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# Environmental Impact Assessment of Civil Engineering Project on the Distribution of Gorillas and Chimpanzees in Deng Deng National Park Cameroon

**Séverin Mbog Mbog[1, 2, *], Gareth Zo'obo Engolo[2], Bill Vaneck Bot[2, *], Julbert Ndi Wamba[2], Dieudonné Bitondo[1, 2]**

[1]Department of Quality, Health, Safety and Industrial Environment Engineering, Higher National Polytechnic School, University of Douala, Douala, Cameroon

[2]Laboratory of Energy, Materials, Modelling and Methods, Doctorate School of Fundamental and Applied Sciences, University of Douala, Douala, Cameroon

## Email address:

severinmbog.sm@gmail.com (Séverin Mbog Mbog), garethmartinienzooboengolo@gmail.com (Gareth Zo'obo Engolo), bbillvaneck@yahoo.fr (Bill Vaneck Bot), bitondodieudonne@yahoo.fr (Dieudonné Bitondo)

[*]Corresponding author

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**Abstract:** Civil engineering projects have many impacts in environment sustainability. The purpose of this research is to evaluate the human consequences of civil engineering building activities on the natural habitats of gorillas and chimps in the Deng Deng National Park, in particular, and Cameroon in general. An indirect census based on single-pass nest counts was used to estimate ape density at Deng Deng National Park. Data were collected at the various field trips during 3 months. The line transect was the most efficient and reliable census method. It has been used in many studies concerning the estimation of ape population density. This method consisted of making observations along the centre line of the transect. The principle was based on the assumption that the probability of detecting a nest decreases. The identification of consequences entailed listing all important environmental components that were likely to be affected. According to the study's findings, the number of nid sites and population density of great crested newts rose in the Deng Deng National Park to 80 sites, 391 nids, and 0.80 ind/km2. The Lom Pangar hydroelectric dam has had significant ripple effects on the distribution of great apes in general and particularly on the density of chimps. The study finds that, despite habitat fragmentation, the population of large singes has increased significantly in the Deng Deng National Park.

**Keywords:** Environment, Animals, Fauna, Impact, Hydroelectric Construction

## 1. Introduction

The Congo Basin accounts for 70% of the African continent's forest cover and is home to much of Africa's biodiversity. The six states of this basin, Cameroon, Gabon, Equatorial Guinea, the Central African Republic, Democratic Republic of Congo and Republic of Congo, share this ecosystem; about 57% of it is covered by forest and is therefore part of the second largest tropical forest area in the world, after the Amazon [1].

From a biological point of view, these forests of the Congo Basin are considered to be the richest and most complex ecosystems. They are also probably the most threatened in the world [2]. In Cameroon, the forest represents one of the greatest riches. It occupies more than 60% of the national territory and is characterised by a remarkable biodiversity that depends on the variety of natural landscapes [3]. Knowledge of the quantitative (density), qualitative (species, protection status), and distribution of animal resources is therefore of fundamental importance in the development of biodiversity conservation strategies [4]. Thus, disturbances in natural

environments due to human needs, accentuated by population growth and the evolution of science and technology, lead to significant changes in the dynamics of biodiversity. These changes affect both the composition and structure of the living organisms that inhabit these ecosystems.

The conversion of forests for plantations, agriculture, grazing, logging, mining, road building, and dams is contributing uncontrollably to the fragmentation and degradation of wildlife habitats and, consequently, to the loss of biodiversity. Large mammals such as elephants and great apes have been chosen as indicators of intact and functioning ecosystems because, if a forest is unsustainably hunted, these species are the first to disappear, for three reasons: Large mammals are chosen by hunters because they give a higher return per hunting effort; they generally occur at lower densities than small species; and, because of their slow reproductive rate, removals occur more quickly than replacements.

In the face of hunting pressures and threats to the natural habitat of gorillas and chimpanzees in particular, many researchers suggest that sustainable management of tropical forests inevitably requires the protection and conservation of fruit-eating mammals that facilitate seed dispersal [5], hence the importance of their role in the natural regeneration of Africa's primary forests.

