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Research Paper

Perceptions and alternatives of the population and stakeholders (PNKB and partners) in reducing deforestation

Emmanuel Bisimwa Ciregereza[1,2], Fils Milau Empwal[2], Lukoki Luyeye[2,4], Jean Augustin Rubabura Kituta[1], Parent Zihalirwa Kulimushi[3], Honoré Belesi Katula[2]

[1]*Department of Environment, Research Centre in Natural Sciences, South Kivu, DRC*
[2] *Faculty of Sciences, Department of Environment, Kinshasa University, DRC*
[3] *Faculty of Agronomy and Environment Sciences, Department of Alimentary Technology and Biotechnology, Evangelical Africa University, South Kivu, DRC*
[4] *Faculty of Sciences, Faculty of Sciences, Department of Biology, Kinshasa University, DRC*
Corresponding Author: Emmanuel Bisimwa Ciregereza

ABSTRACT: *In this article, we analyzed the perceptions and alternatives of the population and stakeholders (PNKB and partners) in contributing to reducing deforestation by identifying resources and showing alternative activities. Data were collected in the field using participant observation coupled with semi-structured interviews, focus groups and survey questionnaires. The results obtained showed that biogas resources, the application of environmental laws, micro-hydroelectric plants and hydroelectric power stations, peat bogs, the photovoltaic power station, the falls of the large rivers in the villages, methane gas from Lake Kivu, the hydroelectric power station, Brickworks, gravel quarries, sand quarries, reforestation by households and plantations by companies established in the area, clay quarries and the Katana cement plant could all contribute to reducing deforestation in the villages and in the park. Reducing deforestation also requires encouragement and support for the domestication in the villages of the trees sought after in the PNKB by local residents, and the reforestation and development of ecological villages around the PNKB in the Kabare Chiefdom.*

KEYWORDS: *PNKB, Ecological, Population, Alternatives, Reducing, Perceptions, Stakeholders, Deforestation*

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I. INTRODUCTION

The Democratic Republic of Congo (DRC) is firmly committed to a national strategy aimed at reducing greenhouse gas emissions from deforestation and forest degradation (REDD+). In this context, the country has developed and has a REDD+ Preparation Plan (R-PP), a plan which has been developed, discussed and validated in the country as well as adopted internationally. In this context, the DRC enjoys the joint support of the Forest Carbon Partnership Facility (FCPF) of the World Bank, and the UN-REDD collaborative program of the United Nations [1]. The direct causes of deforestation are human activities that directly affect the environment. They can be interpreted as the most immediate factors that directly impact forest cover. In terms of scale, the direct causes are observed at the local level such as the observation sites of the studies for example [2]. The underlying causes of deforestation (or social processes) are seen as the fundamental forces that underlie the direct causes of deforestation. They can be seen as associations of social, political, technological and cultural variables which constitute the initial conditions in human-environment relations. In terms of scale, the underlying causes can operate directly at a local scale or indirectly at a national or even global level [1].

In the East of the DRC in the province of South Kivu, in the PNKB and its surrounding villages; deforestation is done daily through extensive agriculture following the demographic explosion, the search for land, the carbonization of wood for energy needs, the search for building materials, the proliferation of clandestine sawmills for timber and the illicit exploitation of minerals. The latter is also dominant. This situation

is more catastrophic the closer you get to the city of Bukavu, the more the carbonization and cutting of wood for energy needs and the construction or firing of bricks increase their impact on deforestation[3] and [4].
Some authors such as Muhigwa and al. (2007) [5] and Karume (2010) [6] reveal that wood consumption is related to deforestation. The majority of houses in South Kivu use wood (in rural areas) or charcoal (in urban areas), including 5.23 million and 3.81 million tons per year. Per carbonization episode, the carbonizes obtain an average of 7 bags of embers and the carbonization frequency is twice a week with an average felling of 6-7 trees.

According the deforestation, Karume (2010) [6] informs that the accentuation of energy shortages is a corollary of untimely power cuts and the low use of gas in domestic use despite the potential of Lake Kivu as this source of energy. He adds by pointing out that despite the large hydroelectric capacities of South Kivu estimated at 3000 MW, less than 1% of this capacity is exploited. This situation is a legacy of nearly two decades of political turmoil, internal conflict and economic decline that have reduced commercial energy supplies while weakening energy production and use and thereby increasing the importance and cost of exploitation … inadequate for the management of energy resources. The net result has been strong pressure on the natural resource base, mainly forests leading to forest degradation and deforestation [6]. The operators are mostly local natives working for them or the big traders in these products [6] and [7]. Apart from firewood, the PNKB in particular, in the high altitude part, is under significant pressure, especially in the bamboo forest. This shrub is sufficiently sought after in the construction of fences, and dwellings in neighboring villages as well as in the city of Bukavu which already has more than 600,000 inhabitants. In addition, every year about 10,000 bags of charcoal are sold in the northern part of Kabare territory alone park [8] and [9]. This strong dependence of the population of the city of Bukavu and other surrounding areas on firewood and charcoal leads to growing deforestation, sometimes uncontrolled, inside the Kahuzi-Biega National Park and outside in peripheral territories. Its consequences lead to enormous losses and/or the reduction of certain ecosystem services offered by these forest ecosystems (climate change, vulnerability to natural risks, reduction of wood and non-wood forest products, etc.) to local communities [10] and [11].

This paper contributes to the analysis of the perceptions and alternatives of the population and stakeholders (PNKB and partners) in the reduction of deforestation by determining the resources or potentialities available and showing the substitution activities.

II. MATERIAL AND METHOD

2.1 STUDY MATERIAL

The study focused on 7 groups (Bugobe, Cirunga, Bushwira, Mudaka, Miti, Bugorhe and Irhambi-Katana) out of 14 groups that make up the Kabare Chiefdom. It lies between Longitudes 28° 55’ and 28°45’ E to Latitude 2°27’ and 2°19’ S. The area covers 1265 km^2, with an elevation between 1460 and 3000 m above the sea level. Its 14 groups are Irhambi-Katana (117 km^2), Bugorhe (108 km^2), Cirunga (102 km^2), Bushwira (100 km^2), Bushumba (98 km^2), Mudaka (93 km^2), Mudusa (91 km^2), Bugobe (90 km^2), Mumosho (87 km^2), Luhihi (86 km^2), Lugendo (85 km^2), Kagabi (83 km^2), Miti (80 km^2) and Ishungu (45 km^2) (Kabare Chiefdom Office, 2019). The neighbouring villages of PNKB that were the subject of this study are Karhwa/Kalulu (Bugobe), Munguzi/Cibingu (Cirunga), Bibanda/ Bushwira centre (Bushwira), Mugangane/Cibumbiro (Mudaka), Kamalyongo/Cibinda (Miti), Cisirhu/Kamakombe (Bugorhe) and Maziba/Kahungu (Irhambi-Katana). Participant observation and survey were carried out from January 7, 2019, to October 18, 2021. Figure 1 represents the sampling sites in the seven groups of the study area.

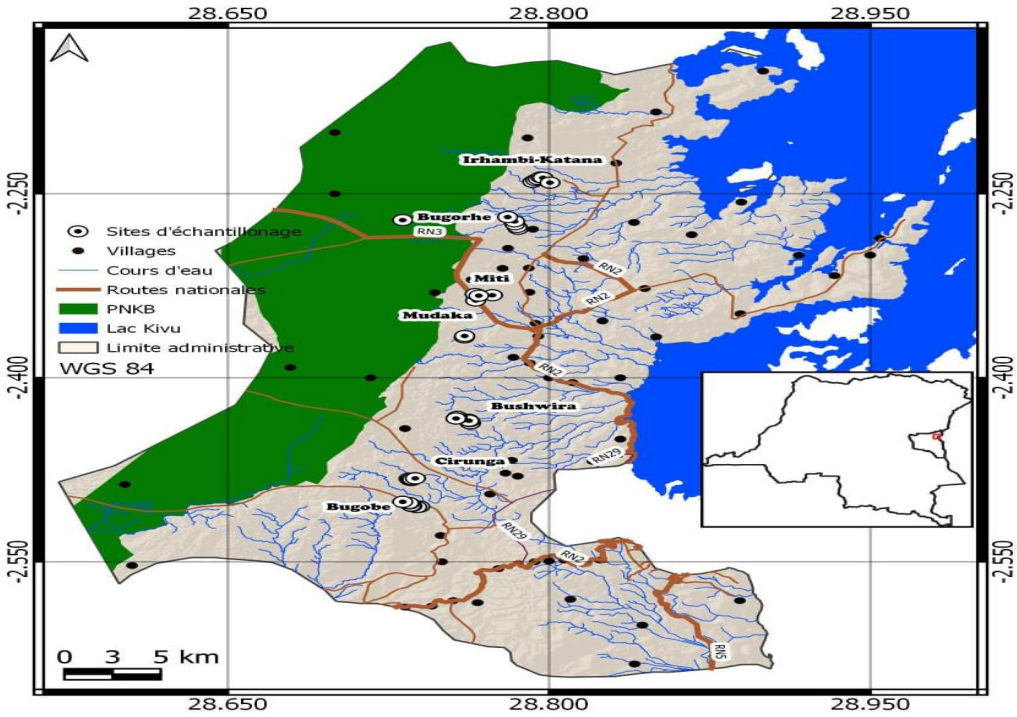

Figure 1: Sampling sites in seven groups of the Kabare Chiefdom

This study area located west of the former province of Kivu, the Kabare Chiefdom (Figure 2) is limited:

- To the north by the Nyabarongo River which separates it from the territory of Kalehe,
- To the south by the Chiefdom of Ngweshe in Walungu territory,
- To the west by the Kahuzi Biega National Park (PNKB) and by the Lushanja River which separates it from the Nindja Chiefdom, the Kalonge group (Buhavu community in Kalehe territory),
- To the east by the Bukavu City, by the Ruzizi river towards Rwanda and by Lake Kivu.

