

# Socio-Economic Impact of the Creation of Protected Areas on the Well-Being of the Riparian Population of the Kahuzi-Biega National Park and the Itombwe Nature Reserve, Democratic Republic of Congo

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**How to cite this paper:** Basubi, M.M., Bobo, S.K., Kazamwali, L.M., Aseaku, F.N., Maiyanpa, P. and Nyembo, C.K. (2025) Socio-Economic Impact of the Creation of Protected Areas on the Well-Being of the Riparian Population of the Kahuzi-Biega National Park and the Itombwe Nature Reserve, Democratic Republic of Congo. *Open Journal of Ecology*, 15, 419-434.

<https://doi.org/10.4236/oje.2025.156024>

**Received:** November 22, 2024

**Accepted:** June 22, 2025

**Published:** June 25, 2025

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## Abstract

The paper analyzes the socio-economic effects of the creation of Kahuzi-Biega National Park and Itombwe Nature Reserve on the daily lives of riparian populations. It highlights negative impacts on household activities such as agriculture, hunting, firewood exploitation, and non-timber forest product collection. Key challenges include declining soil fertility, reduced agricultural yields, scarcity of resources, and human-wildlife conflicts. Efforts should be directed towards reducing these changes through the involvement of local populations in all the protected area conservation processes.

## Keywords

Protected Area, Riparian Well-Being, Socio-Economic Impact

## 1. Introduction

The role of protected areas (PAs) is known by many for both biological diversity and ecosystem conservation [1] [2] and in improving living conditions (socio-economic and cultural) for communities [3]-[5]. PA's creation should be perceived as

an opportunity for sustainable development for local communities through job creation [6], support for community development [7] and ecotourism [8] [9], but it can also be the source of conflicts between conservation initiatives and local livelihoods generated by the population relocation [10] [11]. In developing countries, the conflict between PA's manager and the population often comes from the non-compensation for the damage caused by the relocation, or it's below the damage suffered [12], and the lack of equity in the PA's income distribution [13]. This leads to the decline of household activities incomes, forest resources overuse (wood for charcoal making, etc.), the price explosion in the area [12] [14] [15], and ecosystem degradation (habitat fragmentation and the poaching of protected or unprotected species) [16].

The Kahuzi-Biega National Park (KBNP) and Itombwe Nature Reserve (INR) are located in poor rural areas characterized by a growing population rate, a low schooling rate and a subsistence lifestyle based on the natural resources exploitation (NTFPs and wood use, hunting, etc.) and the arable land use [6] [14] [17] [18]. The conservation and protection efforts in both KBNP and INR are oriented and focused on wildlife only; local populations feel a sense of exclusion, dispossession and contempt for the managers, especially since they think that animals represent more value than the population to the public authorities [1] [19]-[21]. Many studies have been carried out on biodiversity conservation and conflict management around the KBNP and the INR [1] [22]-[25], but none one of them has been carried out to highlight the real impact of the creation of these spaces on the daily lives of the local populations. In addition, the difference in the implementation of the conservation management approach in KBNP compared to the INR remains to be determined, particularly the direct externalities generated by each one of these PAs on the standard of living. The effective involvement of the local population in the management of KBNP and INR is an essential and urgent tool for improving the sustainable management of PA resources.

Thus, the aim of this study is to contribute to the sustainable management of protected areas (PAs) by analyzing the socio-economic effects of the creation of Kahuzi-Biega National Park (KBNP) and Itombwe Nature Reserve (INR) on the well-being of local populations.

## 2. Methodology

### 2.1. Study Area

The KBNP (latitude: 1°36' - 2°37'S, longitude: 27°33' - 28°46'E, altitude: 600 - 3308 m) and the INR (latitude: 2°41' - 3°52'S, longitude: 28°02' - 29°04'E, altitude: 1500 - 3000 m) are located in the province of South Kivu, East of the Democratic Republic of Congo [25]-[27].

