DRC has suffered greatly from the war, the greed for natural resources is widely recognized as one of the important factors of recent armed and communal conflicts. These mainly concerned mineral resources, but access to land and timber also came into consideration.

In South Kivu, conflicts between forestry companies and local communities were frequent, for reasons such as the non-payment of local taxes, the absence of compensation for families for damage caused to their harvests, or

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the insufficient jobs and social and transport services offered to the population. These conflicts have often led communities to block access roads to construction sites. Agriculture seems to be currently the main direct cause of deforestation, even if the harvesting of firewood also has a major impact in the countryside of the northern part of Kabare territory. It should be noted that deforestation is increasing in the PNKB and in most of the groups surrounding it, as the population increases or moves. Admittedly, groups have taken advantage of the war and community conflicts to illegally exploit wood resources, especially in the PNKB and its surroundings, and the influx of refugees has caused serious ecological problems in the northern part of Kabare territory. The first devastations of the war would have hit the Kahuzi Biéga National Park with the massive influx of Rwandan refugees in 1994. Nearly one million refugees crossed the border and settled in and around the PNKB. A section of the Nyamunyunyi camp housed up to more than 10,000 families, with their needs for construction and firewood, which perpetrated deforestation and the exploitation of wood resources, mining or arable land (BIRHACIHANA, 2014). Inter-community conflicts between indigenous peoples, associated communities and PNKB leaders including the surrounding population for two decades causing accelerated deforestation.

Thus, this study aims to answer the following questions:

1. What is the rate of deforestation in the post-conflict area in the northern part of Kabare territory and community forests around PNKB in particular?
2. What are the strategies to be put in place to mitigate this rate of deforestation and/or deforestation in this part?

Overall, this study aims to determine the strategies to be put in place to mitigate this rate of deforestation and/or deforestation in the northern part of Kabare territory.

Presentation of the study environment

The territory of Kabare is our study environment and particularly its northern part. It is located in the province of South Kivu in the Democratic Republic of Congo. It shares its boundaries with the territory of Kalehe to the north, with the territory of Walungu to the south, with Lake Kivu to the east and with the PNKB (Kahuzi Biega National Park) to the west.

Figure 1: Geolocation of Kabare territory

It is at an altitude of 1500 meters and subject to a humid tropical climate. Rainfall varies between 1300mm and 1800mm per year. It extends between 28° east longitude, 29° west longitude and between 2° south latitude. Its relief is dominated by mountains whose highest peaks are: Kahuzi with 3300m and Biega with 2700m. Inside this entity, we also find whole hills which are unfavorable structures for human life and they are uninhabited. The average temperature of this territory is 19.5°C. The soil of Kabare is by nature volcanic for the greater part of the territory. It is a rich and productive soil but following overexploitation and exposure to erosion in all its forms (water and wind), it has become one of the poorest. The ONGDs and the customary authorities have mobilized to protect this soil through awareness-raising and training for Kabare farmers on the fight against erosion, the development of nurseries.

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Materials and methods

Location of research: northern part of Kabare territory

Our research took place in the northern part of Kabare territory and mainly in the Mudaka, Miti, Bugorhe, Irhambi-Katana and Bushumba groupements. With a population of 354,791 inhabitants (including 61,945 in Bushumba, 32,653 in Miti, 51,978 in Mudaka, 63,653 in Irhambi-Katana and 144,562 in Bugorhe) living mainly from agricultural activities and using firewood for cooking food. Before cooking food, building a house … there must be a tree or even several trees to cut down, which increasingly accentuates deforestation in this part.

Conduct of investigations

Several visits to the field allowed us to be in direct contact with the population, chiefs and local leaders. A survey questionnaire was made available to them and involved a randomly drawn sample. It was 0.067% or 240 people living in this part of the territory. The questionnaire contained questions relating to:

- Has the possession of a forest in Kabare North and its area,
- The frequency of cuts in the afforestation and/or community forest,
- The reasons for cutting trees in the afforestation and/or community forest,
- The number of trees felled per day in community afforestation,
- To the actors, main customers of trees and their derivatives,
- To community conflicts in Kabare and their impact on timber resources,
- Strategies to be put in place to mitigate this rate of deforestation and/or deforestation.