This Chiefdom extends over an area of 1265Km^2 with a population of 824418 inhabitants in 2020 and a density of 686 inhabitants/Km^2 from Kabare Chiefdom, Local Development Plan 2021-2025[12].

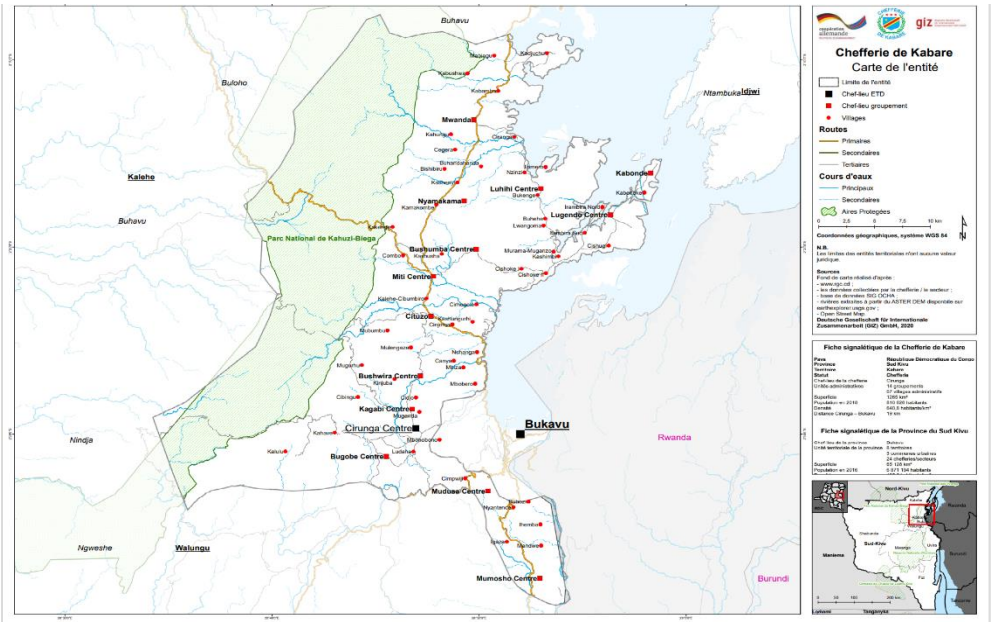

Figure 2: Geographic location map of Kabare Chiefdom [12] and [13]**.**

2.2 STUDY METHODOLOGY

2.2.1. Direct observation method

This method of participant observation consisted of this study carrying out field investigations with households, with actors involved in forestry in the study area. It was also used to observe the effects of deforestation on the real life of respondents in the field through their lifestyles. Then she helped us stay (live) in the study area for the duration of the research. This allowed us to familiarize ourselves with the respondents, to easily collect data on deforestation and then also to discuss with the respondents in their environment to deepen the information received, the observations made directly on the phenomena of deforestation which underlie their socio-economic life in this part of the Kabare Chiefdom.

2.2.2. Documentary method

Documentary research as an indirect observation consisted in identifying and clearly defining the problem related to deforestation in the study area. To do this, documentary research related to deforestation in the study area was linked in a critical approach to the contents of linear documents (books, encyclopedias, electronic sites, articles, activity reports, maps, plans development of the Kabare Chiefdom,…); with particular attention to writings that emphasize aspects of the socio-economic life of the area population study.

2.2.3. Remote sensing and mapping

Remote sensing by uploading images to the USGS site and mapping were carried out to obtain maps of the evolution of plant cover and land occupancy rates in the study area from 1990 to 2020. To do this, the Landsat satellite images and the shape file of the study area were exploited in the WGS 84 geographic coordinate system from the website: https://earthexplorer.usgs.gov/. Then, these images were visualized and analyzed with the QGIS 3.22.8 software in order to allow this study to define the different classes of land cover in the study area. Through the SCP extension (Semi-automatic classification plugin) of this QGIS 3.22.8 software, the classes of vegetation, buildings, watercourses and soils have been used as objective classes or macro-classes. The classes of forests, plantations, crops, swamps, dwellings, bare soil and water have also been used as subclasses or spectral classes[12].

2.2.4. Survey Questionnaire

The survey questionnaire technique was used in the field to collect data from the sample of respondents drawn from households and staff members working in the study area. This technique allowed us to obtain reliable information thanks to the questions posed directly to the respondents involved (households and stakeholders) in deforestation and/or in its effects across the study area. The answers obtained were directly recorded in the notebooks in the field before being entered on the computer in the data matrix.

2.2.5. Semi-structured interview (intensive indirect observation)

The collection of data in the field through participant observation coupled with a semi-structured interview nourished by exchanges with the respondents was carried out using the questionnaire (with open and in-depth questions) serving as an interview guide in 7 groups in the study area (Bugobe, Cirunga, Bushwira, Mudaka, Miti, Bugorhe and Irhambi-Katana). This interview was conducted as an individual interview in order to deepen the understanding, opinions and positions of the respondents regarding the object of study. This phase allowed us to build the socio-economic events of deforestation activities on the life of the population surveyed in the Kabare Chiefdom on the edge of the PNKB.

2.2.6. Focus groups

Focus groups with members of the staff of institutions operating in the study area, and even with members of households in the same area, were carried out in the seven groups targeted. These focus groups provided information or data on strategies or mechanisms that could be used to reduce deforestation and/or pressure on wood resources in the study area. This technique was also used to understand the determining factors for the development of ecological villages around the PNKB in the Kabare Chiefdom.

2.3 SAMPLING AND ANALYSES

The sample was considered to be a segment or part of the studied community that bears the characteristics of this community and represents it with regard to the object of the research [12]. In this regard and given the difficulty of being able to reach all households in the Kabare Chiefdom, the study focused on 7 groups (Bugobe, Cirunga, Bushwira, Mudaka, Miti, Bugorhe and Irhambi-Katana) out of 14 groups which make up the of Kabare Chiefdom.

Households and institutions in villages close to the PNKB, i.e. on the direct border with the PNKB, were taken into account. The distribution of the probabilistic sample for the survey was carried out taking into account the two categories (households living around the PNKB forest and development actors engaged in the fight against deforestation who work directly with the households around the PNKB) to obtain useful information on the perception and alternative of the population and stakeholders (PNKB and partners) in reducing deforestation in the study area.

To do this, the probability sampling technique has been chosen for its ability to give each element of the parent population the same chance of participating directly in this survey with a degree of precision of 5% and confidence of 95% [15] and [16] . The sample was calculated based on the degree of confidence of 95% and that of precision of 5% obtained using the table for estimating the size of a probability sample as proposed by [15]. This sample must represent at least 10% of the size of the parent population and must consist of a minimum of 30 units [15]. Moreover, the sample calculation as done at this level in this study is also confirmed by the Raosoft formula online [16]. In terms of the numbers we have selected below, the sample size (n) and the margin of error (E) are given by

$x = Z\left(\frac{c}{100}\right)^2 r(100-r)$, $n = \frac{x}{\left((N-1)E^2 + x\right)}$, $E = Sqrt\left[\frac{(N-n)x}{n(N-1)}\right]$ Where N is the population size, r is the fraction of responses you are interested in, and $Z\left(\frac{c}{100}\right)$ is the critical value for the confidence level.

The sample is 19.7% or 307 households drawn from a parent population of 1560 households bordering the PNKB and from a sample of 52.2% of staff members of institutions working in the fight against deforestation on the edge of the PNKB i.e. 58 agents taken from a parent population of 111 staff members involved in the field of deforestation in the study area. Hence the sample of 307 households and 58 local development actors was chosen to provide information and other data for this study.

2.2.7. Statistical analysis

This technique was then used in the collection of data in the study area, through the linking of information obtained from the respondents and in the assessment of the relationships between the different variables chosen for study. The data obtained during the surveys were encoded on Microsoft Excel (2010) sheets. And the descriptive analysis of the data was done using IBM SPSS Statistics 25 software and pie charts by Microsoft Excel (2010).

III. RESULT AND DISCUSSION

3.1. Perceptions

3.1.1. Perceptions of deforestation reduction projects in the study area

The results presented in Figure 3 below about projects or activities to combat deforestation carried out by stakeholders in the study area: According to 50% of respondents, there are no projects to combat or reduce deforestation in the study area, and 14% reported population has been made aware of the need to reforest of villages in the study area. This was followed by modest support (with a few seedlings and/or seeds) for agroforestry and the rehabilitation of *Eucalyptus* sp. afforestation. Again, 14% of respondents reported microcredits were granted to a few influential households in the villages (teachers, shepherds, village chiefs and sub-chiefs) to prevent the population from continuing deforestation in the world heritage area (PNKB), not to mention the deforestation already taking place in the villages around the park. There is support for the schooling

of some Pygmy children in the study area reported by 7% of respondents. Additionally, 7% of them reported micro-projects to support the marketing of a few works of art (gorilla sculptures in wood or on banana sheaths, mats, wooden statutes, wooden cups, baskets, ropes, valves, mortar, mixers, harps, spears, etc.) from households in the villages around the PNKB. Then, 2% of respondents reported domestication of the forest tree species of the PNKB, and other 2% reported there have been patrols and anti-poaching activities in the riparian zone of the Kabare Chiefdom. Other again 2% reported to support for stabling livestock in the area around the PNKB. Respectively 1% reported erosion control at some points in the study area, and other ecological education has been carried out in the study area for a small number of the population (Figure 3). Given the above, these results show that deforestation in the villages of the Kabare Chiefdom around and the PNKB has not yet found a solution that addresses the root causes driving the population to put pressure on wood resources in the study area. Actions taken to date to reduce deforestation have neither targeted its causes (the primary or survival needs of the poor population) nor its environmental effects (erosion in villages, infertile soils, disappearance and threat to flora and fauna, etc.). Moreover, a few people with high rank and/or influence in the area are the ones who benefit from financial support to the detriment of the majority of the population, who are poor and would be the most direct beneficiaries. Marginalization in microcredit (financial) support encourages the poorest, who are the most numerous, to resort to deforestation for their financial needs and other goods and services necessary for their lives. In addition to the fact that most of the people surveyed belong to this category, who live off the deforestation around the park, as mentioned in the results of the study on the "Socio-economic and ecological characteristics of deforestation at the edge of the PNKB, Kabare Chiefdom" [12].