The KBNP is characterized by an Afro-alpine climate (average rainfall: around 1500 mm and an average annual temperature: 20.5°C). The relief is formed by steep mountains, cut by varied deep valleys whose altitude varies between 600 m and 3308 m, and the low altitude of the Congo Basin, characterized by essentially

forest vegetation, varying with geographical location and altitude [26]. The RNI is one of the exceptional high-altitude mountain forests with a variation of the climate along an East-West axis. Its relief is characterized by two major geomorphological units: the plateau located at half of the Eastern side, and the Northern and Eastern mountains, and the slopes and plains river of half of the Western side. The reserve has a dense hydrographic network belonging entirely to the Congo River watershed, and its flora belongs to the “Centre for Guinean-Congolese Endemism” in the West and the “Regional Centre for Zambian Endemism” in the South [27] [28]. The diversity of habitats and climatic conditions of the INR is favourable to the development of a rich diversity of animal species, some of which are endemic and/or threatened with extinction and included on the IUCN Red List [28].

## 2.2. Data Collection

A socio-economic survey was conducted individually among households around the KBNP and INR from April to August 2023. The interview sheet was incorporated into the Kobbo collect tool and submitted to respondents. The main questions focused on anthropogenic activities such as the main sources of household income, perceptions of changes in human activities generated by the establishment and conservation of PAs, and the participation of local communities in sustainable management. All households within a 3 km radius of the PA were considered, which gives a chance to all individuals in the studied population to be selected because the population around the PAs in Eastern DRC is smaller and relatively homogeneous [11] [25]. This area is defined by its close proximity to the PA, which influences the population’s perception of her dependence level on the forest resources and the impact of the AP conservation on the local population’s livelihood. Twelve villages were selected: Kafulumaye, Katana and Ihembe (Kabare territory) and Bitale, Muhongozi and Nyamukubi (Kalehe territory), located in the high-altitude part of the KBNP; Kitamba, Kasalalo, Kakozi, Kalundu, Ilibo and Ilowe (Mwenga territory) in the western part of the INR. 621 households were surveyed, including 345 in the villages around KBNP and 276 around the INR.

## 2.3. Data Processing and Analysis

Data was encoded in Microsoft Excel 2019, from which the pivot tables were retrieved for a descriptive visualization form of tables. Descriptive analyses focused on the frequencies of socio-economic characteristics and local population perception of the changes generated by the establishment of the KBNP and INR. The Chi<sup>2</sup> independence test was carried out by Xlsat 2024.3 software and was validated by R software [29] at the 5% threshold. The Chi<sup>2</sup> test was applied to show differences between the parameters depending on the AP neighboring villages under study [30].

### 3. Results

#### 3.1. Socio-Economic Characteristics of Households around Kahuzi-Biega National Park and Itombwe Nature Reserve

##### 3.1.1. Respondent's Source of Income

**Table 1** presents the activities carried out by the respondents in and around the KBNP and INR.

**Table 1** shows a significant difference between income-generating activities and the activities practiced inside the forest depending on the village around the KBNP and INR ( $p < 0.001$ ). Agriculture is presented as the main source of income for the targeted population around the KBNP (with 83.3% in Ihembe, 70% in Kafulumaye, 57.1% in Katana, 100% in Mbinga-nord and Mbinga-sud) and INR (with 83.9% in Ilibo, 82.2% in Ilowe, 76% in Kakozi, 54.6% in Kalundu, 90% in Kasalalo and 46% in Kitamba), followed by the trade so around KBNP (13.4% in Ihembe, 10% in Kafulumaye and 34.2% in Katana) as around the INR (8% in Ilibo, 9.7% in Ilowe, 24% in Kakozi and 36.5% in Kitamba), the craft (3.3% in Ihembe, 10% in Kafulumaye, 5.8% in Katana around the KBNP, and 4.9% in Ilibo, 33.3% in Kalundu, 10% in Kasalalo, 4% in Kitamba around the INR) and the teaching (10% in Kafulumaye, 2.9% in Katana around the KBNP, and 3.2% in Ilibo, 8% in Ilowe, 12.1% in Kalundu and 13.5% in Kitamba around the INR).

