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Interactions Between People and Nigeria-Cameroon Chimpanzee (*Pan troglodytes ellioti*) Around Mbam-Djerem National Park, Central Cameroon

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Abstract

Understanding the interactions between local people and chimpanzees is crucial to develop sustainable wildlife conservation strategies and management policy in the Mbam-Djerem National Park (MDNP). The MDNP covers about 416,512 ha and shelters the Nigeria-Cameroon chimpanzee (*Pan troglodytes ellioti*) being the most endangered of all currently recognized chimpanzee subspecies. Close to 30,000 people live in the periphery of the MDNP and depend on the park's resources for subsistence. We investigated the extent of, and factors leading to, the interactions between people and chimpanzees through a socio-economic survey focusing on households (124) and individual interviews (38) in 30% of villages around MDNP. About 95% of the respondents stated that human–wildlife conflict is an issue around MDNP. Access to resources (78.9%), crop damage (84%), and animal attack (11.3%) were the main sources of conflicts. The ground squirrel *Xerus erythropus* (59.7%), the green monkey *Chlorocebus aethiops* (20.2%), chimpanzees (7.3%) and baboons *Papio anubis* (5.6%) were identified as the main conflict animals and the destroyed crops included peanuts (70.2%), maize (15%) and cassava (5%). The population perceptions differed between the park's **four** sectors and were significantly influenced by education and the main **livelihood** activity. The study also provided quantitative evidence on the role of personal and religious beliefs on the behavior towards chimpanzees. Our findings suggest that the improvement of income-generating activities and education will contribute to strengthening the conservation of chimpanzees.

Keywords

Mbam-Djerem National Park, people–chimpanzee interactions, Nigeria-Cameroon chimpanzee, human wildlife conflict, management policy

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Introduction

The wildlife is essential to maintain the ecological balance of an ecosystem and needs to be carefully considered for the effective management of protected and conserved areas. The Mbam-Djerem National Park (MDNP) is the largest national park within the protected area network **of** Cameroon and is characterized **by** a high diversity of wildlife (MINFOF, 2007; Morgan et al., 2011). MDNP is home to more than 450 species of birds, 60 species of reptiles, 35 species of fish and 16 species of

mammals including the endangered Nigeria-Cameroon chimpanzee *Pan troglodytes ellioti* (MINFOF, 2007; Morgan et al., 2011).

The Nigeria-Cameroon chimpanzee, is recognized as **one of** four subspecies of chimpanzee (Gonder et al., 1997; Morgan et al., 2011), is classified as **E**ndangered by **the** IUCN **Red List of Threatened Species** (Hayward, 2009), with between 3,500 and 9,000 individuals remaining (Beck & Chapman, 2008a; Hayward, 2009; Morgan et al., 2011; Oates et al., 2016). Their population is facing a rapid decline across their limited **geographic** range, as a consequence of landscape fragmentation, habitat loss, diseases, commercial bushmeat hunting, climate change and human wildlife conflict (Beck & Chapman, 2008b; Cameron et al., 2016; Sesink Clee et al., 2015). In fact, this great ape can be seen not only as a source of conflict, but also as an important source of income generated through ecotourism (Teel et al., 2010; Tsakem et al., 2015).

Therefore, understanding the relationship between people and great ape populations **is** necessary for an adequate biodiversity conservation planning and practice around National Parks (Aharikundira & Tweheyo 2011b; Bortolamiol, 2014; Hill & Wallace, 2012; Hill & Webber, 2010). The increase in human population and deforestation for agricultural purposes are negatively influencing great ape **populations** and **their** habitat (De Wasseige et al., 2012; Ghimire, 1994; Tsakem et al., 2015). For example, the magnitude of anthropogenic activity on great ape habitats translates into a forest conversion rate of over 90% (Last & Muh, 2013; Nellemann et al., 2014), predisposing surrounding local people and wildlife to conflictual relationships for the use of space and natural resources (Aharikundira & Tweheyo, 2011a). The permanent search for a compromise between improving the living conditions of local populations around national parks and the sustainable management of biodiversity would explain the increasing number of studies relating to the coexistence of humans and wildlife (Bukie et al., 2018; Eniang et al., 2011; Weladji & Tchamba, 2003).