During the surveys, the people to be surveyed were drawn at random. A digital camera was used to capture the photos instead of tree cutting and storage.

Results and discussion

Results

Possession of a forest in Kabare Nord and its area

Overall, almost the entire population of the northern part of Kabare territory has afforestation regardless of its size. The following tables explain the ownership and area of afforestation in Kabare North.

Table 1: Opinion on the possession of a woodlot

Modality	Frequency	%
Yes	240	100
Nope	0	0
Total	**240**	**100**

This result shows us that out of 240 people surveyed, all have a forest in the northern part of Kabare territory like the group of Mudaka, Miti, Bugorhe, Irhambi Katana and Bushumba; and whose groups are close to the PNKB and have experienced inter-tribal conflicts. The ownership of this afforestation is either family or community (churches, associations and business or commercial). These woodlots are much more family-oriented for 77.5% of our respondents and community-based for 22.5%.

Table 2: Area of afforestation

Modality	Xi	Frequency	Fxi	%
1 – 5 ha	3	101	303	42,08
6 – 10 ha	8	93	744	38,75
11 – 15 ha	13	23	299	9,58
16 – 20 ha	18	23	414	9,58
Total		**240**	**Σfxi = 1760**	**100**

The afforestation area available in the northern part of Kabare territory ranges from 1 to 20 ha. It is 1 to 5ha for 42.08% of our respondents; from 6 to 10ha for 38.75% of our respondents. On the other hand, it is 11 to 15ha for 5.58% of our respondents and finally 16 to 20ha for 9.58% of our respondents.

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Wanting to know the average total forested area in our study settings, we used the average formula: **M** = $\frac{\sum fxi}{N} = \frac{1760}{240} = 7,33$

This gives us an average wooded area of 7.33 hectares.

The frequency of cuts in the afforestation and/or community forest

The following table provides information on the frequency of tree felling in afforestation and/or community forests.

Table 3: Frequency of cuts in afforestation and/or community forest.

Modality	**Frequency**	**%**
By trimester	40	16.66
Per year	123	53.24
Once every two years	77	33.33
Total	**240**	**100**

According to the results of the survey, the frequency of tree cutting is either quarterly, annual and biannual. It is annual for 123 people in our sample, i.e. 53.24% of our respondents,

It is biennial for 77 people in our sample, i.e. 33.33% of our respondents; and is Quarterly for only 40 people in our sample, i.e. 16.66% of our respondents.

This leads us to say that the forests and/or woodlands of the northern part of Kabare territory lose their trees all year round because cutting is more frequent during the year than during the quarter or two years.

Reasons for cutting trees in afforestation and/or community forest

Several reasons push the population of the northern part of the territory of Kabare to cut the trees in the woodlands and community forests.

Table 4: Reasons for cutting trees in afforestation and/or community forest

Reasons	**Frequency**	**%**
Construction of houses	97	41.99
Finding firewood	46	19.16
Embers for cooking food	52	22.51
Schooling of children	17	7.35
Health care	15	6.49
Children's dowry	13	5.62
Total	**240**	**100**

According to the results of our investigations, the following reasons are the basis for cutting trees:

- 97 people in our sample, i.e. 41.99% of our respondents, cut trees for reasons of house construction (construction wood);
- 52 people in our sample or 22.51% of our respondents cut trees in search of embers for cooking food;
- 46 people in our sample, i.e. 19.16% of our respondents, cut trees while looking for firewood,
- 17 people in our sample, i.e. 7.35% of our respondents, cut trees following the schooling of their children;
- 15 people in our sample, i.e. 6.49% of our respondents, cut trees for health care reasons and finally,
- 13 people in our sample, i.e. 5.62% of our respondents, cut down trees because of their children's dowry.

Note that the construction of houses, the search for firewood and embers occupy the first place because man has always needed to shelter and cook food or even heat himself, unfortunately in the northern part In the territory

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of Kabare, to meet food needs, we often use firewood and embers because the stoves are less used in this part but rather braziers and the traditional mode.