In order to fill the energy gap and connect the northern part of Cameroon to the southern interconnected grid, the government of Cameroon, with the help of donors, has undertaken the construction of the Lom Pangar hydroelectric dam in the Deng Deng forest massif in the eastern region. The site of the Lom Pangar hydroelectric dam is located in a hotspot of great ape habitats, at the northern limit of the range of the great apes, namely gorillas and chimpanzees, which are fully protected species, as well as their natural habitats. Due to the increasing hunting pressure on apes in their natural habitat and the increasing degradation of their natural habitat, the gorilla and chimpanzee populations and their natural habitat, especially in the Deng Deng forest, will be subject to various disturbances caused by the concentration of technical and human resources in the project site. Furthermore, the degradation of the massif will certainly result in a general impoverishment of the massif's biodiversity and a gradual decline in the population of animals, including the large primates (gorillas and chimpanzees) [6]. It should be noted that the safeguarding of the large primates of the Deng Deng Forest is a conditionality of the World Bank, hence the reclassification of part of the Deng Deng Forest. This reclassified part of the Deng Deng Forest was set up as a national park by Decree No. 2010/0482 PM of 18 March 18, 2010, creating the Deng Deng National Park, covering an area of 523 km².

## 2. Materials and Methods

### *2.1. Location of Study Area*

With a surface area of 58091 ha, the Deng Deng National Park (DNDP) is located between 13°20' and 13°35' East Longitude and 05°35' and 05°60' North Latitude, at the northern limit of the dense humid forest of the Congo Basin and the edge of the great ape distribution zone. On the one hand, the project site is located on the Lom River, 4 km from its confluence with the Pangar, and 13 km from its affluence with the Djerem. The DNDP is administratively located in the Eastern Region, Lom and Djerem department, in the districts of Bélabo and Betare Oya (Decree N° 2010 / 0482 pm of March 18, 2010 with an area of approximately 523 $km^2$). It is the core conservation area of the Deng Deng Technical Operational Unit (TOU), and covers a geographical area of about 574,993 ha, Figure 1 shows its geographical location. First, confirm that you have the correct template for your paper size. This template has been tailored for output on the A4 paper size.

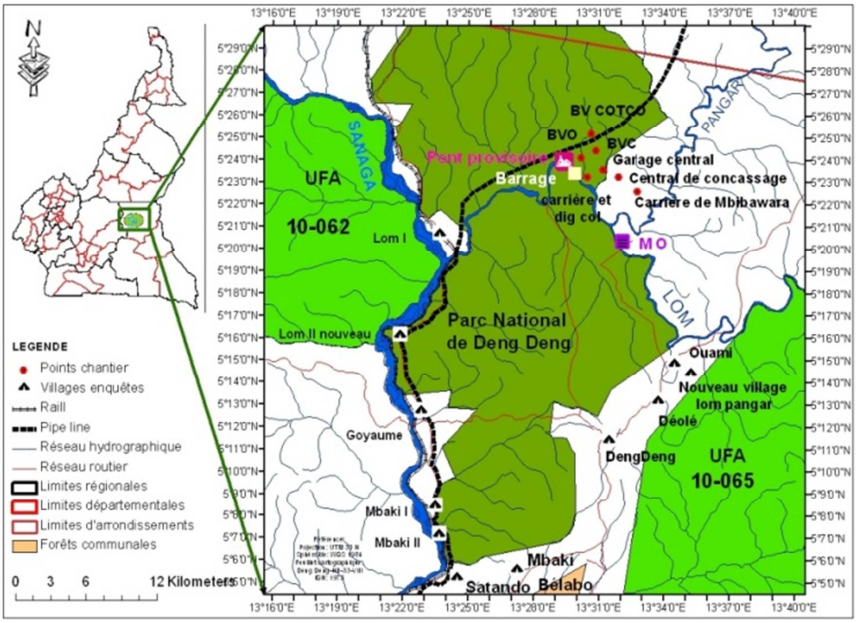


***Figure 1.*** *Location of DENG DENG national park.*

### *2.2. Data Collection*

Data collection was carried out during the various field trips from November 12, 2012, to December 9, 2013. The line transect was the most efficient and reliable census method. It has been used in many studies concerning the estimation of ape population density [7], [8]. This method consists of making observations along the centre line of the transect. The principle is based on the assumption that the probability of detecting a nest decreases with the distance perpendicular to the axis of travel [9].

