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Impacts of refugee settlement on the plant dynamics and sustainable management of the environment of Minawao Camp, Far North, Cameroon.

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Abstract

The study conducted in June and July in the Minawao Refugee Camp focused on the impacts of the settlement of refugees on the dynamics of vegetation cover. It allowed to analyze the perceptions of refugees and their installation on the vegetal cover and finally to propose a plan of sustainable management of the vegetal resources. Socio-economic surveys were administered to 200 people including 140 refugees and 60 NGO staff. Four transects of 20 x 1000 m following the four cardinal points of the Camp were made with three repetitions. Stat-graphics plus 5.0 Xl-stat pro and Excel 2016 were used for data analysis. These analyzes show that the remarkable impacts are deforestation, land degradation and environmental pollution by refugees. 99% of refugees use wood as a source of energy; 1.6 kg of firewood consumed per household per day. Refugees travel about 18 km to get supplies of wood while this distance was only 3 km 30 years ago. Only 30 species have been inventoried. Faced with this situation, the Cameroonian humanitarian community has not taken full measure of the stakes for safeguarding the plant cover, although reforestation and nursery establishment activities have been set up by the Office of the United Nations High Commissioner for Refugees. Refugee and Lutheran World Federation.

Keywords: Refugee, settlement impacts, plant dynamics, sustainable management, Minawao Camp, Far North, Cameroon.

Introduction

The relationship between forced displacement of populations and environmental change is a major concern of the international community (Lassailly and Zmolek 1992, Black 1994, Jacobson 1994, IOM 1996). This concern about the impact of IDPs or refugees on the environment is not new (Simmace, 1987). For this, in 1993, the Office of the High Commissioner for Refugees (UNHCR) established the Office of the Senior Coordinator for Environmental Affairs (SCEA, now known as the Environment Unit), which was tasked with developing "green guidelines". In action programs (UNHCR, 1996a). This growing attention manifests itself in many ways. It is first the emergence around 1994-1995 of an environment unit within UNHCR financing seminars, environmental guides and a growing number of studies on the impact of the arrival of refugees in the host regions (Black, 1998). The Office of the United Nations High Commissioner for Refugees has begun to place more emphasis on environmental issues in refugee

assistance planning since the Rio Conference (UNHCR, 1996b). Despite the establishment of these environmental organizations within UNHCR, the number of refugees is increasing over time. In 1996, the number of refugees was around 13 million worldwide (UNHCR, 1996b). According to the report released by UNHCR on 19 June 2017, 65.6 million people leave their countries as a result of the conflict, more than 300,000 people in the year 2016 (Romulus, 2017). The majority of continents in the world, including Africa in particular, have been confronted for a long time with the problems of deforestation in refugee settlements due to different conflicts (Black, 1998). Cameroon, for its part, hosts about 338,000 refugees. Of these, 64,000 are Nigerian refugees who fled the Boko Haram violence and reside in Manawao camp and another 274,000 are from the Central African Republic (CAR) based in the Eastern Region (UNHCR, 2016).). In addition, the Far North part of Cameroon has 182,000 refugees who have been forced to move to the interior of the country because of the conflict (UNHCR, 2016). But UNHCR's report at the 17th refugee day in 2017 indicates that Cameroon has about 367,000 refugees and asylum seekers. So 259,000 Central Africans (living in the regions of the East, Adamaoua and North); 88,000 Nigerians in the Far North region; 20000 others living in the cities of Douala and Yaoundé, not to mention the 220000 internally displaced (Romulus, 2017). Other studies have been carried out on the impact of refugees on vegetation cover dynamics, such as those of Black (1998) on the environment and refugees in sub-Saharan Africa, Florence (2009) on the migratory effects in the East of Chad and Poura (2011) on land use by refugees in the eastern region of Cameroon. But initiatives to deal with the impacts of settling refugees on vegetation are often.