The number of trees felled per day in community afforestation

In view of the previous results relating to the reasons for felling trees, it is a question of knowing how many trees are felled per day in community afforestation. This led us to contact these same respondents and Table 5 shows us the exact number.

Table 5: Number of trees felled per day in community afforestation

Question	Number	Xi	Frequency	Fxi	%
How many trees can you cut down per day?	1 – 9 trees	5	95	475	39,58
	10 – 18 trees	14	47	658	20,34
	19 – 27 trees	23	31	713	13,41
	28 – 36 trees	32	25	800	10,82
	37 – 45 trees	41	21	861	9,09
	46 – 54 trees	50	9	450	3,89
	55 trees or more	59	12	708	5,19
	Total		**240**	**Σfxi = 4665**	**100**

Trees felled per day range from one to more than 55 trees. They are between 1 to 9 trees for 95 people in our sample, i.e. 39.58% of our respondents; from 10 to 18 trees for 47 people in our sample, i.e. 20.34% of our respondents; from 19 to 27 trees for 31 people in our sample, i.e. 13.41% of our respondents.

On the other hand, they range from 28 to 36 trees for 25 people in our sample, i.e. 10.82% of our respondents; from 37 to 45 trees for 21 people in our sample or 9.09% of our respondents; from 46 to 54 trees for 9 people or 3.89% of our respondents and finally from 55 trees and more for 12 people or 5.19% of our respondents.

If we calculate the average number of trees felled per day using the average formula we will have: $\mathbf{M} = \frac{\sum fxi}{N} = \frac{4665}{240} = \mathbf{19,43 \sim 20}$ Hence, an average of 20 trees are felled per day in the 5 groups that make up our study environment. If we extrapolate these results to know the number of trees cut during a year, we take the number of trees cut daily which we multiply by 366 days in the calendar year.

Which gives us **20 X 366 = 7320** trees are cut on average during the year. The question would be how many more do we plant?

The main clients of trees and their derivatives

The table below sheds light on the main clients of trees and their derivatives

Table 6: The main clients of trees and their derivatives

Modality	Frequency	%
Local population	146	63,2
City populations	74	32,03
united nations officers	20	8,33
Total	**240**	**100**

This result shows that the main customers of the trees that are cut from day to day in the northern part of the territory of Kabare are: firstly the local population at 63.2% or 146 people in our sample, secondly the population of the city (Bukavu) at 32.03% or 74 people from our sample and United Nations agents at 8.33% or 20 people from our sample.

This is for reasons previously mentioned in Table 4 of this work.

Community conflicts in Kabare and their impact on timber resources

The territory of Kabare being one of the territories appearing in the east of the DRC has not been spared from community conflicts. However, multiple conflicts have affected this territory, causing the destruction of wood resources.

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Table 7: Types of conflict

Modality	**Frequency**	**%**
Between tribe	66	27,5
Between pygmy and PNKB manager	174	72,5
Total	**240**	**100**

The types of conflicts experienced in the northern part of Kabare territory are conflict between tribes at 27.5% or 19 people of our respondents and conflict between pygmy and PNKB managers at 72.5% or 128 people of our sample.

These conflicts have several origins as shown in the table below:

Table 8: The origin of these conflicts

Modality	**Frequency**	**%**
Lack of arable land	109	45,41
Population explosion	82	34,16
Poor distribution of resources	26	17,68
Political manipulation	23	15,64
Total	**240**	**100**

It appears from this table that the origin of the conflicts is at 45.41% or 109 people of our sample the insufficiency of arable land, this is valid for the residents of the PNKB but also for small farmers; at 34.16% or 36 people in our sample the demographic explosion. On the other hand, 17.68% or 26 people from our sample affirm that the mismanagement of resources is at the root of the conflicts raging in the northern part of the territory of Kabaré and 15.64% or 23 people give as origin of the conflicts the political manipulation.

It should be recalled that our investigations confirm that these conflicts are increasingly accentuating the rate of deforestation in the northern part of Kabare territory and this requires the implementation of strategies to mitigate this rate of deforestation.