The coexistence of human and wildlife might generate various interactions including conflicts, ecotourism and ritual practices which have been reported around protected and conserved areas (Sillero-Zubiri & Laurenson, 2001; Sillero-Zubiri & Switzer, 2001; Tsakem et al., 2015). As shown in previous studies, human–wildlife interactions have intensified around protected areas, requiring rigorous management policy especially for a charismatic species like chimpanzee (Hill, 2004; Hill & Wallace, 2012; Littlewood et al., 2020; Teel et al., 2010). Some findings highlighted crop attacks as a major human–wildlife conflict in many countries of tropical ecosystems (Bukie et al., 2018; Tsakem et al., 2015; Weladji & Tchamba, 2003). Crop attacks by wildlife are considered a serious problem in most rural territories found at the periphery of protected and conserved areas in Central Africa. This may cause the loss of life, human injury, destruction of crops and agricultural infrastructure (Treves & Naughton-Treves, 2005; Treves et al., 2006).

However, human–chimpanzee interactions might generate socio-economic benefits through ecotourism, research, cultural belief and education, but also a conflict for the use of feeding resources considered as a priority by the IUCN/Primate Specialist Group (Hockings, 2009). Chimpanzees feeding on crops have been reported for many protected and conserved areas across Africa (Hockings et al., 2012; Hockings et al., 2017; McLennan et al., 2012). Given the actual anthropogenic threat on natural habitat, **chimpanzees** can adapt their feeding behavior to cultivated crops which are palatable, easily digestible, and offer energetic advantages over natural foods (Bessa et al., 2015; Doran, 1997; Hockings et al., 2017; McLennan et al., 2012; McLennan & Ganzhorn, 2017). We assumed chimpanzee could be identified as the fauna species mostly involved in interactions with local community although potential crop raiding by this ape has not yet been evaluated in MDNP.

The objectives of the present study were to establish the types of interactions between local populations and wildlife, to evaluate the importance of chimpanzees in human wildlife interactions, and to assess the extent of damages caused by wildlife to the livelihood of local farmers. Achieving these objectives is relevant for informing national parks managers for improving the current conservation policy at MDNP by focusing on more sustainable approaches with regards to human–wildlife interaction, livelihood creation and an understanding of the need for conservation action. An improved policy and adapted strategies will help to achieve acceptance of conservation practices by the local population and thus enhance the quality of great ape habitats and reduce threats to this endangered species.

Methods

Study Area

Created in 2000, the MDNP covers $4,165.2\,km^2$ and lies between 5°30′N and 6°14′N, and 12°20′E and 13°15′E (Bobo et al., 2006; Mitchard et al., 2009) (Figure 3). A $1,662.34\,km^2$ core zone is established at the **center** of the MDNP with the primary purpose to ensure a safe and long term persistence of the chimpanzee population and other large mammals. The climate of the area comprises two seasons of almost equal length: the rainy season from mid-April to mid-October and the dry season from mid-October to mid-April. The average annual

rainfall is 1,900 mm while the average annual temperature is 24 °C (Bobo et al., 2006). The MDNP is located partially in the Guinea-Congolian and in the Sudanian regions (White, 1993) with savannah in the north and the Central African forest block in the south. The national park is therefore dominated by forest-savannah mosaic, with a primary lowland rain forest in the southern sector (Maisels et al., 2006; Maisels et al., 2007). The relief is relatively flat and the altitude ranges from 650 m to 930 m above sea level (a.s.l.). About 60 species of mammals belonging to 10 orders, 26 families and 34 subfamilies have been identified at the MDNP (Bobo et al., 2006). More than 50,000 inhabitants, whose lives depend almost entirely on the natural resources, reside around the MDNP (Fosso et al., 2017; MINFOF, 2007). The local population includes Christians, Muslims and Animists distributed in more than 75 villages and their main **activity** varies between farmers, cattle breeders, fishermen and hunters (MINFOF, 2007; Morgan et al., 2011). The human population tends to be concentrated in the northern periphery where grazing lands are available and where the Mbakaou dam was constructed in 1964, and in the eastern periphery of the national park where the Belabo-Ngaoudéré railway link is located which was constructed in 1970 (Bobo & Weladji, 2011) (Figure 1). Established at the edge of the forest and the savannah ecosystems in Cameroon (Maisels et al., 2009; Mitchard et al., 2009), it appears that, the MDNP is an ideal place for assessing the relationship between people and the **Nigerian–Cameroon** chimpanzee, which is the least studied of all great ape subspecies (Gonder et al., 2006; Oates et al., 2016).