Despite the sources of income, these are still insignificant to meet the needs of the households due to their low productivity. So, the riparian population is obliged to carry some activities inside of PA as the slash-and-burn agriculture (29.7% in Bitale, 9% in Mbinga-nord, 6.4% in Kafulumaye, 2.9% in Katana inside the KBNP, and 88.7% in Ilowe, 45% in Kasalalo, 42.4% in Kalundu, 40% in Kakozi, 33.9% in Ilibo and 24.3% in Kitamba inside the INR), the firewood cutting (46.7% in Ihembe, 35.4% in Bitale, 34.2% in Katana, 6.8% in Mbinga-nord inside the KBNP, and 20% in Kakozi, 17.6% in Kitamba, 14.4% respectively in Ilibo and Ilowe, 12.1% in Kalundu and 10% in Kasalalo inside the INR), the carbonization (23.2% in Bitale, 11.3% in Mbinga-nord, 3.2% in Kafulumaye inside the KBNP, and 14.9% in Kitamba, 12.1% in Kalundu, 8% in Ilibo, 4M in Kakaozi and 1.6% in Ilowe inside the INR), the timber exploitation (25.7% in Katana, 20% in Ihembe, 13% in Kafulumaye, 11% in Bitale, 6.8% in Mbinga-nord inside the KBNP, and 10.8% in Kitamba, 9.1% in Kalundu, 5% in Kasalalo, 3.2% in Ilowe and 1.6% in Ilibo inside the INR) and the hunting (3.3% in Ihembe, 2.2% in Mbinga-nord, 0.6% in Bitale inside the KBNP, and 13.5% in Kitamba, 12% in Kakozi, 10% in Kasalalo, 6.1% in Kalundu, 4.8% in Ilowe and 3.2% in Ilibo inside the INR). The results show that NTFP exploitation occurred only inside the INR (38.7% in Ilibo, 29% in Ilowe, 20% in Kakozi, 18.1% in Kalundu, 25% in Kasalalo and 19% in Kitamba).

##### 3.1.2. Food crops production

**Table 2** shows the crop's yield level and income generated around the KBNP and INR.

**Table 1.** Activities carried out by respondents.

Variables	KBNP							INR					p-value	
	Kabare			Kalehe				Mwenga						
	Ihembe (N = 30)	Kafulumaye (N = 31)	Katana (N = 35)	Bitale (N = 155)	Mbinga-nord (N = 44)	Mbinga-sud (N = 50)	Ilibo (N = 62)	Ilowe (N = 62)	Kakozi (N = 25)	Kalundu (N = 33)	Kasalalo (N = 20)	Kitamba (N = 74)		
Source of income	Agriculture	25 (83.3%)	22 (70%)	20 (57.1%)	155 (100%)	44 (100%)	50 (100%)	52 (83.9%)	51 (82.2%)	19 (76%)	18 (54.6%)	18 (90%)	34 (46%)	<0.001
	Craft	1 (3.3%)	3 (10%)	2 (5.8%)	0 (0%)	0 (0%)	0 (0%)	3 (4.9%)	0 (0%)	0 (0%)	11 (33.3%)	2 (10%)	3 (4%)	
	Trade	4 (13.4%)	3 (10%)	12 (34.2%)	0 (0%)	0 (0%)	0 (0%)	5 (8%)	6 (9.7%)	10 (24%)	0 (0%)	0 (0%)	27 (36.5%)	
	Teaching	0 (0%)	3 (10%)	1 (2.9%)	0 (0%)	0 (0%)	0 (0%)	2 (3.2%)	5 (8%)	0 (0%)	4 (12.1%)	0 (0%)	10 (13.5%)	
Activities inside the forest	Slash-and-burn agriculture	0 (0%)	2 (6.4%)	1 (2.9%)	46 (29.7%)	4 (9%)	0 (0%)	21 (33.9%)	55 (88.7%)	10 (40%)	14 (42.4%)	9 (45%)	18 (24.3%)	<0.001
	No one	9 (30%)	24 (77.4%)	13 (37.1%)	0 (0%)	26 (59%)	50 (100%)	0 (0%)	0 (0%)	1 (4%)	0 (0%)	1 (5%)	0 (0%)	
	Carbonization	0 (0%)	1 (3.2%)	0 (0%)	36 (23.2%)	5 (11.3%)	0 (0%)	5 (8%)	1 (1.6%)	1 (4%)	4 (12.1%)	0 (0%)	11 (14.9%)	
	Hunting	1 (3.3%)	0 (0%)	0 (0%)	1 (0.6%)	1 (2.2%)	0 (0%)	2 (3.2%)	3 (4.8%)	3 (12%)	2 (6.1%)	2 (10%)	10 (13.5%)	
Non Timber Forest Products exploitation	Timber cutting	6 (20%)	4 (13%)	9 (25.7%)	17 (11%)	3 (6.8%)	0 (0%)	1 (1.6%)	2 (3.2%)	0 (0%)	3 (9.1%)	1 (5%)	8 (10.8%)	<0.001
	Firewood cutting	14 (46.7%)	0 (0%)	12 (34.2%)	55 (35.4%)	3 (6.8%)	0 (0%)	9 (14.5%)	9 (14.5%)	5 (20%)	4 (12.1%)	2 (10%)	13 (17.6%)	
		0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	24 (38.7%)	18 (29%)	5 (20%)	6 (18.1%)	5 (25%)	14 (19%)	