In summary, considering these results relating to the projects carried out, for half of the respondents there has been no project to reduce deforestation in this study area. The projects have not focused on the livelihoods of households on the edge of the park who are struggling to survive and whose survival depends on deforestation. And in all respects, the projects or activities carried out have not sufficiently met the aspirations and expectations of the population. Households involved in deforestation in the villages and the PNKB have been reached neither directly nor indirectly by the positive impact of the projects implemented. These households do not feel concerned so as not to focus more and more on the deforestation that ensures their survival. Although trees are becoming increasingly rare in this environment, deforestation is increasing overnight. Instead, they are complaining about the increasing remoteness of the forests. They are forced to travel and/or stay in other areas (especially those with chainsaws) to carry out deforestation activities from village to village and sometimes beyond the Kabare Chiefdom, in the neighbouring of Nindja Chiefdom and/or that of Ngweshe/Walungu territory or in the Buhavu Chiefdom, in Kalehe territory. The demand for wood energy and charcoal is increasing not only because of the energy demand but also because of the demand for trees and planks for building houses. This is good business for the households that benefit from it. This is further increasing the pressure on wood resources, despite the existing potential for renewable energy and the conventions ratified by the DRC. The DRC has ratified several agreements relating to the reduction of emissions that contribute to global warming of planet Earth (the protective mother of all living things). In this respect, Kasongo (2017) [17] points out that the earth is undergoing profound ecological changes often caused by human activities in many areas, such as energy, which generates greenhouse gases with remarkable negative impacts on the environment. Because of the worrying scale of these negative impacts on the environment, some countries, including the DRC, have signed international agreements which they must take on board to reduce deforestation and live up to the commitments they have made. In the case of the DRC, these include the Convention on the Protection of the World Cultural and Natural Heritage, ratified on 17 December 1975, the Convention on the Protection of the Ozone Layer, ratified on 15 September 1994, the Convention on the Conservation of Nature and Natural Resources, ratified on 13 November 1976, and the Convention on the Conservation of European Wildlife and Natural Habitats, the Convention on the Conservation of Biological Diversity ratified on 15 September 1994, the Tropical Timber Convention or Agreement ratified on 20 November 1990, the Plant Protection Convention ratified on 16 September 1975, the Convention on the Protection of Wetlands ratified on 15 September 1994, ... [17].These findings are in line with those of [8] ratified on 16 September 1975, the Convention on the Protection of Wetlands ratified on 15 September 1994, ... who reports that around 10,000 bags of charcoal are sold each year in this area, in the northern part of the Kabare Chiefdom alone. He also points out that this quantity of charcoal is equivalent to 1,700 carbonized trees, which represents more than 90 hectares of deforestation in the field.

These results also tie in with the analysis of forest degradation indicators carried out by [18], which reveals that deforestation is one of the major problems facing tropical countries. For these authors, in Madagascar, the natural forest is gradually diminishing and now covers only 16 to 17% of the country, whereas in 1950 it still represented 24 to 28% of the national surface area. And between 1950 and 1970, the country had an annual deforestation rate of 0.3%. This progressive rate rose to 1.7% between 1970 and 1990, and between 1990 and 2000 it fell to 0.7%. These results are also in line with those of Asia et al, reveal in turn that for forest governance in the DRC at the community level, participatory sustainable management of forests or types of

specialized areas (community forests, buffer zones for protected areas, hunting domains, etc.) has always come up against difficulties of a technical nature due to the methods of exploitation, of a financial nature (conflict of interest), of an organizational nature (methods of association) and a political nature (with the involvement of power elites linked to the management and use of the natural environment). Forest management and the implementation of projects or programs neglect community participation and the forecasting of impacts (positive or negative) before project design and implementation, despite the existence of donor funding to support and encourage sustainable and responsible participatory management of natural resources for present and future generations. For these authors, the main difficulty lies in the anthological analysis of the beneficiary populations, and in the sustainable environmental development policies put in place to demonstrate the crucial importance of forests to the well-being of the Congolese population, 70% of whom depend on forests for their livelihoods.

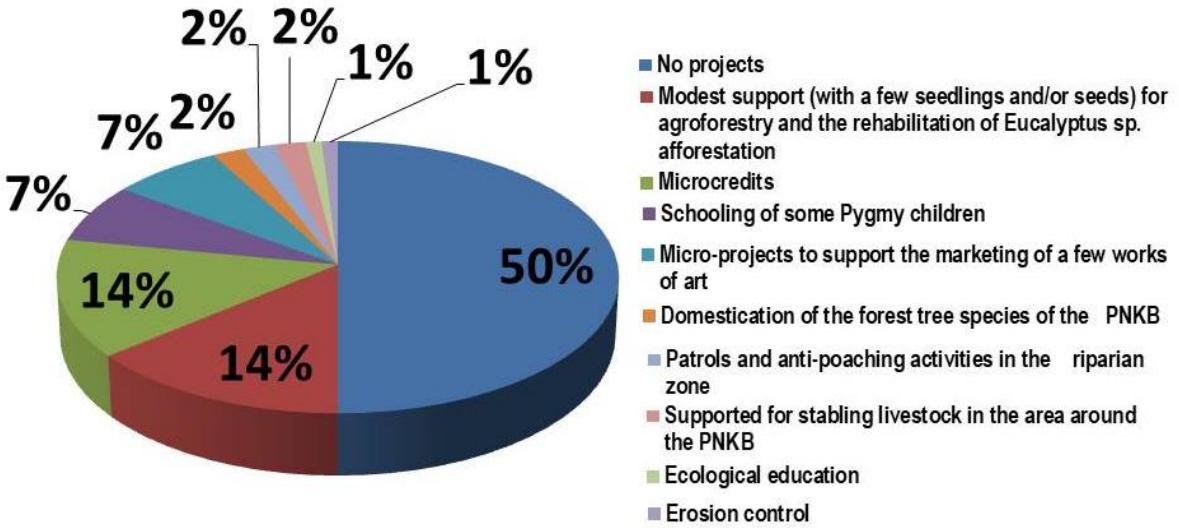

Figure 3: Deforestation reduction projects and activities carried out in the study area

3.1.2. Type of lighting and fuel used in the study area

3.1.2.1. Types of lighting

Table 1 below shows the types of lighting used by the population around study area, Kahuzi Biega National Park in South Kivu region.

Table 1: Types of lighting

N°	Lighting used by households in the study area	%
1	Battery torches	75,6
2	Small-capacity solar panels	16,6
3	Kerosene lamps	7,8
Total		100

To the results shown in Table 1, the majority of households surveyed in the study area use battery torches (75.6%) to provide light at night in their homes and outside if they have to leave the house at night. 16.6% use solar panels to provide light at night and 7.8% use paraffin lamps to provide light inside and outside the house at night. These types of lighting are used in this area because of the lack of electricity. Most are imported from China. Farmers normally have access to them after selling their agricultural produce, especially onions and tomatoes, or trees and their by-products (planks, fuelwood, charcoal, furniture, works of art, etc.). They do not contribute enough to improving the socio-economic living conditions of households in this part of the Chiefdom and/or to increasing the economic well-being of this poor population, which depends on wood products, and so the forest is part of their way of life, expressed more by the effects of deforestation. These results are in line with [19],Badie and Tolotti (2008), who assert that poor development conditions for a population have the serious consequence of leading to the emergence of precariousness in the environment, resulting in an increase in the number of new poor due to the mechanisms of social reproduction. [20],

Barhimanya et al (2014) echoing these findings and drawing on the positive impact of electrification as a trigger for positive change and a driving force for improving living conditions in rural areas in Abidjan in 2002, reassured us that electricity is a key factor in the development of the rural population. They reassure us that electricity on the edge of the PNKB will help to reduce deforestation in the area thanks to its traditional capacity to promote socio-economic and ecological development and to protect the environment. They go on to say that an integrated and comprehensive bio-economic program needs to be put in place in the PNKB coastal area to reduce the negative impact of human activities on the biodiversity of the PNKB and its surroundings, particularly the onerous tasks associated with the search for wood energy and charcoal in the villages.

These results are also in line with the views of [21] White and Anderson (2013), who stress that energy needs must be met using existing renewable production technologies (taking care to respect the following order of priority and sustainability criteria: solar, wind, hydro, geothermal, and only then, under certain conditions, bioenergy). They insist that the global energy transition between now and 2050 must be based on maximizing the real energy potential available in the environment by making the most of energy sources and the economics of energy. These energy sources must be drawn from the energy potential of renewable resources. They must then contribute to reducing as far as possible the greenhouse gas emissions associated with the search for energy in this environment.