Data Collection

We conducted two socio-economic surveys (Document S1) combining the approach used by other authors (Aharikundira & Tweheyo 2011b; Fetters et al., 2013): a questionnaire survey of households in villages surrounding the MDNP and individual interviews of resource persons (Hill & Wallace, 2012; Hill & Webber, 2010). The questionnaire survey was conducted in the four sectors of the MDNP (North, South, East and West) as defined in the National Park management plan. **The questions in the s**urvey w**ere** focused on characteristics such as geographic location, access to the park, local perception of population which could have an influence on the management of the MDNP **and the bushmeat consumption.**

The questionnaire survey was conducted in 30% (22) randomly selected villages out of the 74 found around MDNP. In each village, a household was considered as a sampling unit. Eight villages and 42 households were selected in the North, four villages and 18 households in the South, five villages and 28 households in the East and five villages and 36 households in the West. This provided for a total of 124 households surveyed around the MDNP. The questionnaires were administered to the head of household. The woman in a household was considered head of household when her husband was absent. Respondents represented various socio-economic backgrounds. **In regards to bushmeat, we just asked whether the respondent eat bushmeat or not, in order to evaluate the extent of bushmeat as a potential threat to chimpanzee in MDNP.**
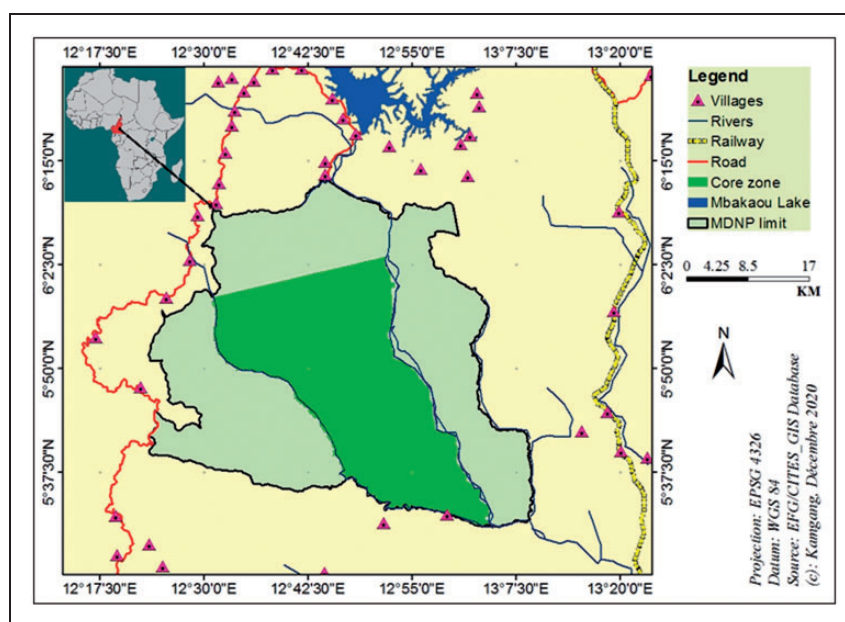

Figure 1. The Study Area Highlighting Villages and Roads Around MDNP.

As the second part of the assessment, a total of 38 resource persons (experts leading conservation projects and traditional leaders in the study area) including park warden, ecoguards, NGO coordinators, and chiefs of the villages were interviewed in the selected villages with 11 resource persons in the North, 12 in the West, seven in the East and eight in the South. These 38 individuals represented one National Park warden, four forest officers, four heads of sectors (leader of the team protecting each of the four designed areas called sectors of the park to strengthen its management effectiveness), 22 traditional leaders and 11 heads of private organizations operating locally.

Data Analysis

The data collected (Document S2) were reviewed, **categorized** and **analyzed using** IBM SPSS Statistic 20 software. Descriptive statistics were used to examine patterns in the human–wildlife conflict including the type of conflict, type of crop damage, the crop-raiding animal, and the solution to the conflict. The type of conflict was compared across sectors using an ANOVA with a significance level of 5% to assess whether certain characteristics of the respondents (religion, education, ethnic group, main activity, tribes) could influence the perception of populations on wildlife, damage to crops, conflict resolution, and conservation. Chi-square test and the Multiple Component Analysis (MCA) were also used to assess the correlation between certain characteristics of the respondents (ethnic group, religion, main activity) and drivers of human–wildlife conflict in the MDNP.