**Table 2.** Food crop production.

Variables	KBNP				p-value	INR				p-value
	Low	Medium	High	Very high		Low	Medium	High	Very high	
Yield level	Pure cultivation	3 (0.9%)	258 (74.9%)	0 (0%)	0 (0%)	14 (5.1%)	3 (1.1%)	0 (0%)	0 (0%)	<0.001
	Polyculture	61 (17.8%)	4 (1.2%)	16 (4.7%)	2 (0.6%)	66 (23.9%)	156 (56.5%)	18 (6.5%)	19 (6.9%)	
Income level	Pure cultivation	7 (2%)	0 (0%)	0 (0%)	0 (0%)	16 (5.8%)	0 (0%)	0 (0%)	1 (0.4%)	0.060
	Polyculture	204 (59.1%)	113 (32.8%)	11 (3.2%)	10 (2.9%)	161 (58.3%)	22 (8%)	42 (15.2%)	34 (12.3%)	

In **Table 2**, pure cultivation and polyculture are the two main agricultural systems practiced in food speculation around the KBNP and INR. A highly significant difference was observed between the pure and the polyculture agricultural systems depending on the crop's yield level in the food crop production both around KBNP and INR ( $p < 0.001$ ). The pure cultivation system is seen as the main agricultural system used by farmers around the KBNP (75.8%) compared to the polyculture (24.2%). However, the crop's yield level is shown to be mostly medium (74.9%) in pure cultivation, but as far as polyculture is concerned, it is mostly low (17.8%). Around the INR, the polyculture system is the main agricultural system used by farmers (93.8%), compared to the pure cultivation system (6.2%). In this system, the crop's yield level is considered to be mostly medium (56.5%), followed by low yield (23.9%). It has been observed that the polyculture system is the agricultural system that generates income for most farmers, although the income level is reputed to be mostly low (59.1% around the KBNP and 58.3% around the INR). No significant difference was observed between the pure and the polyculture agricultural systems depending on the income level around the APs.

### 3.2. Impact of the Creation of Kahuzi-Biega National Park and Itombwe Nature Reserve

The analysis of the impact of the creation of the KBNP and INR was based on the main income-generating activities of the local population: agriculture, Non-Timber Forest Products exploitation, firewood use, carbonization and hunting activities.

#### 3.2.1. Impact on Agriculture and Non-Timber Forest Products Exploitation

The results presented in **Table 3** show that the creation of studied PAs has had a negative impact on the daily lives of the riparian population.

**Table 3** presents the declining soil fertility (11.1% in Bitale, 1.4% in Mbinga-nord, 5.1% in Ilibo, 7.8% in Ilowe, 2.6% in Kakozi, 4% in Kalundu, 3.7% in Kasalalo and 4.8% in Kitamba), the reduced agricultural yield (10.8% in Bitale, 2.2% in Ilibo, 3.3% in Ilowe and 4.4% in Kitamba), the long distances between homes and fields (11.3% in Bitale, 1.8% in Mbinga-nord, 10.7% in Ilibo, 8.4% in Ilowe, 5.1% in Kakozi, 5.5% in Kalundu, 1.4% in Kasalalo and 9.6% in Kitamba), the deforestation (8.8% in Ithembe, 8.4% Kafulumaye, 10% in Katana, 7.2% in Mbinga-nord, 14.6% in Mbinga-sud, 3% in Ilowe, 1.8% in Kasalalo and 6.6% in Kitamba) and the human-wildlife conflict (11.1% in Bitale, 1.1% in Mbinga-nord, 3.3% in Ilibo and 1.1% in Kalundu) as the impact of the creation of studied PAs on agricultural activities around KBNP and INR. A significant difference was observed between the impacts of the creation on agriculture depending on villages ( $p < 0.001$ ).