3.1.2.2 Fuel types

Table 2 below shows the types of fuel used by households or the population in the study area.

Table 2 : Types of fuel

N°	Fuels used by the household in the study area	%
1	Wood-energy	65,8
2	Charcoal	34,2
Total		100

The results in Table 2 show that 65.8% of households use wood energy or wood as fuel for cooking in the household. 34.2% use charcoal as fuel. It should be emphasized here that the fuels are based on deforestation in the study area (Bugobe, Cirunga, Bushwira, Mudaka, Miti, Bugorhe and Irhambi Katana groups in the Kabare Chiefdom on the edge of the PNKB). In addition, there is sufficient potential to generate hydroelectric power in this area. The electric current that arrives in this area is insufficiently weak to ensure cooking. Secondly, it arrives very late at night (after midnight and only in certain places). The population does not rely on this current for lighting, cooking or other activities requiring electrical energy. These energies (wood energy, charcoal, paraffin lamps, pails, torches and panels) are used without any prior calculation or study of their short-, medium- and long-term impact (waste and other pollution) on the health of the population, on biodiversity, on the environment and on the climate change that often follows as a result of nature's reaction.

Tables 1 and 2 are naturally in line with those of [22] PNUE (2011) and [23] Balagizi (2012), who argue that wood energy and charcoal are the fuels most used by households (in South Kivu province), which are dependent on them, without taking account of the heavy expenditure that can be expected in the forestry and agricultural sectors in terms of resilience in the face of climate change and the rehabilitation of degraded plant cover. [6] Karume (2010) and [23] Balagizi (2012) add to this by pointing out that even in the town of Bukavu, which is at least 12 km from the Kabare Chiefdom, the electricity supply is often interrupted, forcing households to rely on wood and charcoal for more than 90% of their cooking needs. In Karume, 9% of the population of Bukavu has access to electricity. In rural areas such as Kabare, only 1% of homes are connected to the electricity network. This increases the demand for fuels derived from forest biomass (charcoal, wood energy) and increases the rate of deforestation, forest degradation, erosion, landslides and other ecosystems[23].

These findings are also in line with those of [24] Lepage(2008), who announced in the State of the World 2009 [19] (Badie and Tolotti 2008) that climate change calls on everyone to adapt because the contribution of human activities to global warming is no longer in doubt. The consequences of climate upheaval are unequivocal and call for rational action to deal with disruption and its effects on ecosystems. It also adds that the vulnerability of the populations affected by ecological transformations and climate upheavals highlights the need to challenge every society's ability to respond.

3.1.3 Degraded ecological zones, causes of Degradation and victim populations

3.1.3.1 Ecologically degraded areas

Figure 4 presents the results of the ecological zones degraded or weakened by deforestation in the study area through the villages bordering the PNKB in the chiefdom of Kabare (Figure 4, 1st, 2nd, 3rd and 4th groups):

For the first group, 62% of respondents did not answer this question. This was followed by 12% for the PNKB ecosystems, 5% for the vulnerable ecological zone of Kamakombe, 9% for the degraded ecological zones, including 3% each for Lukananda, Kafurumaye and Tchombo, and 12% for the other ecological zones. degraded, with 2% each for Cironge, Kajeje, Kakundu, Maziba, Mulangala and Mushuva. The second group, 91% also did not answer, 5% for the ecologically degraded area of Rwabika, and 2% for those of Muhonga respectively. For the third group, 93% also did not respond, 5% for the ecologically degraded area of Kashenyi and 2% for that of Bulenge. For the fourth group, 90% did not answer, 7% for the ecologically degraded area of Nyamakana, 2% for Kamakombe and 1% for Kabulungu. Briefly, the appearance of ecologically fragile areas affected by deforestation in the villages around the park worries everyone. The results for no response, 93% (third group), 91% (second group), 90% (fourth group) and 62% (first group), do not necessarily mean that there is no ecologically degraded area in the villages of the study area: a hostile climate and boundary conflicts prevail between the PNKB and the residents of the park. In this regard, there is more of an image of concern and guilt in the unsaid around the park that has been degraded by deforestation, where no one takes their responsibility for deforestation seriously or enough yet, given that the environment pays the bill.

These results agree with those of Baligizi et al (2013)[23], who describe the environmental problems and visible impacts of deforestation in the Lwiro region, indicating that 85% of the area of the region is devoid of trees and that at least 10,000 of the households with firewood needs live around these forests. They then specify that the few remaining groves are the private property of the CRSN in the Bugorhe and Irhambi-Katana groups; the remaining groves are those of the minor seminary of Mugeri, the plantation of Kakondo and Fomulac, with a total forest area of 45 hectares for these two groups, neighbors of the PNKB in the chiefdom of Kabare. These results are also in line with Kasisi (2012) [25] who asserts that the natural resource management model must be rethought collectively and clearly to conserve biodiversity. He goes on to point out that due to threats to the biodiversity and/or ecosystems of the PNKB, people have died in clashes between the forest rangers (eco-guards) and the residents of the Kabare park following the attack of these latter. [25] also adds without calling into question the categorization of threats or types of degradation - that there is a lack of sincere debate on the shared meaning of the notion of biodiversity conservation, even though this debate is a necessary prerequisite for a responsible commitment to the process of conservation and protection of ecosystems. In line with these results, Limoges et al (2013)[26] emphasize the need to establish and popularize a common language relating to the unavoidable need to harmonize forestry practices and concepts, and the objectives pursued in the responsible management of protected areas and forests for the imperative of sustainable environmental conservation. The degradation of ecological zones by human activities continues to harm biodiversity and populations of fauna and flora due to the disturbance or denaturation of habitats and/or the alteration of ecological functions. With the majority of States in the world having ratified the Convention on Biological Diversity, ecological planning for sustainable development becomes an imperative for the productivity of biological resources and ecological services, in order to obtain objectively verifiable measures for the harmonized protection of fragile ecosystems. Tsayem (2010) [27] adds that for climate change mitigation (betting on reducing emissions from deforestation and degradation) avoiding or reducing deforestation and ecological and/or forest degradation which ensues; there are additional proposals to the Kyoto Protocol regarding greenhouse gas emissions. These proposals include tropical forests and their ecologically degraded areas.

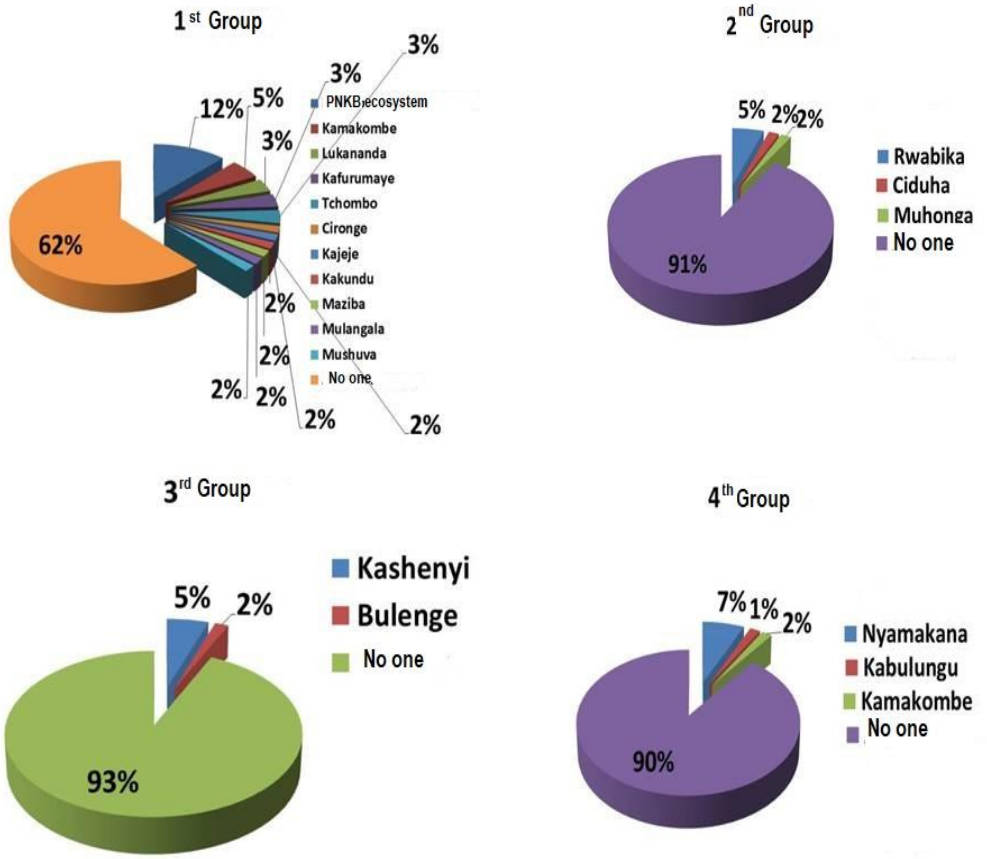

Figure 4: Degraded ecological zones in the study area

3.1.3.2. Causes of degradation

Figure 5 below presents the results of the causes of the degradation of ecological zones in the study area. According to these results, the carbonization of trees in degraded areas is in first place at 48%. It is therefore the main cause. The regular felling of large numbers of trees in the study area is also in second place with 33%. This feeling is carried out to obtain energy for cooking, to sell trees, to build houses, etc., sometimes without taking into account the maturity of the trees to be cut (*Eucalyptus* sp trees are now cut between 2 and 3 years old instead of at least 7 years old) or their ecological role in the environment. The sawing of trees to obtain planks follows with 14% and then comes the poverty of the population in search of income to survive with 5%. These results are in line with those of [23] Balagizi et al (2013), who points out that the hidden causes of the degradation of the ecological zones around the PNKB, particularly in Maziba, Kahungu, Kabushwa and Mantu, are that 100% of the local population depends on wood for cooking, followed by massive and uncontrolled deforestation between 1994 and 1996 due to the influx of refugees and the increase in wood suppliers in the refugee camps during the same period. In addition to deforestation in the villages on the edge of the PNKB, there are no ecological buffer zones where trees should not be cut down. This lack of buffer zones accepted by the park's residents means that the park remains in continuity with the neighboring villages of the Kabare chiefdom. Baboons also often take advantage of this by depredating crops and spreading parasites to the fields in the villages around the PNKB.