Strategies to be put in place to mitigate this rate of deforestation and/or deforestation

With the results of this research, we find that deforestation is a lived reality in the northern part of Kabare territory.

Table 9: Strategies to be put in place to mitigate this rate of deforestation and/or deforestation

Strategy	**Frequency**	**%**
Environmental education	51	21,25
Reforestation	65	27,08
Practice of agroforestry	49	20,41
Restoring state authority for lasting peace	31	12,91
Equitable distribution of resources	33	13,75
Land reform	11	4,58
Total	**240**	**100**

Based on the results in this table, our respondents came up with the following:

- Reforestation for 65 people or 27.08% of our respondents;
- Environmental education for 51 people or 21.25%;
- Practice of agroforestry for 49 people or 20.41% of our respondents;
- The equitable distribution of resources for 33 people or 13.75% of our respondents;
- Restore state authority for lasting peace for 31 people or 12.91% of our respondents;
- Land reform for 11 people or 4.58% of our respondents.

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Determination of deforestation rate

To calculate the rate of deforestation and/or deforestation in our study areas, we will take into account the data shown in Table 2 relating to the area of afforestation and community forest available in our study areas, the table 5 concerning the number of trees felled per day. The average area of afforestation is 7.33 ha and the annual average of felled trees is 7320 trees.

We all know that one hectare is equivalent to 10,000 meters or 100m2, while the normal spacing and/or spacing in afforestation is 1.5 meters between the lines and on the lines.

The number of trees per hectare is: $(\frac{\mathbf{100\ m}}{\mathbf{1{,}5\ m}})^{\mathbf{2}} = \mathbf{66{,}66^2 = 4443{,}55 = 4444\ arbres}$.

Thus, the results shown in Table 2 state that the average area of community forests and/or community afforestation is 7.33 hectares.

However, the number of trees in this area is 4444 X 7.33= 32574.5 = 32575 trees.

Knowing that the average number of trees felled annually is 7320 as is confirmed in Table 5 of this work, the average annual rate of deforestation and/or deforestation in the community forests/afforestation in the northern part of Kabare territory is:

$$\frac{\mathbf{7320\ X\ 100}}{\mathbf{32575}} = \frac{\mathbf{732000}}{\mathbf{32575}} = \mathbf{22{,}47}\%$$

Discussion of results

Recent developments in the general energy situation have not only highlighted the essential role played by wood fuels in today's world. Globally, the majority of the population still uses more firewood, charcoal and agricultural residues to meet their energy needs for cooking fuel. The history of mankind amply proves that hunger, disease and illiteracy continue to worsen and the ecosystems on which its well-being depends are constantly degraded (MICESSIL, 1992). The landslide that Africa has experienced for a century and the destruction of vast areas of forest, the degradation of wildlife, the impoverishment of ecosystems, the impoverishment and continuation at the current rate of the destruction of the vegetation cover of forests by the countries of sub-Saharan Africa, with a speed estimated at 0.7% of the deforestation rate, can lead to a hopeless situation (ENCYCLOPEDIE METAPHYSIQUE, 2009).

Ilunga (2010) points out that in the DRC, among the causes of deforestation in almost the entire country, the population being poor and not having access to electricity or any other form of energy, this people use of wood for the manufacture of charcoal, this is how in most of the country there is deforestation given the need for wood. The DRC has enormous forest potential that can settle this matter, but alas, the issues related to poverty are essential in households.

Which is not far from the results provided by this work giving the reasons for deforestation in the northern part of the territory of Kabare, including the construction of houses (construction wood), the search for embers for cooking food, the search firewood, the schooling of their children, health care and finally the dowry of their children (Table 4).

As for BIRHACIHANA (2014) maintains that the development of camps for Rwandan and Burundian refugees in Bukavu and in the grouping of Miti territory of Kabare required thousands of m3 of wood harvested largely from the grouping of Miti. The supply of firewood to these millions of refugees has also contributed to causing ecological disasters responsible for the deforestation and deforestation experienced by the province of South Kivu.