#### *2.2.1. Estimation of Ape Density*

To estimate ape density at DDNP, an indirect census based on single-pass nest counts was adopted.

The survey set-up consisted of twenty-nine (29) transects of two (02) km each, which were a series of parallel lines running east-west through the DDNP, along which all signs or sightings of gorillas and chimpanzees and human impacts were recorded. Data was collected between 08:00 and 15:30 at a rate of two (02) km per day. The compass placed above the stick was oriented in an East-West direction. The tracker then opened a trail from the compass in the correct direction, under the direction of the compass officer. All nests detected on either side of the centre line of the transect were counted, including all those not visible from the transect. This involved observing up to forty-five (45) metres around the location of the first nest, as gorilla or chimpanzee nests are usually widely scattered [10]. For each nest, it is noted on which side of the transect it is located. The perpendicular distance from the centre of each nest to the centreline of the transect is measured. Since chimpanzee nests are in trees, the point where a vertical projection of the centre of the nest would meet the ground is estimated. For each nest site observed on the transect, the distance along the transect (topofile distance) was to be recorded, as was the distance perpendicular to the centre of the nest site, The waypoint is recorded at the centre of the nest site using the 60X geographic positioning system (GPS), which is left on at all times to record the path taken.

To estimate the density of apes in individuals/km², given that each weanling builds a nest each evening and spends the night in it, and that nests are not reused, equation (1) of Fruth [11], and Brugiere [12] was used below to estimate the density of weanlings:

$$D = Dn / Vdg \quad (1)$$

Where Dn is density of weaned apes (individuals/km²)

Vdg is decay rate (170 days)

The Kilometre Abundance Index, which represents the average number of sites per unit distance, is calculated from the formula.

$$IKA = N/ L \quad (2)$$

Where

IKA: kilometre index of abundance or count

N: total number of nest sites (nests) counted

L: total distance travelled (km)

The comparison of the means was carried out according to the statistical test at the 5% significance level, using Excel software. It allowed us to observe the differences and variations in the parameters studied within a sampling campaign and between the different samplings carried out. The results of the different parameters analysed are expressed as the mean ± standard deviation. These averages are presented in the form of tables or histograms, using Excel 2007 software.

#### *2.2.2. Assessment of the Project's Impact on the Natural Habitats of the DDNP Great Apes*

The identification of impacts consisted, firstly, of listing all relevant components of the environment likely to be affected. Next, all the activities planned as part of the project were inventoried. The third step was to cross-reference the environmental components with the impact-causing activities in order to identify the interrelationships [13]. This matrix served as the basis for identifying the project's impacts. The identification of impacts also took into account consultation meetings, interviews with resource persons, and field observations. This approach made it possible to identify the impacts of the activities of each of the components of the BHLP development project, as well as the cumulative impacts resulting from actual or potential related activities.

To evaluate each impact, the absolute significance was first determined using the Martin Fecteau grid, which combines three parameters (intensity, duration, and extent). To determine the relative significance of the impact, other parameters were integrated, including reversibility, occurrence, value of the affected component, and the cumulative nature of the impact.

## 3. Results

### *3.1. Spatial Distribution of Great Ape Nesting Sites*

Over a total of 58 km of transects surveyed (29 transects of 2 km each), 391 ape nests were recorded at 80 nest sites, most of which were attributed to gorillas (283 nests and 41 nest sites), while 108 nests and 39 nest sites were attributed to apes only, and no nests, nest sites definitely attributed to chimpanzees, with an encounter index of 1.37 sites/km for apes in general, at the 5% probability threshold, a confidence index (0.3 - 3.1) and coefficient of variation of 44.19%.