Results

Socio-Economic Background of the Respondents

Among the interviewed persons, 60.5% lived in the community for more than 15 years compared to 26.3% who lived there less than 5 years old, which allow to better address the problem of wildlife conservation in the study area. Of 124 respondents, 90% were men and only 10% were women, representing different age groups (Table 1).

Table 1. Age Groups of the Respondents (years).

Age groups	Frequency	Percentage (%)
< 20	3	2.4
20–30	11	8.9
30–40	24	19.4
40–50	45	36.3
> 50	41	33.1
Total	124	100.0

The level of education remained limited to primary (60.5%) and secondary school (29%) with only (0.8%) of the respondents having attended high school or university, while 9.7% had never been in school at all. Overall, the main livelihood activity was farming (87.1%) although it showed a significant difference between geographic sectors (Chi-square = 38.94, $df = 9$, **$p = 0.0001$**) (Figure 2).

With the given activities, the annual income of respondents also differs according to the sectors ($F_{1,3} = 4.25$, $p = 0.007$) and vary between 25,000 and 50,000 FCFA (20.2%) to more than 75,000 FCFA (58.9%) (Table 2).

Human–Wildlife Conflict

Human–wildlife conflict is an issue in the MDNP according to 94.73% of the respondents although no evidence of significant difference between sectors was found (Chi-square = 11,787 $df = 9$, $p = 0.226$). Responses indicated that crop raiding (83.9%) was the main form of conflict, followed by aggression (11.3%) and social disruption or disorder (3.2%), with the least reported being predation (0.8%) (Table 3). **By social disruption we referred to the disorder found between individuals in the community especially when one assumed that his crop was damaged by an animal considered as the**
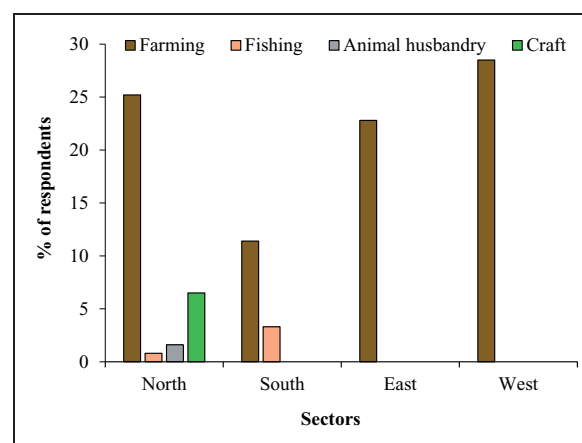

Figure 2. The Main Activity of the Responded According to Sectors.

Table 2. Annual Income (FCFA, 1US $= 500 FCFA) of the Respondents.

Revenue class (FCFA)	Frequency	Percentage
<25,000	8	6.5
25,000–50,000	25	20.2
50,000–75,000	18	14.5
>75,000	73	58.9
Total	124	100.0

Table 3. Types of Conflict Found Around Mbam-Djerem National Park.

Form of conflicts	Frequency	Percentage
Crop raiding	104	83.9
Aggression	14	11.3
Predation	1	0.8
Social disruption	4	3.2
Other	1	0.8
Total	124	100.0
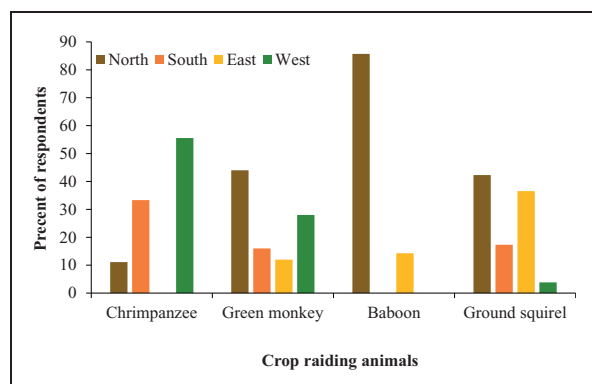
Figure 3. Animals Involved in Crop Raiding According to Four Sectors of the MDNP.
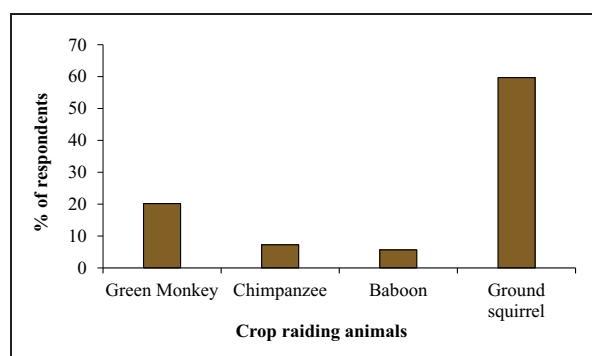
Figure 4. Animals Involved in Crop Raiding in the Study Area.

totem of other. Is some extent community may got afraid when they know in the farm, they can encounter baboon or chimpanzee.