According to the NTFPs exploitation, the impact of creation the creation was observed in the changes in the dietary habits (25.5% in Bitale, 8.7% in Ithembe,

**Table 3.** Impact on agriculture and NTFPs exploitation.

Variables	KBNP						INR						p-value
	Bitale (N = 155)	Ihembe (N = 30)	Kafulumaye (N = 31)	Katana (N = 35)	Mbinga-nord (N = 44)	Mbinga-sud (N = 50)	Ilibo (N = 62)	Ilowe (N = 62)	Kakozi (N = 25)	Kalundu (N = 33)	Kasalalo (N = 20)	Kitamba (N = 74)	
Forest deforestation	2 (0.6%)	30 (8.8%)	29 (8.4%)	35 (10%)	25 (7.2%)	50 (14.6%)	2 (0.8%)	8 (3%)	1 (0.3%)	1 (0.3%)	5 (1.8%)	18 (6.6%)	
Reduced agricultural yield	37 (10.8%)	0 (0%)	0 (0%)	0 (0%)	3 (0.9%)	0 (0%)	6 (2.2%)	9 (3.3%)	1 (0.3%)	2 (0.7%)	1 (0.3%)	12 (4.4%)	
Human-wildlife conflict	38 (11.1%)	0 (0%)	0 (0%)	0 (0%)	4 (1.1%)	0 (0%)	9 (3.3%)	1 (0.3%)	2 (0.8%)	4 (1.1%)	2 (0.7%)	2 (0.7%)	<0.001
Declining soil fertility	38 (11.1%)	0 (0%)	0 (0%)	1 (0.2%)	5 (1.4%)	0 (0%)	14 (5.1%)	22 (7.8%)	9 (2.6%)	11 (4%)	10 (3.7%)	13 (4.8%)	
Long distance between home and fields	39 (11.3%)	0 (0%)	2 (0.6%)	0 (0%)	6 (1.8%)	0 (0%)	30 (10.7%)	23 (8.4%)	14 (5.1%)	15 (5.5%)	4 (1.4%)	26 (9.6%)	
Scarcity of NTFPs	67 (19.4%)	0 (0%)	29 (8.4%)	35 (10.1%)	0 (0%)	0 (0%)	38 (13.8%)	32 (11.6%)	15 (5.4%)	22 (8%)	10 (3.7%)	41 (14.9%)	
Changes in the dietary habits	88 (25.5%)	30 (8.7%)	2 (0.6%)	0 (0%)	44 (12.8%)	50 (14.4%)	24 (8.7%)	30 (10.9%)	10 (3.6%)	11 (4%)	10 (3.6%)	33 (11.9%)	0.082



12.8% in Mbinga-nord, 14.4% in Mbinga-sud, 8.7% in Ilibo, 10.9% in Ilowe, 3.6% in Kakozi, 4% in Kalundu, 3.6% in Kasalalo and 11.9% in Kitamba) and the scarcity of NTFPs (19.4% in Bitale, 8.4% in Kafulumaye, 10.1% in Katana, 13.8% in Ilibo, 11.6% in Ilowe, 5.4% in Kakozi, 8% in Kalundu, 3.7% in Kasalalo and 14.9% in Kitamba). A significant difference was observed between the impacts of the creation of PAs on the NTFP exploitation depending on the village around the KBNP ( $p < 0.001$ ).