The estimated density of apes in the DDNP obtained is 0.8 ind/km² for all apes, 0.6 ind/km² for gorillas, 0.22 ind/km² for great apes, and 0 ind/km² for chimpanzees. The effective detection distance of ape nests in general was estimated at 24.75 m, with nest sites distributed over most of the sampled area.

The distribution of apes was more representative on transects (T5, T6, T8, T9, T10, T13, T14, T17 and T18) in the heart of the park, and sparse on transects (T01, T02, T04, T07, T11, T15, T16, T19, T20, T21, T22, T23, T24, T28 and T29) on the periphery of the park.

### *3.2. Distribution of Ape Nest Sites by Type of Impacted Area*

***Table 1.*** *Results of great ape surveys and PNDD surveys.*

| surveyed areas | Great Ape nest sites | Gorilla nest sites |
|---|---|---|
| Area A | 20 | 19 |
| Area B | 16 | 17 |
| Area C | 3 | 5 |
| total | 39 | 41 |

Great ape nest sites were recorded in almost all habitat types at the study site at DDNP. The results show a non-homogeneous distribution of nest sites (Figure 1). The frequency of observation of nest sites is highest in Zone A 48.75% (gorillas 46.34%; apes 51.3%), followed by Zone B 41.25% (gorillas 39.02%; apes 41.02%) and low in Zone C 10% (gorillas 12.19%; apes 07.7%). The frequency of observation is lower in Zone C (10%). Of the 391 nests recorded, over half, or 90%, were found in Zone A and Zone B (Table 1).

### *3.3. Identification of Impacting Environments and Activities*

Table 2 below shows my identification of interactions between project activities and valued environmental components (VECs). The matrix shows that almost all activities carried out in the vicinity of the DDNP interact with the VECs, except for the resettlement activity, which does not interact at all. In addition, the activities of labour recruitment and road maintenance have interactions with the human component of the environment.

***Table 2.*** *Interaction matrix of impacting activities.*

| VEC impacting activities | Physical area | | | Biological area | | | Human area | |
|---|---|---|---|---|---|---|---|---|
| | Soil | Water | Air | Flora | Fauna | Ecosystems | Resources use | Social |
| Creation of the main and secondary accesses | X | X | X | X | X | X | X | X |
| Creation of the project owner's quarters | X | X | X | X | X | X | X | X |
| Creation of the managers' housing | X | X | X | X | X | X | X | X |
| Creation of workers' housing | X | X | X | X | X | X | X | X |
| Relocation of Lom Pangar village | X | X | X | X | X | X | X | X |
| Relocation of the Lom II village | | | | | | | | |
| Installation of the crushing plant and concreting | X | X | X | X | X | X | X | X |
| Transport of materials and circulation of machinery | | X | X | | X | | X | X |
| Use of fuel and lubricants | X | X | X | X | X | X | | |
| Recruitment of labour | | | | | | | | X |
| Maintenance of roads used | | | | | | | X | X |
| Poaching | | | | | | | | X |
| Presence of foreign labour | | | | X | X | X | X | X |
| Deviation of the Lom River bed and the pipeline route | X | X | X | X | X | X | X | X |
| Rock blasting | X | X | X | | X | | | X |
| Topography works | X | | | | | | X | X |
| Excavation and backfill works | X | X | X | X | X | X | | X |
| Mbibarawa quarry facility | X | X | X | X | X | X | X | X |
| Development of BHLP into BCR, left bank and right bank embankment wings | X | X | X | X | X | X | X | X |

The tables from 3 to 5 present, after identification of the interactions and their evaluations, which had been made according to the various activities and the modifications made to the various VECs to do so, two types of impacts were identified, namely positive impacts and negative impacts, with a rating varying from no impact to strong impact.