Crop Raiding Animal

Only 7.3% of respondents considered chimpanzees as crop raiding animals although we found differences between geographic sectors (Figure 3) (Chi-square $= 19,385$ $df = 9$, $p = 0.022$). Instead, the ground squirrel (59.7%) and the green monkey (20.2%) were identified as mainly being involved in crop raiding, followed by the baboon (5.6%) (Figure 4).
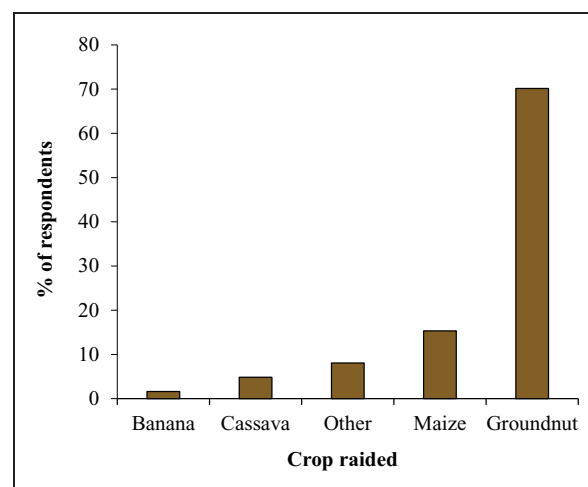
Figure 5. Crop Types Damaged in the Study Area.

Table 4. Monetary Loss (FCFA, 1 US $= 500$ FCFA) as the Consequence of Human–Wildlife Conflict.

Value class (FCFA)	Frequency	Percentage
<50000	51	41.5
51,000–100,000	36	29.3
101,000–150,000	23	18.7
151,000–200,000	4	3.3
>200,000	9	7.3

Crop Types Damaged by Wildlife

Crop species mostly raided by wildlife around MDNP are groundnut *Arachis hypogea* (70.2%), maize *Zea mays* (15%), cassava *Manihot esculenta* (4.8%) and banana *Musa spp.* (1.61%) as shown in Figure 5. We found significant differences between geographic sectors (Chi-square $= 23,466$ $df = 9$, $p = 0.005$). Damages for groundnut and maize were most recorded in the western and northern sectors, while cassava and banana were frequently destroyed in the southern and eastern sectors of the MDNP.

The extent of crop damages was not different between geographic sectors (ANOVA: $F_{1, 3} = 0.35$, $p = 0.787$). Farmers reported extents as 0.5 to 1 ha (40.3%), more than 1 ha (39.5%) and less than 0.5 ha (12.1%).

Impacts of Human–Wildlife Conflict on Livelihoods

Based on a monetary evaluation of crop losses for farmers, we found no evidence of differences between geographic sectors (ANOVA: $F_{1, 3} = 0.77$, $p = 0.5$). In most occasions, losses were below 50,000 FCFA (41.5%), and only 7.3% of the respondents declared losses above 200,000 FCFA (Table 4).

Reactions of People against Crop Attacks

Among the respondents, 53.2% of famers used traps and dogs to protect their crops from crop-raiding animals, while 28.2% reported **no reaction** to the **crop attacks** (Table 5). This pattern varied between geographic sectors (Figure 6) (Chi-square = 18.063, *df* = 9, *p* = 0.034). People also used poison (9%) to deter wildlife from crop attack which represented a high risk of wildlife extinction. Poison product used is the chemical called Furadan. Most farmers also used a locally made product including the seeds of *Thevetia peruviana* added to fermented urine and carbon rod (graphite) from useless batteries which more often killed the animal involved in crop raiding and even scavengers.