These results are also in line with [27] Tsayem (2010), who points out that many human activities are still responsible for the degradation of ecological zones. These include charcoal burning, oil and gas burning, deforestation, livestock farming, urbanization, transport, etc., the consequences of which contribute to ecological imbalance and temperature increases due to the concentration of greenhouse gases (GHGs) in the atmosphere. These results are also in line with [25] Kasisi (2012), who states that what accentuates the causes of the degradation of ecological zones in sub-Saharan Africa is the difficulty of getting people to take up the cause of conserving biological diversity and protecting ecosystems. Populations consider themselves marginalized socially, economically, politically and culturally by the cause of protecting and conserving biodiversity, to the detriment of their well-being. These results are in line with [28] François (2015), who also states that for the

causes of ecological degradation and the philosophical vision of creation in the face of biological innovation, it is important to remember that the human being is not an external factor to be excluded from the conservation of ecosystems and biodiversity. They certainly intervene in the plant and animal world and/or make use of it when necessary for their survival. To do this, the experiments must be legitimate and respect the integrity of the existence of both plants and animals. The conservation of biological diversity, the protection of ecosystems and respect for ecological preservation remain essential for the quality of life (the integrity of ecosystems and human life). They must be done within reasonable limits, so contribute to and continue to save and care for the reason for being on the planet. The dignity of living beings must not suffer needlessly on earth, and humans must not find themselves driven to waste their lives. The need for a new direction is clear. The collective awareness of the ecological, cultural, educational and spiritual challenge is highlighted and calls for a long process of regeneration.

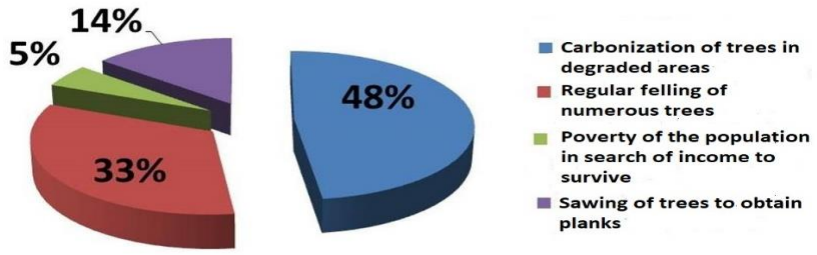

Figure 5: Causes of degradation

3.1.3.3. Biodiversity Threatened in degraded ecological zones

Figure 6 (group 1 and group 2) shows the threatened biodiversity that needs to be protected in ecological zones degraded by deforestation. These threats are progressive and can already be broken down into the following two groups: For the first group, Gorillas Beringei graueri at 26% and varieties of food crops at 26% are the most threatened. Next, come all the bird species with 14%, then the arable soil and soil fauna in the villages around the PNKB with 10% and the PNKB forests and other large mammals (elephants, antelopes, buffalo, wild boar, monkeys and chimpanzees) with 10%. Cane rats or "Aulacodes" (9%) are the most threatened, along with other small mammals in the PNKB (3%); trees in the ecological zones of the PNKB are also threatened (2%). For the second group, arable soil and soil fauna in the villages around the PNKB with 26% occupy first place whereas in the first group where the threats occur inside the PNKB, they were in third place with all the birds in the study area. Food crops followed with 21% (they continue to occupy the second place as in the first group). Crop varieties have become vulnerable to new emerging plant diseases, resulting in reduced plant yields and soil productivity), small mammals in the PNKB with 19% (whereas in the first group of threats, they had only 3%), gorillas *Beringei graueri* with 12%, cane rats with 3%, the flora of the PNKB with 2% and the vegetation and even certain medicinal plants in the villages around the PNKB also with 2%. And yet the protection and conservation of all these biodiversities and their habitats for sustainable development constitute an alternative to resilience to climate variability or climate disruption and certain disasters currently occurring in this region. These results show that the threats vary depending on whether we are in or around the park in the Kabare chiefdom. These results are in line with [29] Ron Hubbard (2001), who points out that all animals, including human beings, are always looking for a less threatening environment, or at least a way of coping better with the hostile environment in which they live or evolve. For [30] Lutfalla et al (2019), on the other hand, without taking into account the effects of changes in land use, stocks and the release of organic carbon from the soil into the atmosphere. The warmer and drier climate expected in Africa and Latin America will probably lead to a global balance corresponding to a significant drop in soil carbon stocks. As well as contributing to the increase in CO2 concentration in the atmosphere, this drop in stocks is likely to pose a serious threat to the ability of soils to fulfil their role as a substrate for agricultural production in regions that are already vulnerable in terms of food security.

[31] Eglin et al.(2010) argue that deforestation increases the threats posed by historical changes in land use. The irrational exploitation of resources and the ensuing changes have led to the overall release of organic carbon stocks into the atmosphere. In this way, the human-induced decrease in soil organic carbon stocks has been almost offset by the net increase in organic carbon stocks due to the increase in CO_2 and precipitation and

the ensuing disasters. At a global level, the mechanization of agriculture and the increase in cultivated areas without taking account of their negative impacts after the 1950s also accelerated the loss of organic carbon stocks in cultivated land, whereas the development of carbon sequestration practices over the last few decades may have limited the loss of carbon stocks in arable soils. The continuation and/or intensification of deforestation is likely to further increase the decline in soil carbon stocks and thus increase the challenges for biodiversity, which is already under threat in degraded ecological zones.

These results are in line with the national biodiversity strategy and action plan 2016-2020 of the DRC's Ministry of the Environment, Nature Conservation and Sustainable Development [32] ,which supports the conservation of biodiversity following the 1994 Convention on Biological Diversity (CBD) as supported by the United Nations. About the main threats to biodiversity in the DRC, this strategy focuses on the rational management and sustainable use of biological resources, the conservation of biodiversity and the fair and equitable sharing of the benefits arising from the efficient exploitation of natural resources, in particular the DRC's genetic resources. Given the scale of the threats, this national strategy advocate integrating the conservation and sustainable use of biodiversity through the relevant sectoral or cross-sectoral plans, programs, projects and policies for degraded ecological zones for the benefit of all possible forms of life on earth [33]. These findings are in line with those of [34] Tchautchou et al.,who notes that the lack of a natural function for the biogeochemical cycle, ecological degradation, loss of soil fertility, absence or reduction of forest cover, soil compaction and salinization, which prevents or delay forest regeneration, are real threats to biodiversity and indirectly disrupt key ecological processes such as pollination, seed dispersal, loss of soil biological activity and gene flow. Forest fragmentation can also compromise the ability of plant and/or animal species to adapt to global warming, as migration routes disappear, just as forest fragmentation leads to a loss of forest and animal biodiversity. For these authors, even temporary forest degradation has several serious consequences. It can lead to the opening up of the canopy, loss of biodiversity, modification of the vertical structure or a change in other attributes. About the threats to biodiversity, [35] Noss (1999) states that not only does it reduce the quality and quantity of forest area, but it also alters the spatial structure of landscapes through the process of fragmentation, even though forests are still essential for the protection and conservation of biodiversity.

The evaluation of the expected results and the results achieved during the impact study and the analysis or monitoring of the production and distribution network of products and services about the threats to biodiversity; These results are also in line with the DRC's Electricity Market Development Project for Domestic Consumption and Exports (PMEDE), which stresses the need for an environmental and social management framework for the ecologically sound and sustainable management of threats to the environment and living beings, based on the proactive management of ecosystems and certain practices used in Africa. It is a framework for analyzing all the threats that can contaminate the soil, water and air and/or harm biodiversity in ecosystems. These same threats hardly spare human and animal health (emergence of zoonosis) (6th meeting of the Conference of the Parties to the Basel Convention in December 2002).