***Table 3.*** *Identification of the interactions and their evaluations on physical area.*

| | Potential Impacts | Construction sites | | | | |
|---|---|---|---|---|---|---|
| | | Creation of housing estates | | New construction villages | | |
| | | Principal access | Secondary access | MO housing | Cadres housing | Workers' housing |
| Soil | Change in relief | - | | - | - | - |
| | Erosion | - | | - | - | - |
| | Change in soil structure | 0 | | 0 | 0 | 0 |
| Water | Effect on hydrology | 0 | | 0 | 0 | 0 |
| | Effect on groundwater quality | 0 | | 0 | 0 | 0 |
| | Water quality in the reservoir | 0 | | 0 | 0 | 0 |
| | Downstream water quality | 0 | | - | - | -- |
| Air | Air pollution | - | - | - | - | - |
| | Noise pollution | --- | - | - | - | - |
| | Release of odours | 0 | 0 | 0 | 0 | 0 |

***Table 3.*** *Continued.*

| | Potential Impacts | Construction sites | | | |
|---|---|---|---|---|---|
| | | New villages | | construction | |
| | | Lom Pangar | Lom II | Construction site installation | Construction bridge |
| Soil | Change in relief | - | - | -- | 0 |
| | Erosion | - | - | -- | - |
| | Change in soil structure | 0 | 0 | 0 | 0 |
| Water | Effect on hydrology | 0 | 0 | - | 0 |
| | Effect on groundwater quality | 0 | 0 | 0 | 0 |
| | Water quality in the reservoir | 0 | 0 | 0 | 0 |
| | Downstream water quality | 0 | 0 | -- | - |
| Air | Air pollution | 0 | 0 | -- | - |
| | Noise pollution | 0 | 0 | --- | - |
| | Release of odours | 0 | 0 | 0 | 0 |

Legend: Positive impact Negative impact
+: Minor -: Minor
++: Average --: Average
+++: Strong ---: Strong
0: No impact

***Table 4.*** *Identification of the interactions and their evaluations on biological area.*

| | Potential Impacts | Construction sites | | | | |
|---|---|---|---|---|---|---|
| | | Creation of access | | Creation of housing | | |
| | | Principal access | Secondary access | Cité du MO | Cadres housting | Workers' housing |
| Flore | Effect on the forest | - | | - | 0 | 0 |
| | Effect on savannah | 0 | | 0 | - | -- |
| | Effect on cultivated areas | - | | 0 | 0 | -- |
| | Effect on aquatic flora | 0 | | - | - | - |
| Fauna | Effect on endangered species | 0 | | 0 | 0 | 0 |
| | Effect on mammals | --- | | - | - | --/- |
| | Effect on birds | 0 | | 0 | 0 | 0 |
| | Effect on fish | 0 | | 0 | 0 | - |
| | Effect on protected species | --- | | 0 | 0 | --/- |
| | Effect on migratory species | - | | 0 | 0 | -- |
| | Effect on wildlife habitats | --- | | - | - | -- |
| Ecosystèms | Destruction of ecosystems | --- | | -- | - | --- |
| | Fragmentation of natural habitats | -- | | - | - | - |

***Table 4.*** *Continued.*

| | Potential Impacts | Construction sites | | | |
|---|---|---|---|---|---|
| | | New villages | | Construction | |
| | | Lom Pangar | Lom II | Construction site installation | Construction bridge |
| Flore | Effect on the forest | - | - | 0 | - |
| | Effect on savannah | 0 | 0 | -- | - |
| | Effect on cultivated areas | - | - | 0 | 0 |
| | Effect on aquatic flora | - | - | - | - |
| Fauna | Effect on endangered species | 0 | 0 | 0 | 0 |
| | Effect on mammals | - | - | -- | - |
| | Effect on birds | 0 | 0 | 0 | 0 |
| | Effect on fish | - | - | -- | - |
| | Effect on protected species | -- | -- | -- | - |
| | Effect on migratory species | -- | -- | -- | - |
| | Effect on wildlife habitats | - | - | -- | - |
| Ecosystèms | Destruction of ecosystems | - | - | --- | - |
| | Fragmentation of natural habitats | - | - | -- | - |