Local Population Perception of Chimpanzees

We assessed the local population perception of chimpanzee based on cultural beliefs (Table 6), tribes (Table 7) and geographic sectors. Around MDNP, 79.8% of the respondents were Christian while only 6.4% were animist. Chimpanzees were perceived as totem (68.2% of responses) according to geographic sectors (ANOVA: $F_{1,3} = 3.778$, $p = 0.029$), tribes (ANOVA: $F_{1,3} = 6.173$, $p = 0.001$), and religion (ANOVA: $F_{1,3} = 1.346$, $p = 0.263$). In the south and west sectors, peoples considered chimpanzee as the savior of their ancestor during the past. While according to the tribe, **the** Gbaya and

Vuté tribes consider chimpanzee as a totem, for Bororo and Fulbe, are **animal species like any other animal, though** human-like. According to the tribes, 29.8% and 36.3% of the respondents were Gbaya and Mboum respectively, and both tribes also considered chimpanzees as human.

We also assessed the correlation between variables (Appendix A). The different variables have a high internal consistency (Cronbach's Alpha = 0.806). Thus, we find that the ethnic group is strongly correlated with **bushmeat** consumption (0.575), religion (0.424) and main activity (0.444). **Muslim do not ate bushmeat. According to their social norm, animal need to be slaughtered (by cutting the neck) before they eat any part of it.**

Discussion

Understanding interactions between the local population and chimpanzees is crucial for the development of sustainable conservation strategies in protected areas. The access to the natural resources often gives rise to various conflicts between human population and wildlife.

Human–Wildlife Conflicts

From our results, the main livelihood activity of the local population around the MDNP was farming. Mostly peanuts were destroyed, followed by other crops being maize, cassava and banana as stated by survey respondents. Similarly, in Kainji Lake National Park in Nigeria (Adeola et al., 2018; Ogunjobi & Adeola, 2016) and in Lobéké National Park in Cameroon (Tsakem et al., 2015), maize, groundnuts and cassava

Table 5. Different Reaction of People Against Crop Attacks.

Reactions	Frequency	Percentage
Traps	66	53.2
Shotgun	7	5.6
Guarding	5	4.0
Poisoning (Furadan®)	11	8.9
No reaction	35	28.2
Total	124	100.0
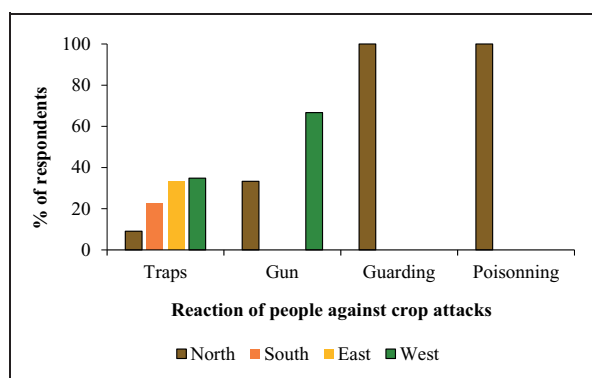
Figure 6. Reaction of People Against Crop Attacks According to the Four Sectors of MDNP.

Table 6. Cultural Beliefs of People Around Mbam-Djerem National Park.

Beliefs	Frequency	Percentage
Christian	99	79.8
Muslim	17	13.7
Animist	8	6.4
Total	124	100.0

Table 7. Different Tribes and Their Belief Around Mbam-Djerem National Park.

Ethnics group	Frequency	Percentage	Belief
Gbaya	37	29.8	Christian
Vute	23	18.5	Christian
Bororo	4	3.2	Muslim
Mboum	45	36.3	Christian
Mambila	12	9.7	Animist
Fulbe	3	2.4	Muslim
Total	124	100.0	–

were the most widely grown crops, with maize and groundnuts mainly being raided by wildlife (Bukie et al., 2018; Sillero-Zubiri & Switzer, 2001).

The ground squirrel was the animal species mostly involved in crop raiding around MDNP. In other region such as Senegal and Nigeria, rodents have similarly been identified as being strongly involved in crop raiding around protected areas (Bukie et al., 2018). Several other animal species were involved in the conflicts around MDNP like the green monkey, the chimpanzee and the baboon. Baboons were involved in maize raiding in the north sector of the MDNP which ecologically is a savannah. This result is consistent with others authors who confirmed that baboon are known to favor maize crop around National Parks (Bobo & Weladji, 2011; Eniang et al., 2011; Warren, 2003), while chimpanzees were pointed as aggressive animal in the southern sector of the National Park. Chimpanzees were mainly found in this sector of the MDNP which is a forest, and people also using this sector for collecting non timber forest products. Interactions with chimpanzees here are then most frequent and they may be aggressive in order to defend their territory.