Bérenger et al (2015) demonstrate that the Congo Basin has low rates of deforestation and degradation compared to some regions of the world. However, the rate of net deforestation fell from 0.09% between 1990 and 2000 to 0.17% between 2000 and 2005. This increase was driven upwards by the DRC, where the rate doubled between the two periods, dropping from 0.11% between 1990 and 2000 to 0.22% between 2000 and 2005. Several causes can explain deforestation: direct causes, such as infrastructure development or agricultural expansion, and underlying causes, such as economic development or population expansion. Nevertheless, agriculture is the main cause, in particular the shifting cultivation practiced by the populations.

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Laporte and Justice estimated that the annual rate of deforestation between 1984 and 1998 was around 0.4%, which seems modest by standards encountered elsewhere in the tropics. However, no estimate can be considered as really reliable in the DRC (Laporte and Justice, 2001). This national average also hides strong disparities between regions. Most of the forests around Kinshasa have disappeared. Deforestation has also marked the heavily populated regions of Bas-Congo and the East.

While for this work, the average annual rate of deforestation and/or deforestation in the northern part of Kabare territory (group of Mudaka, Miti, Bugorhe, Bushumba and Irhambi Katana) is 22.47%, which is very far from the results provided by Bérenger et al.

Conclusion and strategies

Aiming to determine and assess the rate of deforestation in the post-conflict zone, the case of community forests around the Kahuzi-Bièga National Park in Kabare Nord; During our field investigations, with a representative sample of 240 people or 0.067% randomly drawn, we observed that all our respondents have a forest in the northern part of Kabare territory.

Our respondents have once cut down a tree or more than one tree in the forest, whether family or community (churches, associations and businesses) and the frequency is annual at 53.24%. Several reasons are at the base of this cutting of trees including the construction of houses (construction wood), the search for embers for cooking food, and the search for firewood, the schooling of their children, health care and finally the dowry of their children. On average 20 trees are felled per day in the 4 groups that make up our study environment and 7320 trees are cut on average during the year (Table 19); thus reducing the rate of deforestation and/or deforestation to 22.47%.

Thus, with the results obtained on the ground, we believe that the following strategies would be a palliative in order to mitigate the rate of deforestation around the PNKB:

1. **Reforestation**: With a view to plant cover and the restoration of tree species deforested following community conflicts, our respondents insist on the strategy of reforesting spaces that have been laid bare by man. This will then go through the stage of installing germinators for the multiplication of tree seedlings. Once multiplied, the seedlings will be placed in a nursery in each village before being distributed to the population in order to move on to the reforestation stage. Once distributed, everyone (population) in their plot can plant at least one tree there and those with large areas can do better by enhancing them through reforestation.
2. **Environmental Education:** Protecting the environment is everyone's business. The machines are major with regard to a future limitation of raw material and energy resources and the environmental and health impact of the non-protection of the environment. The environmental education of the population in terms of the environment integrates the problem from upstream and when an activity can potentially cause an impact on the environment. The engine of this protection must take into account environmental education through sensitization on the advantages and disadvantages of the tree in the daily life of the inhabitant of North Kabare.
3. **Restoration of state authority for lasting peace:** Nothing can work without state authority. Supported by 12.91% of our respondents, i.e. 31 people in our sample, this restoration of State authority involves peacekeeping operations based on three components (presence, capacities, and legitimacy). The equitable distribution of resources The inequality in the possession and natural distribution by man on a regional or even national and global scale is a reality that all disciplines are trying to understand better and better today because the equality has far-reaching consequences for the development of society as well as the destruction of the environment. It is therefore preferable to distribute the resources fairly, thus limiting the destruction of the fact that everyone benefits equally.
4. **Land reform:** In North Kabare, since the colonial states introduced Roman land law, there are, in theory, no longer pure customary land systems, i.e. based on collective ownership. However, the overlapping of different legal registers in practice leads to a plurality of legitimacies and generates problems of land tenure security. Hence, the principle of land reform should generally be based on transforming a land system based on private property into a land system based on collective property. Thus, land reform should be understood as the unification of different land tenure systems.

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