***Table 5.*** *Identification of the interactions and their evaluations on human activities.*

| | Potential impacts | Construction sites | | | | |
|---|---|---|---|---|---|---|
| | | Creation of access | | Creation of housing | | |
| | | Principal access | Secondary access | MO housing | Cadres housing | Workers' housing |
| Resources use | Effect on rural areas | ++ | | 0 | 0 | 0 |
| | Effect on the agricultural economy | ++ | | 0 | 0 | 0 |
| | Effect on the forestry economy | - | | 0 | 0 | 0 |
| | Effect on fishing | ++ | | 0 | 0 | 0 |
| | Effect on hunting | --- | | 0 | 0 | --- |
| | Effect on mining | 0 | | 0 | 0 | 0 |
| Social | Displacement of populations | -- | | 0 | 0 | - |
| | Population influx | --- | | 0 | 0 | -- |
| | Increased poaching | --- | | 0 | 0 | --- |
| | Increased trade | ++ | | 0 | 0 | ++ |
| | Proliferation of hunting tools | --- | | 0 | 0 | --- |
| | Jobs | + | | + | + | + |

***Table 5.*** *Continued.*

| | Potential impacts | Construction sites | | | |
|---|---|---|---|---|---|
| | | New villages | | Construction | |
| | | Lom Pangar | Lom II | Construction site installation | Construction bridge |
| Resources use | Effect on rural areas | 0 | 0 | 0 | 0 |
| | Effect on the agricultural economy | 0 | 0 | 0 | 0 |
| | Effect on the forestry economy | 0 | 0 | 0 | 0 |
| | Effect on fishing | 0 | 0 | 0 | 0 |
| | Effect on hunting | -- | -- | -- | - |
| | Effect on mining | 0 | 0 | 0 | 0 |
| Social | Displacement of populations | 0 | 0 | - | 0 |
| | Population influx | -- | -- | --- | -- |
| | Increased poaching | -- | -- | --- | - |
| | Increased trade | + | + | + | + |
| | Proliferation of hunting tools | -- | -- | --- | -- |
| | Jobs | + | + | +++ | 0 |

These three tables show that several activities have no impact on the VECs, and we have identified several positive impacts on the human component of the environment, proving that the activities will improve social life in the locality, but this improvement will increase the number of people in the locality and contribute to the intensification of poaching and illegal hunting.

# 4. Discussion

This study yields a number of insights into the distribution of large mammals in their natural habitats, as well as the human impacts of the DDNP during the implementation of the BHLP.

The density of the DDNP 's large singes is 0.8 individuals per $km^2$ (6,74 sites nids per km), or 48.75% in Zone A, 41.5% in Zone B, and 10% in Zone C. This result does not correspond to that obtained by Adong [14], who obtained 6,15 nid sites per $km^2$ in Deng Deng's forest reserve. It is also higher than the results obtained by WCS in 2008 and 2010, when the Deng Deng and DDNP forests obtained 0.44 and 0.49 individuals per square kilometer, respectively. These findings may be justified by the fact that the most commonly used hunting technique is piégeage; fusil hunting primarily affects small primates.

The distribution of large singe nid sites on the DDNP is heavily concentrated on the transects (T5, T6, T7, T8, T9, T10, T12, T13, T14, T17, and T18) located more than 15 kilometres from the perimeter on either side; the remaining transects located between 15 and 05 kilometres have a distribution. These findings may be justified by the high level of human penetration in the DDNP, as seen through the villages of Goyoum, Mbaki, Satando, Deng Deng, and Ouami on the one hand, and the barrage on the other, as seen through the Ouami-Site access route to the barrage. Similarly, WCS's 2010 map of the distribution of large singes in the DDNP revealed a high concentration of those in the Lom River's right bank, close to the project site, and uncommon elsewhere in the village. Several studies [15-16] have found similar findings; the animals do not approach villages. The encounter rates that we obtained, while not statistically significant, show that as one moves away from human concentration zones, encounters become more important. Human activities have an impact on their distribution. According to Tutin and Fernandez [17], gorilles were absent in a 10 km radius around the villages. The conclusion was that animal traces were more visible beyond

15 kilometres of villages.