Around the MDNP, most people are famers and crop raiding causing monetary losses constitutes an economic risk for households. The extent of the conflict has hampered the subsistence system of the local population. The estimated annual losses was high**er** than the annual income of some respondents. This may result **from farmers possibly perceiving the damages as more severe than they were in reality or because of the lack of proper tools to assess the damages**. This was already the case in Bénin and Ivory Coast where farmers around the Pendjari Biosphere Reserve and the Tanoé-Ehy Marsh Forest declared losses much higher than expected (Houinato & Sinsin, 2000; Kouao et al., 2018).

Monetary losses due to human–wildlife conflicts have been reported around most protected areas (Aharikundira & Tweheyo 2011b; Bukie et al., 2018; Marchal & Hill, 2009; Tsakem et al., 2015; Weladji et al., 2003) and conflict mitigation/compensation measures should be incorporated in the protected area management strategies. The choice of maize and groundnuts as main crops in farming around MDNP is explained by their short production period that sometimes allows for off-season production. In addition, these crops are the most popular food source for the population because their local transformation is simple and diversified.

Chimpanzees were less involved in crop raiding around MDNP. This is not the case for example at Budongo in Uganda, where chimpanzees spoil fruits in orchards (Dudley et al., 2002) and at Cantanhez in Guinea Bissau where they are perceived as the main pest of maize crops and sugar cane *Saccharum officinarum* (Hockings & Sousa, 2013). At MDNP, the local population received economic benefits only through research activities focused on chimpanzees although more income could be generated through ecotourism development (Tsakem et al., 2015).

Local people around protected areas generally use several approaches to protect crops against wildlife. These include day and nighttime guarding, noises to frighten animals as well as fences and traps (Hill, 2004; Mwakatobe et al., 2014; Sillero-Zubiri & Switzer, 2001). In our study area, people used different approaches to protect their crops which varied between geographic sectors and depended on the animal species involved in the conflict. To deter chimpanzees in the west sector, and baboons in the north sector, **which are both large-sized mammals**, the rifle can be used while traps and poison products are set against ground squirrels in the north. Poison products including the use of *Thevetia peruviana* seeds have been highlighted by many authors to prevent crop attacks (Dooh et al., 2014; Mboussi et al., 2018). However, we advised the community to adopt a combination of approaches as this may help to better protect their crops and contribute to the conservation of wildlife (Karidozo & Osborn, 2007; Mwakatobe et al., 2014; Ringo & Kaswamila, 2014).

Impacts of Human–Wildlife Conflict and Implication for Conservation

Wildlife conflicts can have negative consequences if they are not effectively apprehended (Houinato & Sinsin, 2000). **The local population of different tribes around the MDNP depend on the natural resources of the park and therefore conflicts of interest are inevitable** (Bobo & Weladji, 2011). Although chimpanzees are not yet subject to reprisals by the population, if current conflicts remain unresolved, biodiversity conservation in the MDNP might **be negative affected**. In fact, intolerance of crop raiding species could lead to dramatic actions (poisoning and illegal killing), reducing the size of animal populations (Ijeomah & Ogbara, 2013; Woodroffe et al., 2005).

Around MDNP, local beliefs are a supporting asset for chimpanzee conservation (Appendix B), which is an opportunity to strengthen biodiversity management programs. For instance, we discovered that in MDNP, Muslim do not **eat** bushmeat mainly because according to their social norm, animal need to be slaughtered (by cutting the neck) before they eat any part of it. Also Gbaya and Vute tribes considered chimpanzee as a savior of their ancestor. Local communities should therefore be more effectively involved in the national park management and the sustainable use of natural resources (Morgan et al., 2011). A participatory approach, where the opinion of communities and other stakeholders are considered when making management

decisions, could be meaningful and help to make the communities autonomous in solving their own problems. Farmers need to be sensitized on legislative regulation and informed about diseases and zoonosis risks form hunting and **eaten bush**meat, and their point of view considered for the sustainable wildlife management issues (Aharikundira & Tweheyo 2011b; Junker et al., 2020; Littlewood et al., 2020; Petrovan et al., 2018). Further, a local database on human–wildlife conflicts should be established for regional long-term monitoring. Similarly, a conservation education program could be developed around MDNP to educate children from primary and secondary schools about the importance of biodiversity for local communities.