### 3.2.2. Impact on Firewood Use and Hunting

**Table 4** shows that the creation of the KBNP and INR was the impact on the loss of good woods (12.3% in Ilibo, 6.1% in Ilowe, 1.8% in Kalundu, 3.2% in Kasalalo and 4.3% in Kitamba), and the long-distance settlement between the home and the place where wood is supplied in the PA (44.9% in Bitale, 5.5% in Ihembe, 8.4% in Kafulumaye, 6.7% in Katana, 12.4% in Mbinga-nord, 14.4% in Mbinga-sud, 5.8% in Ilibo, 9.8% in Ilowe, 2.5% in Kakozi, 6.1% in Kalundu and 18.4% in Kitamba). A significant difference was observed between the impacts generated by the AP creation on firewood use depending on villages around KBNP ( $p < 0.001$ ).

Around the KBNP, the use of firewood depends on the wood availability and accessibility in the households. This situation is the cause of the scarcity of firewood in this area, which gives way to the charcoal use by the riparian population. However, for 7.5% of respondents around the KBNP and 27.9% around the INR, no change was observed in firewood use. This proportion of the population was installed after the AP's creation.

Hunting is seen as a main source of income and one of the ways against food insecurity for most households around the PAs studied. In the villages around KBNP and INR, the hunting activity depends on the hunting income and the wild animals' availability and accessibility ( $p < 0.001$ ). But the creation of these AP had impacts on this activity through the decreased hunting benefits (25.2% in Bitale, 7.5% in Ihembe, 1.4% in Mbinga-nord), the scarcity of wild animals (9% in Kafulumaye, 10.1% in Katana, 5.8% in Ilibo, 3.2% in Ilowe, 6.6% in Kalundu and Kitamba, 2.6% in Kasalalo). So, hunters travel long distances to reach the hunting sites located in the forest (19.7% in Bitale, 11% in Mbinga-nord, 14.4% in Mbinga-sud, 16% in Ilibo, 18.6% in Ilowe, 5.4% in Kakozi, 3.6% in Kalundu, 3.2% in Kasalalo and 16% in Kitamba).

### 3.2.3. Impact on Carbonization

In **Table 5**, the creation of studies of PAs impacted the KBNP and INR riparian population's carbonization activity. Thus, the AP impact varies from one village to another around the KBNP and INR ( $p < 0.001$ ).

Around KBNP, the impact was shown by the installation of a long distance to reach the coal-making areas (24.9% in Bitale, 8.7% in Ihembe, 9% in Kafulumaye, 10.1% in Katana, 7.2% in Mbinga-nord and 8.1% in Mbinga-sud), and by the forest fragmentation (20% in Bitale, 5.5% in Mbinga-nord and 6.3% in Mbinga-sud). On the other hand, in the villages around the INR, the creation of this AP has led

**Table 4.** Impact on wood use and hunting activity.

Variables	KBNP						RNI						p-value
	Bitale (N = 155)	Ihembe (N = 30)	Kafulumaye (N = 31)	Katana (N = 35)	Mbinga-nord (N = 44)	Mbinga-sud (N = 50)	Ilibo (N = 62)	Ilowe (N = 62)	Kakozi (N = 25)	Kalundu (N = 33)	Kasalalo (N = 20)	Kitamba (N = 74)	
Non one	0 (0%)	11 (3.1%)	1 (0.2%)	12 (3.4%)	1 (0.2%)	0 (0%)	12 (4.3%)	18 (6.5%)	16 (5.8%)	11 (4%)	9 (3.2%)	11 (4%)	
Loss of good wood use	0 (0%)	0 (0%)	1 (0.2%)	0 (0%)	0 (0%)	0 (0%)	34 (12.3%)	17 (6.1%)	2 (0.7%)	5 (1.8%)	9 (3.2%)	12 (4.3%)	0.99
Long distance	155 (44.9%)	19 (5.5%)	29 (8.4%)	23 (6.7%)	43 (12.4%)	50 (14.4%)	16 (5.8%)	27 (9.8%)	7 (2.5%)	17 (6.1%)	2 (0.7%)	51 (18.4%)	
No one	0 (0%)	1 (0.2%)	0 (0%)	0 (0%)	1 (0.2%)	0 (0%)	2 (0.7%)	2 (0.7%)	8 (2.9%)	3 (1.1%)	4 (1.4%)	9 (3.2%)	
Decreased hunting benefits	87 (25.2%)	26 (7.5%)	0 (0%)	0 (0%)	5 (1.4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (0.7%)	0 (0%)	2 (0.7%)	
Hunting													<0.001
Animal's scarcity	0 (0%)	3 (0.9%)	31 (9%)	35 (10.1%)	0 (0%)	0 (0%)	16 (5.8%)	9 (3.2%)	2 (0.7%)	18 (6.6%)	7 (2.6%)	18 (6.6%)	
Long distance	68 (19.7%)	0 (0%)	0 (0%)	0 (0%)	38 (11%)	50 (14.4%)	44 (16%)	51 (18.6%)	15 (5.4%)	10 (3.6%)	9 (3.2%)	44 (16%)	