The gorilles density, 0.06 ind/km$^2$, and the metric abundance index, IKA, are 4,88 nids per km$^2$, 283 nids, and 41 nid sites, respectively. These results are higher than those obtained by WCS (2008 and 2010), who obtained 0.22 and 0.33 individuals per km$^2$ in the Deng Deng forest massif and the DDNP, respectively. This may be justified by anti-braconnage activities, DDNP tour village sensitization, and the fight against commercial hunting.

Some Gorilles distributions along the transects (T1, T4, T6, T7, T11, T16, T19, T24, and T26) all around the villages, near the barrage site and access routes to the barrage, and some Gorilles nest sites should be noted. These findings could be explained by the gorille's herbivorous lifestyle, as this species prefers cultivating plants such as bananas and other young saplings, leading to its rapid adaptation near human concentration zones and frequenting secondary forests rich in marantacées.

During the exploration, no chimp nid sites were discovered. However, WCS results from 2008 and 2010 in the Deng Deng forest massif and the DDNP revealed five and three nesting sites, respectively. The DDNP has seen a decrease in the number of chimp nesting sites over the years. This could be explained by the fact that the study area was previously used for pipeline installation, illegal forest harvesting, and, more recently, BHLP construction. Ceux-ci have a particularly negative impact on the chimp's habitat, as the chimp is an animal that relies on primary forests. This progressive reduction in chimp nid sites indicates that the DDNP chimps may face a territoriality problem.

The kilometric index of abundance of human impacts at the PNDD is 1.55 signs/km. The distribution of human impacts is higher on the transects (T1, T2, T4, T7, T11, T12, T15, T16, T19, T20, T21, T22, T23, T24, T27, T28 and T29).

During the survey at DDNP, the different nest sites and nests were recorded. However, it was found that the number of ape nest sites and nests.

However, it was found that the number of ape nest sites and nests is 50% in Zone A, around the dam site, 40% in Zone B, west of the dam site, and 10% in Zone C, south of the dam.

It could be explained that this difference is due to the fact that zones B and C located respectively at the western and southern peripheries of the park, are in the vicinity of villages, which justifies the hunting pressure, both village and commercial.

A summary of all surveys was used to define ape density. The results obtained were 0.6 ind/km for gorillas, zero for chimpanzees, and 0.22 ind/km² for non-specifically identified apes. When the ape species are grouped together, the density obtained is 0.8 ind/km². This shows that gorillas seem to frequent this area much more than chimpanzees. This may be due to the impression we got during the survey. Because it appears that the forest is lacking in fruit trees.

Inventories carried out by (Nzoo et al., 2005) [18], gave a density of 0.21 ind / km² for chimpanzees. It can be assumed that the impacts of the dam could be responsible for the drop in chimpanzee density or nest sites recorded. The low chimpanzee encounter rate is contrary to what WCS found in 2008 and 2010. But with different densities, especially in the surveyed areas and along the Lom River, the decline in chimpanzee numbers could still be explained by their frugivore status.

Apes are observed in different areas. The presence rates we recorded back up their findings. They were absent on transects around villages and along access roads. This corroborates the work of Mekui Siyogo in 2008, who confirmed the absence of apes around ten kilometres from villages, but beyond that, their presence was noted. The presence of secondary forests may also explain why gorillas are the second most frequent visitors to the area.

# 5. Conclusion

This work was done in order to assess the human impacts of the BHLP's construction work on the natural habitats of gorillas and chimps in the Deng Deng National Park in particular, and Cameroon in general.

The study's findings show that the number of nid sites and population density of great crested newts increased to 80 sites, 391 nids, and 0.80 ind/km$^2$ in the DDNP.

The number of nid sites, de nids, and density constructed by gorillas, chimps, and gorillas are 41 nid sites, 283 nids, and 0.06 gorillas per square kilometer; 0 nid sites, and 0 nids; and finally, 39 nid sites, 108 nids, and 0.22 ind per km$^2$. The PNDD's major settlements are concentrated in the Deng Deng forest, closest to the project site (zone A), north of the village Goyoum (zone B), and a small population in the outskirts of the villages Satando, Mbaki, and Mbaki village. Human impacts are represented by 90 signs: 52 pièges, or 0.09 pièges per km; 22 cartouches (0.38 cartouches per km); 13 coups de feu (0.22 coups de feu / km); and 3 hunting campouts (0.05 hunting campout / km)..