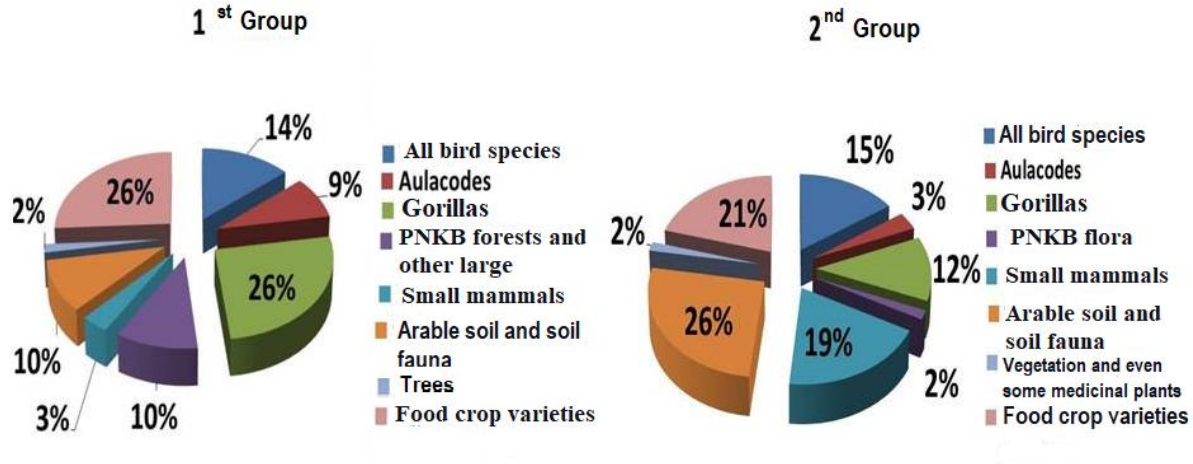

Figure 6: Biodiversity to be protected in degraded ecological zones

3.2. Prospects for reducing deforestation in the Kabare Chiefdom

3.2.1. Alternatives for reducing deforestation in the short, medium and long term

Figure 7 shows the alternatives that could be exploited to help reduce deforestation in the villages on the edge of the PNKB in the Kabare chiefdom. These alternatives are proposed for the short, medium and long term, to enhance the ecological process of sustainable change, which capitalizes on the achievements made step by step to restore and make viable what deforestation has destroyed and thus protect the ecosystems.

In the short term, the results suggested: agroforestry on the population's cropland (34%), controlling water erosion in crop fields throughout the villages (21%), agro-ecology (19%), making good quality seeds available to the whole population (9%), reforestation in all the villages along the PNKB (7%) and 5% respectively for biological education for everyone in the villages around the PNKB, and schooling for all the population's children without discrimination. This will naturally reduce the impact of deforestation on school fees for children, especially from marginalized households.

In the medium term, the results mainly concern agroecology (30%), followed by the extension of microcredits to all households bordering the PNKB (29%), schooling for all children (22%), reforestation in all villages bordering the PNKB (10%), eco-tourism villages (7%), and seed services "for all" throughout the villages bordering the PNKB (2%).

In the long term, the results still show agroecology (41%). Agro-ecology must be designed to improve the living conditions of the population of the Kabare chiefdom on the edge of the PNKB and to reduce deforestation in the villages and the PNKB. It must focus on the quality environment to ensure food security and sovereignty for the population in an area where food products are imported from neighboring countries and other countries concerned with economic profit for products that sometimes do not even take into account food quality or production conditions (which are less protective of the environment). These are foods derived from chemical products and increased yields from plants or animals genetically modified for marketing. In this respect, a population unable to produce what it eats and unable to eat only what it produces and whose quality it can control runs the risk of developing several of the diseases of the civilizations of globalization as a result of imported foods and sometimes intolerable food products intended for the market economy of a consumer society. This population is a victim not only of a destabilized rural economy and poor soil but also of the limited space occupied. Agroecology, as an environmental approach and an organizational policy for the terroir, will therefore focus on renewable natural resources for the endogenous development of this study area. Concerning the result relating to the extension of micro-credits to all households bordering the PNKB (22%): it should be remembered that the most vulnerable population (some pygmies expelled from the park and some bamboo sellers to prevent them from continuing to deforest the bamboo) are the only ones eligible for the micro-credit service. The amount received per beneficiary household rarely exceeds fifty US dollars. This is followed by eco-tourism villages (16%), village agroforestry (13%) and reforestation in all villages along the PNKB (8%). Given the need to recover a vegetation cover that is perforated and appropriate to the context of the villages on the edge of the PNKB, agroforestry in line with reforestation techniques remains sustainable in this biotope. In addition, reforestation (in the short, medium and long term) must continue to be applied in the population's fields to continue to revitalize the soil into arable land and contribute to the agricultural yield of households. As the terrain is sufficiently rugged, it is essential to apply appropriate management techniques to combat the water erosion that carries the soil into the lowlands. Activities can begin in the short term and be integrated into an eco-development process (in its social purpose, diachronic with future generations, and its effectiveness and economic efficiency) of rational management of the land. This agroforestry system, combined with land-use planning to combat erosion (through flowerbeds, living hedges, discontinuous ditches capable of contributing to soil fertilization, mulching (soil mulching) favourable to the production of organic matter, contour lines integrated with alley cropping, can improve soil fertility and encourage plant cover to supply the elements required for the agroecology farming system. Agroecology is capable of generating the factors governing functional biodiversity and linking biodiversity to the functioning of agroecosystems. Agroecology protects the soil against erosion using a consistent erosion control plan. This plan could include, for example, indicators for calculating slopes, indicators for contour lines to be drawn, indicators for sediment filters, sediment trap basins or ditches, etc. The protection of steeply sloping soils, such as in the villages of the Kabare chiefdom around the PNKB, must be carried out in strict compliance with the efficient management of resources (water (upstream and downstream of Lake Kivu) and energy) in strict compliance with nature's biogeochemical cycle. As everyone in the study area is in need, micro-credits should be extended to all households living near the PNKB, as should schooling for all children living near the PNKB, not just pygmies and their children [(346 pygmy children to be provided with schooling to alleviate the threats and concern for revenge for having been driven out of the Kahuzi Biega National Park (PNKB)]. The approaches applied must contribute to the balance between man and nature by reducing the anthropic threats to ecosystems among poor households that turn to deforestation for survival or to satisfy their primary needs. To this end, the synergy between the different elements of the system put in place must be established and support the smooth evolution of the deforestation reduction dynamic towards an ecological impact based on the rational participative management of natural

resources in the environment. These results are in line with the findings of agricultural research for sustainable development and research into process innovation, which indicate (speaking of the Asia-Pacific region) that because of environmental degradation and growing poverty in degraded environments, research and sustainable development, programs must reduce poverty among populations, emphasize ecological profitability and household food security, and focus on the rational management of biodiversity. In this respect, the eco-development program must respond to the real need to enhance and sustain the protection of a quality environment for all forms of life and to conserve (exploit without destroying) natural resources by responding to demographic issues and conflicts relating to the illicit and irrational exploitation of natural resources[36] (GFAR, 2003). For the agroforestry result, [37] Rocheleau et al, (1994) adapted agroforestry can be assimilated into one or more practices to improve soil fertility, or the use of plants and landforms. It responds to ecological needs and the needs of populations and should be treated as a practical strategy for land management and the combination of particular species in systems associating crops and ligneous plants, ligneous plants and pastures, ligneous plants and animals, ligneous plants and particular sites, etc., for some expected benefits (stabilization of sloping land, conservation of arable land, increased water reserves in the soil, regulation of temperature and wind, improved agricultural conditions and increased agricultural yields).

These results are also in line with those of [38] Kaushik(2011), who emphasizes that the agroecology of sustainable family farming focuses on the land's capacity to feed its inhabitants properly, by giving priority to its environmental dimension throughout the production process, step by step. For example, solar energy naturally contributes to photosynthesis, atmospheric nitrogen (from the air) contributes to the synthesis of proteins and elements from subsoil minerals derived from the daily alteration of parent rocks, and carbon from atmospheric carbon dioxide is used to produce carbohydrates (sugar, starch, oils), etc. In addition, farmers make less use of external inputs to encourage all kinds of possible synergies: association of crops in the field, rational integration of agriculture and livestock (fodder and organic matter in return), mulching, exploitation of mycorrhizal fungi to flush out mineral elements trapped between the leaves, etc.

Considering the results of the DRC study, [39] MECNT (2011), following the results of this study, MECNT informs that the causes of deforestation and forest degradation in the DRC are heterogeneous. The most striking of these are much more closely linked to demographic explosion and the poverty of the population. These causes constitute serious threats to natural resources, and they are more serious in the provinces of South Kivu and North Kivu. Energy alternatives, encouraging job creation and income-generating activities, promoting reforestation, sedentarization of agriculture using appropriate techniques, bee-keeping, support for small-scale livestock farming, the introduction of ecological education from family to school, support for microfinance and micro-projects, reconstitution of forest capital for agroforestry and reforestation, taking advantage of REDD and other funding, support and promotion of appropriate technologies, especially in forest areas, and electrification of towns.

Energy alternatives, incentives for job creation and income-generating activities, promotion of reforestation, sedentarization of agriculture using appropriate techniques, beekeeping, support for small-scale livestock farming, the introduction of ecological education of the family at school, support for microfinance and micro-projects, reconstitution of forest capital for agroforestry and reforestation, taking advantage of REDD and other funding, support and promotion of appropriate technologies, especially in forest areas, electrification of agglomerations in the provinces and cities, revision and application of all legal provisions relating to rational forest management, strengthening the institutional capacities of the forest administration, taking account of the gender aspect in the effectiveness of forest management, etc. are just some of the effective and appropriate measures to reduce deforestation in the DRC, starting with its major causes.