**Table 5.** Impacts of creation on carbonization activity.

Variables	KBNP						p-value
	Bitale (N = 155)	Ihembe (N = 30)	Kafulumaye (N = 31)	Katana (N = 35)	Mbinga-nord (N = 44)	Mbinga-sud (N = 50)	
No one	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	<0.001
Loss of good wood	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Forest fragmentation	69 (20%)	0 (0%)	0 (0%)	0 (0%)	19 (5.5%)	22 (6.3%)	
Long distance	86 (24.9%)	30 (8.7%)	31 (9%)	35 (10.1%)	25 (7.2%)	28 (8.1%)	
	INR						p-value
	Ilibo (N = 62)	Ilowe (N = 62)	Kakozi (N = 25)	Kalundu (N = 33)	Kasalalo (N = 20)	Kitamba (N = 74)	
No one	16 (5.8%)	15 (5.4%)	11 (4%)	16 (5.8%)	2 (0.7%)	10 (3.6%)	< 0.001
Loss of good wood	9 (3.2%)	21 (7.6%)	8 (2.9%)	7 (2.5%)	12 (4.3%)	9 (3.2%)	
Forest fragmentation	2 (0.7%)	10 (3.6%)	0 (0%)	2 (0.7%)	0 (0%)	26 (9.4%)	
Long distance	35 (12.7%)	16 (5.8%)	6 (2.1%)	8 (2.9%)	6 (2.1%)	29 (10.5%)	

to changes in the installation of a long distance to reach the manufacturing ovens (12.7% in Ilibo, 5.8% in Ilowe, 2.1% in Kakozi and Kalundu, 2.9% in Kasalalo, and 10.5% in Kitamba), the loss of good wood for good charcoal (3.2% in Ilibo, 7.6% in Ilowe, 2.9% in Kakozi, 2.5% in Kalundu, 4.3% in Kasalalo and 3.2% in Kitamba) and the forest fragmentation (3.6% in Ilowe and 9.4% in Kitamba). Nevertheless, 25.3% did not highlight changes, and they use firewood as the energy source.

## 4. Discussion

### 4.1. Socio-Economic Characteristics of Households

Agriculture and hunting are the main sources of income and major ways to control food insecurity around the KBNP and INR. However, these activities remain prohibited both in the enclave and within the boundaries of these PAs. Access to forest resources depends, however, on the type of activities and/or ecosystem service to be provided by PA. Hence, deforestation, setting up agricultural fields, and poaching are seen as the only means of supplying plant and animal nutrients in the area [31]. The importance of the NTFPs and their dependence on the local community are recognized by many, especially in terms of their food, economic, social, ecological, and cultural values [22]. In the eastern part of the Democratic Republic of Congo, bushmeat, fish, and wild plants contribute to a large share of the total value of food consumed in households [32]. NTFPs represent a valid source of nutrients for households around KBNP and INR. They contribute on a large scale to the fight against hunger, often consumed as fruits, vegetables, gum, nuts, seeds or juices [22]. On this side, wood (from protected areas) is the main source of energy, the only source of energy for cooking and heating, because of

the population's limited access to electricity [33]. In the East of the DRC, as in many African countries, NTFPs play an important role in the pharmacopoeia, especially in settings where access to quality health care seems to be important. So, the rapid growth of the population in the riparian areas of the PAs leads to the illegal felling of trees for firewood and charring, the degradation of the forest cover and the biodiversity decline [34] [35].