The current study on the impact of the Lom Pangar hydroelectric dam construction on the natural habitats of large singes in the Deng Deng National Park finds that, despite habitat fragmentation and other disturbances caused by the dam's various construction activities, the population of large singes has increased significantly in the DDNP. However, the effects of the barrage have had significant ripple effects on the distribution of great apes in general, and particularly significant ripple effects on the density of chimps.

# References

[1] MEGEVAND, CAROLE., (2013). Dynamiques de déforestation dans le basin du Congo: Réconcilier la croissance économique et la protection de la forêt. Washington, DC: World Bank. 201: P. 29.

[2] SAYER J. A., (1985). Conservation and protection of tropical rain forest: the perspective of World Conservation Union Nature and Fauna. FAO (7) 4: 13-23.

[3] HACKER, J., COWLISHAW, G., WILLIAMS, P., (1998). Patterns of African primate diversity and their evaluation for the selection of conservation areas. Biological Conservation 84: P. 251-262.

[4] BUCKLAND, S. T., ANDERSON, D. R., BURNHAM, K. P., LAAKE, J. L. (1993). Distance Sampling. Estimating abundance of biological populations. Chapman & Hall, London, UK.

[5] GRANDJEAN J. P. et LINO M., (2017). Projet de rapport final d'Etude Environnementale du barrage de Lom Pangar. Annalyse des impacts et proposition de mesures compensatoires en vue de l'installation des equipements et des cités de chantier en rive droite du Lom. Rev. 01. P. 95.

[6] WALSH, P. D. AND WHITE, L. J. T. (1999). What will it take to monitor forest elephant populations? Conservation Biology 13: 1194–1202.

[7] KÜHL, HJALMAR; (2008). Best practice guidelines for the surveys and monitoring of great ape populations, 36., IUCN.

[8] BURNHAM, K. P., ANDERSON, D. R., LAAKE, J. L., (1980). Estimation of density from line transect sampling of biological populations. P. 72: 202.

[9] WHITE, L. J. T. AND EDWARDS, A. (eds.) (2000). Conservation Research in the African Rain Forests: A Technical Handbook. Wildlife Conservation Society, New York.

[10] FRUTH, B. AND HOHMANN, G. (1993). Ecological and behavioral aspects of nest building in wild bonobos (Pan paniscus). Ethology 94: 113–126.

[11] BRUGIÈRE, D. AND SAKOM, D. (2001). Population density and nesting, behaviour of lowland gorillas (Gorilla gorilla gorilla) in the Ngotto forest, Central African Republic. Journal of Zoology 255: 251–259.

[12] Léopold, L. B, (1971). A procedure for evaluating environmental impact.

[13] ADONG, R. (2005). The current procedures and policies dominating the disbursement of aid: Are they building strong relationships and enabling NGOs to meet their stated aims. Research report funded by ESCOR and DIFD, UK.

[14] INKAMBA- NKULU, C. (2002) Suivi des bais et identification de l'éléphant de foret (Loxodonta africana cyclotis Matschie 1900) dans le Parc National de Nouabalé-Ndoki. Rapport Annuel 2001–2002. Unpublished report, WCS-Congo, Bomassa, Congo-Brazzaville.

[15] MAISELS, F., EKOUTOUBA, D.-D., ABEGUO, R., MBOULAFINI, M., MAHMADU, M. & MOBOLOMBI, G. (2002) A forest lake in northern Republic of Congo: a window on forest elephant conservation. (Abstract). Pp A86-A87, in: Programme & Abstracts, British Ecological Society/ Society for Conservation Biology, Canterbury, U.K.

[16] FOTSO, (2020). Distribution and Conservation Status of Gorilla Population in the Forests around BELABO, Eastern Province Cameroon. p. 84.

[17] DILLER et al, (2020). A rapid appraisal survey of Gbébé, Bertoua Division, East Province SIL International.