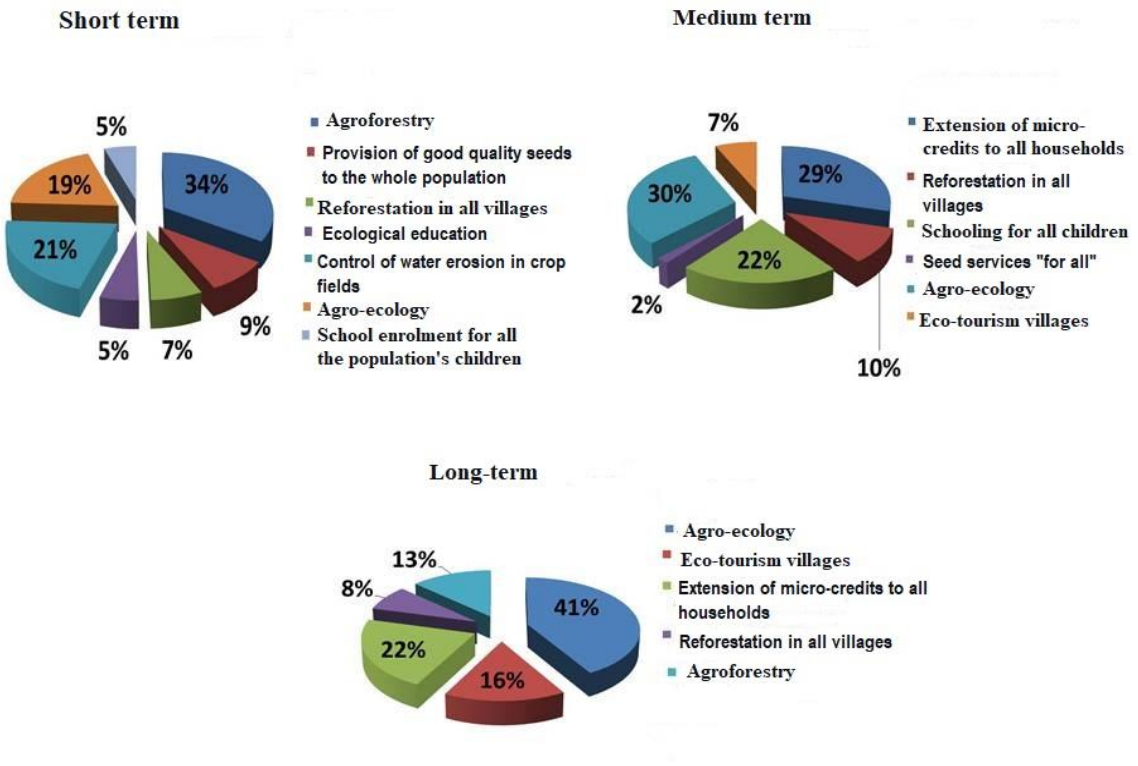

Figure 7: Alternatives for reducing deforestation in the short, medium and long term

3.2.2. Substitution and deforestation reduction mechanisms

In figure 9 (group 1st , group 2nd and 3rd) of alternative mechanisms, 89% of respondents recommended that the PNKB create a framework for consultation, management and permanent dialogue for the preservation of the quality environment in the biotope, 9% recommended raising awareness and launching a process to sensitize residents to the damaging effects of deforestation in this biotope and 2% recommended supporting income-generating activities for households in villages near the park. For the second group, 50% of respondents were in favour of reforesting all the villages surrounding the PNKB in the Kabare chiefdom, 24% were in favour of popularizing the domestication of the species sought in the PNKB by residents, 16% were in favour of making residents aware of the harmful effects of deforestation, and 5% were in favour of establishing permanent consultation between the various stakeholders in the mechanisms for replacing and reducing deforestation in the study area. For the third group, 41% of respondents were in favour of developing the villages around the PNKB in the Kabare chiefdom, 22% for electrifying the villages on the edge of the PNKB, 19% for building a hydroelectric power station to supply the villages around the park with electricity, 12% for popularizing the domestication of forest species sought after in the PNKB by residents, 4% for raising residents' awareness of the harmful effects of deforestation on their biotope, 2% for reforestation in villages surrounding the PNKB. By these mechanisms for replacing and reducing deforestation in the villages and around the PNKB in the Kabare chiefdom, their ecological footprint must be objectively observable in the targeted villages. These footprints must also encourage and entrench the process of development and rational use of resources for sustainable development by promoting the factors of exploitation of biocapacity around the park through the following diagram of the meeting between social sustainability, ecological efficiency and ecological balance in the production of services and goods capable of minimizing the consumption of energy and raw materials in the villages surrounding the park:

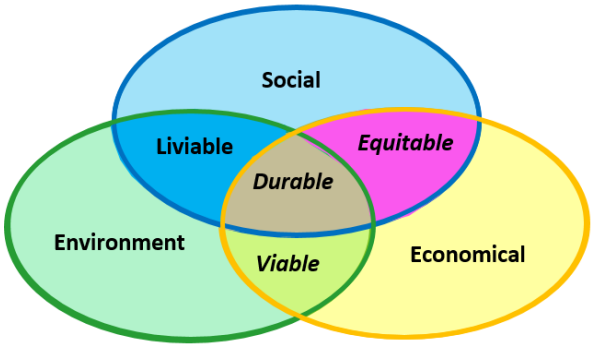

Figure 8: Mechanisms for replacing and reducing deforestation

Figure 8 diagram of the confluence of the three pillars of the sustainable development process, the alternatives to be put in place around the PNKB in the villages of the Kabare chiefdom must contribute to the conditions of ecological balance through the interaction links between the different factors of sustainable development and the values of the natural resource exploitation systems in the area.

The alternative mechanisms for reducing deforestation in this area play the role of serving as a functional structural aspect of the environment and as factors capable of mutually and judiciously influencing biogeochemical exchanges to better ensure economically, socially and ecologically sustainable development, and thus reduce deforestation in the area as much as possible. To achieve this, a**t a social level**: the mechanisms must contribute to the satisfaction of primary or essential needs (housing, employment, food, children's education, health, etc.) that are currently weighing on the forests through deforestation in the villages and the park. These mechanisms must also be proactive in preventing exclusion and positively managing the conflicts that have taken root since the creation and conflictual extension of the Kahuzi Biega National Park forest and ecological reserve in 1970.

At the economic level: the mechanisms put in place as alternatives must be
able to create wealth and improve material living conditions by encouraging the flow of energy and the cycle of materials in ecosystems in a dynamic ecological balance.

Environmentally: the alternatives chosen and implemented in the environment must preserve the species (plant and animal) and all the natural and energy resources for all generations (present and future) in this chiefdom of Kabare around the World Heritage site.

These results concur with [40] Petit O et al, (2022), who emphasizes that the alternatives must be sustainable development, in line with socioeconomic and ecological principles based on a systemic and holistic approach to phenomena and institutional facts, including the family, while respecting the rules, ecological and economic values, customs, laws, norms and formal and informal conventions, not to mention the other essential factors in all the analyses. This is why the biocapacity demand of the ecological economy, as a perspective, must be made necessary by the economic demand linked to the consumption of the environment in its eco-evolutionary development dynamic in the balance between human societies and ecosystems in the face of the exploitation of natural resources in the service of capitalism. In other words, the production capacity of a given environment for one ton of cereals requires as many hectares of arable land capable of sequestering the CO_2 emissions from this production. It cannot be ruled out that in the combination of characteristics of highly productive ecosystems, environments (regions or countries) under-consume their biocapacity; Canada is a case in point. Saudi Arabia, a sparsely populated, very vast country, but with an extremely poor ecosystem, serves as a counter-example in this respect.

These results meet [41] DGPA/DRC (2009) through the perceptions and alternatives of the Natural Resources Network (NRN), which points out that climate change is linked to deforestation, which is destroying the planet's vegetation cover. Deforestation and forest degradation are responsible for 20% of greenhouse gas emissions each year, with the remaining 80% coming from fossil fuel waste, factories, vehicles and industries.

The challenge is for all the inhabitants of our planet to safeguard our ecosystems and contribute to the common effort to keep global temperatures above 2° to 2.4°C. In the DRC, deforestation is largely the result of strong pressure from uncontrolled logging. In terms of alternatives, the national REDD process emphasizes the value of forests and encourages the development of alternatives to gain access to both green and blue funds for the good governance of forest ecosystems and wetlands. These results are also in line with [25] Kasisi (2022), who stresses that biodiversity conservation alternatives must be developed as part of an optimistic process of sustainable and rational management of ecosystems, rather than waiting for imperative actions linked to disaster emergencies. He deplores the fact that in the management of biodiversity and ecosystems such as forests, recourse is had to emergency action which leaves little long-term impact and/or room for manoeuvre for the sustainable development of the environment. Furthermore, the use of foresight as a discipline for planning

strategies and action plans enables the process to act as a tool of collective intelligence and awareness capable of mobilizing real alternative solutions capable of protecting forests from the causes of deforestation. The lack of progress on the Kyoto Protocol illustrates that the sustainable and rational management of the process put in place must also contribute to a better understanding of the crucial issues of the future, particularly in terms of its comprehensive approach to economic, social, environmental, political and cultural changes and, above all, their spatial repercussions. In short, if efforts are to be made to move away from the short-term interests of land conversion towards the long-term benefits derived from ecosystem services, there must be a fair and equitable sharing of the tangible benefits in economic terms between the various stakeholders. The problem of sharing sacrifices and benefits that arises between industrialized and developing countries is acutely transposed to the community level in sub-Saharan Africa, particularly in the DRC.