#### 4.2. Impact of the PA's Creation

PAs offer direct and indirect benefits to the riparian communities at the local, regional and international levels. However, communities are often victims of a failed management system of these protected spaces [36].

This study demonstrates the negative impact of the KBNP and INR creation on the well-being of peripheral communities. This was observed through the declining soil fertility, the reduced agricultural yields in the fields, the installation of long distances that separate the farming areas located within and around PAs, the resurgence of human/wildlife conflicts, the scarcity of wood due to the loss of certain woody species, the intensive cutting of forest trees, the significant decline in income from hunting, the scarcity of bushmeat, as well as the scarcity of NTFPs and the change in dietary habits. Similar results were obtained around Mount Cameroon National Park [37], where the creation of the park generated a negative impact on agricultural activities and the harvesting of forest products, supported by social, economic and political factors such as poverty, high rate of population growth, low rate of people education and subsistence lifestyle based on the natural resources use and the arable land use available for agriculture in the villages. This reality was also observed in the East of the Democratic Republic of Congo [38], where agriculture, livestock farming and the harvesting of forest products are the activities that mainly support the households' income. In addition, the land dispossession of local populations formerly located inside the studied APs, now located in riverside villages, has accentuated the population vulnerability. This engenders a spirit of mistrust with regard to the conservation; some have even promised to intensify poaching in retaliation for the restrictions imposed on them. So, the contradiction between the environmental importance of PAs and the restriction of what they consider to be a traditional right generates PA boundary encroachment, forest fragmentation and biodiversity loss [11]. This represents a major danger to the PA's integrity.

Socio-economic development in the peripheries of the PAs would depend on various factors such as the technical weakness of peasant activities, which leads to a decline in agricultural performance and yield in the exploitation areas, the lack of possible opportunities for local communities to fight poverty linked to the lack of financial support, and the flaws observed at the politico-economic level at the origin of inequalities, exclusion and corruption due to the lack of the established political systems [18] [39]. This accentuates the very extent of the threats, which often lead to managers-local population conflicts. The major impression left by

the creation of PAs is that of restricted access and use for rural populations through legislation, its implementation and privatization [40]. This has an impact on the alteration of land use rights [31] [32]. Restrictions on forest resources have led to increased income losses, significant dietary changes and reduced access to indigenous medicinal plants. Therefore, carrying out these activities on distant lands that are at the borders or even within the PAs by clearing the forest (in search of soil fertility and game) remains the only option for survival. Dispossession (eviction) of the motherland has an effect on lifestyle change and livelihood loss (hunting, gathering, gathering and harvesting of non-timber forest products and lack of access to resources).

So, the community development around the KBNP and the INR depends on reducing the creation of PAs impact to support livelihoods. Thus, the soil fertility restoration in the riparian fields and the creation of community farming spaces in the villages neighbouring the studies area are essential options for reducing and/or preventing the impact on the daily lives of riparian households. Nevertheless, other win-win options, such as the involvement of the local population in the management of the PA through the creation of youth jobs, the regulated access of the population to the priority forest resources located within and at the boundaries of the PAs, environmental education, and rezoning in agreement with the local population for the materialization of the buffer zone can support to improve cohabitation and limit anthropogenic pressures on wild resources.

## 5. Conclusions

The creation of the KBNP and the INR has been the origin of the restrictions and/or moderation of the riparian populations' access to resources. It has led to socio-economic changes that have had a negative impact on the main income-generating activities of households that support their well-being. The changes observed were related to the resurgence of human/wildlife conflicts, the declining of agricultural soil fertility, the reduced agricultural yields in fields and a very long distance between agricultural fields located on the borders of the park and the homes of farmers, access, availability in quantity and quality of wood due to the disappearance of certain woody species and the intensive cutting of forest trees, the significant drop in income from hunting, the scarcity of bushmeat, changes in dietary habits and the scarcity of NTFPs.

To overcome this problem, efforts should be directed towards reducing the changes caused by the creation of PAs under study. This will be possible through the involvement of local populations in all the protected area conservation processes.

## Acknowledgements

The authors acknowledge the Université Evangélique en Afrique for manifold support to this work which was graciously been funded through the project A-COD-2023-0035 on the improvement of research and teaching quality funded by

Pain pour le Monde.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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