Since human–wildlife conflicts are generally becoming more frequent (Eniang et al., 2011; Hockings & Sousa, 2013; Sillero-Zubiri & Laurenson, 2001), research should focus on them in order to gain new insights and suggest possible solutions according to geographic regions and species involved. Small rodents are more often causing damage than larger mammals, although the latter are the focus of most human–wildlife conflict studies (Eniang et al., 2011). Such future findings may further support the understanding and acceptance of conservation measures and foster the collaboration between protected area management and communities, as is needed in the case of MDNP.

Despite the damages not being of a great amplitude, it is advisable to anticipate the conflicts and to limit the monetary losses in order to gain the population's incentive in favor of conservation. According to the tribes and religious attributes in the study area, most people do not hunt or eat chimpanzee meat, which is important information to be considered for reviewing the chimpanzee conservation policy in the MDNP as it may create opportunities for specific conservation action focused on these tribes.

One immediate approach needed is to reinvigorate relations between local communities and the conservation department. Conflict resolution strategies must take into account the specific context of each geographic sector of the National Park. For example, techniques to limit human–chimpanzee conflicts should be developed with priority in the southern sector where chimpanzee attacks have been recorded. Group farming is advisable and it should strongly be recommended for farmers to locate their farms in land use areas far from the border of the national park. Our results provide the baseline data on human–chimpanzee interaction at the MDNP. Although further studies on monetary losses from human–wildlife conflict around MDNP and other protected areas are recommended, cultural beliefs are an asset for chimpanzee conservation in MDNP. Therefore, it is important for partners and stakeholders to work together to strengthen the conservation strategies of *P. t. ellioti* in this forest-savannah transitional area in Cameroon.

Appendix A: Correlation Between Different Variables Which Influence the Conservation of Biodiversity in Mbam-Djerem National Park.

Dimension: 1

	Sector	Ethnic group	Religion	Main activity[a]	Bustmeat consumption	Knowing the park limit	Human-wildlife conflict	Threats on chimpanzee
Sector	1.000	0.278	0.168	0.308	**0.428**	0.252	0.211	0.046
Ethnic group	0.278	1.000	0.424	0.444	0.575	0.123	0.424	0.062
Religion	0.168	0.424	1.000	0.331	0.451	−0.149	0.317	−0.053
Main activity[a]	0.308	0.444	0.331	1.000	0.447	0.157	0.911	0.066
Bustmeat consumption	0.428	0.575	0.451	0.447	1.000	−0.024	0.443	0.047
Knowing the park limit	0.252	0.123	−0.149	0.157	−0.024	1.000	0.085	0.074
Human-wildlife conflict[a]	0.211	0.424	0.317	0.911	0.443	0.085	1.000	0.026
Threats on chimpanzee[a]	0.046	0.062	−0.053	0.066	0.047	0.074	0.026	1.000
Dimension	1	2	3	4	5	6	7	8
Eigen value	3.135	1.260	1.000	0.968	0.673	0.532	0.352	0.080

[a]Missing values were imputed to the mode of the quantified variable.

Appendix B: Strength, Weakness, Opportunity and Threats (SWOT) Analysis.

Activity	Strengths	Weaknesses	Opportunities	Threats
Agriculture	– Availability/fertility of soils – Young manpower	– Lack of organization – Market risk – Lack of training	– Willingness to produce – Existing market – Road and railway	– Loss of yield – Encroachment – Conflict
Fishing	– Local Association – Assistance of the government – Database available	– Bad communication – Corruption – No sanitary control – Failure to respect the closure period – Wrong application of the law	– Market – Employment	– Overexploitation – Conflict
Animal rearing	– Pasture – Climate – Young workforce – Sensitization	– Traditional rearing – Transhumance on foot – No breed selection – Under valuation of products	– Market – Employment	– Encroachment – Conflict – Zoonosis – Hostage
Craft	– Resource available	– Lack of knowledge of the resource – Lack of training and promotion	– Employment – Consumer pole	– Loss of culture – Poverty – Conflict

Declaration of Conflicting Interests

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Supplemental Material

The datasets analyzed during the current study are available from the corresponding author on reasonable request although some data used are included in this published article as Supplementary Material.

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