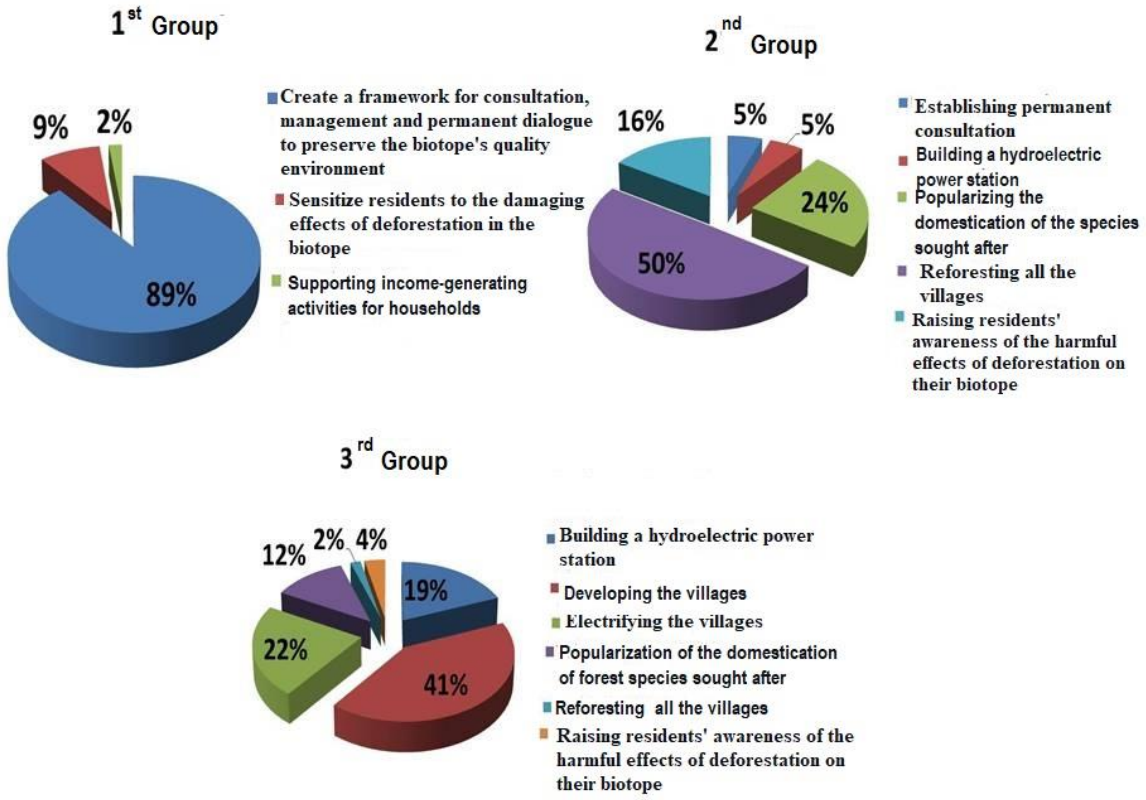

Figure 9: Diagram of sustainable development in the villages of the Kabare chiefdom

3.2.3. Alternatives for reducing deforestation and conflict in and around the PNKB

Table 3 set out the alternatives for the desired situation to reduce deforestation, and degradation and mitigate conflicts between park residents in the Kabare chiefdom and the PNKB.

Table 3: The desired situation for reducing deforestation and conflict in and around the PNKB

N°	**Desired situations**	%
1	Development of ecological and ecotourism villages with special status and joint boundary surveillance with the PNKB using drones, cameras, helicopters, an electric wall, etc. instead of eco-guards.	40
2	Development of ecological and ecotourism villages with special status and joint boundary surveillance with the PNKB using drones, cameras, helicopters,... and eco-guards.	31
3	Development of ecological and ecotourism villages with special status, joint surveillance of boundaries with the PNKB without drones, cameras, helicopters,... and eco-guards.	12
4	Development of ecological and ecotourism villages with special status and joint surveillance of the boundaries between the population and the PNKB with eco-guards.	10

5	Development of ecological and ecotourism villages with special status and joint surveillance of boundaries with the PNKB, local residents without eco-guards and without cameras, drones, and helicopters.	7
6	Other (please specify)	0
Total		100

Development of ecological and ecotourism villages with special status and joint surveillance of boundaries with the PNKB:

- using drones, cameras, helicopters, an electric wall, etc. instead of eco-guards (40%);
- special status and joint surveillance of boundaries with the PNKB using drones, cameras, helicopters, etc. instead of eco-guards (31%);
- without drones, cameras, helicopters,... and eco-guards (12%);
- between the local population and the PNKB with eco-guards (10%);
- and residents without eco-guards and cameras, drones or helicopters (9%).

These results show the need to restore the vegetation cover and the green screen in the villages around the Kahuzi Bièga National Park in the Kabare chiefdom, where the original forest formations, which had become savannah formations in this area, are currently being gradually replaced by bare soil as a result of deforestation and impoverishment caused by overexploitation and/or inadequate exploitation under the influence of human activities by residents[12]. All those interviewed agreed that ecological and ecotourism villages need to be developed around this park, which is under threat from deforestation and degradation in both its hinterland and its interior. About the alternatives, a conscious effort must be made to sincerely integrate all the players (residents, the public, the PNKB and the NGOs working in the environmental field) in this area, and all the means necessary must be used to combat the unsatisfactory situation (by tackling the problem in its causes and not its effects), which risks dangerously jeopardizing the vocation of the villages around the PNKB, and even that of this world heritage site in the east of the DRC. This is in line with [42] Mudinga et al (2013), who state that the failure of the projects carried out in this area lies in the perception of community participation in the governance of collective natural resources in the chiefdom of Kabare on the edge of the Kahuzi Biega National Park. For these same authors, the main problem is the lack of favourable conditions for promoting local development. They go on to point out that this central problem stems from the structural, demographic, technical and political factors involved in the co-management of natural resources in this area, and from the lack of a consensus between the ‘‘Institut Congolais de Conservation de la Nature ’’(ICCN)/PNKB, which represents the Congolese state, and the Communal Committees of Conservation (CCCs), which represent the delegates of the local populations living around this world heritage site. In affirming these results Kasisi (2012)[25] in the perspectives of biodiversity conservation and behaviours relating to sustainable development in a policy of protection and non-conflictual co-management of the environment; recalls that to achieve the desired situation with more positive impacts in the rational management ecosystems for the benefit of living beings in sub-Saharan Africa in general and around the PNKB in particular; the cause-effect relationships between the various negative elements of the major problem must be established in a logical framework that analyses the string of interrelated problems (with their injunctions) around this central problem. The problems of biodiversity management and ecological development around the PNKB, as elsewhere in sub-Saharan Africa, increasingly depend on economic, social and political forces that escape analysis of the context of the forward plan for the exploitation of natural resources. In this respect, the author also points out that about the expected results and impact of the 2002 objective of: "to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national levels as a contribution to poverty alleviation and the benefit of all life on Earth"; governments around the world have not achieved positive impacts despite the resources invested. For sub-Saharan Africa, the reasons lie in the distant structural causes, the local perception of keywords related to biodiversity, nature conservation, protection, threats, preservation, etc. These causes are often forgotten during the analysis of the problem tree and when planning to take into account the situation desired by people living near protected areas. [43] MA, 2005 and Roe et al.(2009)assure us that for participatory management of natural resources (about the Convention on Biological Diversity) in Africa, the global objectives in the context analysis, in the analysis of the origins and evolution of the problems at the basis of the planning, ... must first respond to the real conservation problems in the target environment, respond to the real needs of local development, respond to the needs of residents for satisfactory access to resources to mitigate the intensity of climate change and finally to the increase in the loss of plant and animal species. Locally, the challenges lie in the tensions of governance of natural resources, which need to be adapted to the current economic, ecological and political crises, which have sufficiently demonstrated their limits everywhere. In short, we need to put in place new types of relationships capable of generating trust and then maintaining and perpetuating production systems and the reproduction of natural resources for future generations. In Tanzania, for example, over 3.6 million hectares of forest and woodland are under the rational management of the village population as village land forest reserves. In Tanzania, these ecological developments exist under the joint management of the villagers who occupy them

and the government, with a status that is discussed and adopted by the villagers and the local or central authorities given the importance of the results to be achieved and the positive impact expected in ecological, intentional and economic terms. The Ungersheim town council agrees with these results, stating that the village of Ungersheim - through its socio-economic, cultural and environmental conditions, which have been developed for the purpose - wants to challenge the ecological crisis through its ecological village policy and endogenous development, or local development based on local know-how, responsible management of natural resources, food sovereignty, energy independence, etc. The resilience of the ecological village of Ungersheim defies extroverted consumer societies: For at least ten years, it has been working towards organic farming, financial autonomy, intellectual independence or autonomy of spirit, and building the collective consciousness of the ecological village, which is producing less and less CO_2. For the people of this village, "it is by walking with determination together, without discriminating against one another, that we discover the path to follow for a concrete social project for ecological villages".

V. CONCLUSION

The conclusion drawn from the perceptions and alternatives of the population and stakeholders (PNKB and partners) in reducing deforestation is that we need to encourage forest regeneration and support the domestication in the villages of the trees sought in the PNKB by local residents, as well as reforesting and developing the villages surrounding the PNKB in the Kabare Chiefdom, as this could reduce deforestation rather than continuing to see the forest used as a maneuvering ground for socio-economic stakes. This area has numerous resources, such as biogas, environmental law enforcement, micro-hydro and/or hydroelectric power stations, peat bogs, photovoltaic power stations, methane gas, hydroelectric power stations, large rivers and their waterfalls, brickworks, rubble quarries, sand, household reforestation and plantations by companies established in the area, clay and the Katana cement plant. The perceptions and alternatives capable of ensuring the survival of our planet today and tomorrow, must admit and allow the conversion of the current economy of destruction (centred on deforestation, the degradation of ecosystems, pollution in all its forms,...) into an economy of conservation capable of mobilizing all energies supportive of the right to ecology. The perspectives thus proposed in this study contribute to the reconciliation of the environment, and the economy and the need to promote sustainable development in villages affected by deforestation around the PNKB in Kabare Chiefdom in the province of Sud-Kivu, in eastern DR. Congo.

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