Materials and Methods

Location of study area

The study was conducted in Minawao Township of Zamay; this canton is located in the Extreme North - Cameroon region, precisely in the Mayo Tsanaga Department between 10 ° 33'38 ", latitude North and 13 ° 51'25 ", east longitude and altitude 595 m (Lindsey, 2015). Created by the Cameroonian government and UNHCR as a refugee camp on July 2, 2013, the refugee camp is located about 70 km from Maroua and the Nigerian border (Figure 1). It covers more than 31,900 ha and is home to nearly 64,000 refugees (Max, 2017). (3 km), to the east by Gadala (3 km) and to the west by Sabongari (4 km) (Lindsey, 2015).

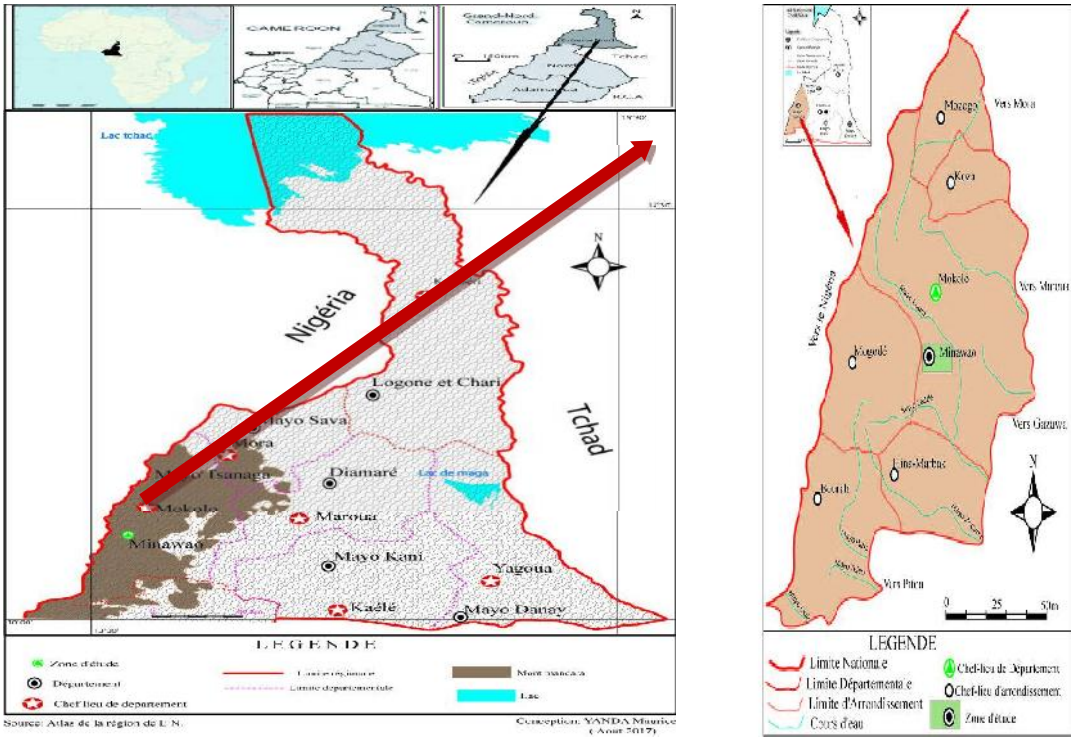

Figure 1: Location map of the study site

Socio-economic survey

A survey was conducted in June and July based on the questionnaires previously prepared in survey cards. The randomly selected populations answered yes or no (semi-structured) and questions where the latter answered according to their will (open). The main points of the questionnaires are the identity of the respondent, the characteristic of the household and the practice of deforestation and its consequences on the dynamics of the vegetation cover. The various questions are asked of 200 people including 140 refugees and 60 NGO and government staff.

Experimental device of floristic surveys

To identify the different impacts of the refugees on the dynamics of the vegetation cover, four transects of 1000 m x 20 m following the four cardinal points (North, South, West and East) were delimited from Camp. Three rehearsals were made as one moves away from the Camp. The experimental setup is a completely randomized block with three repetitions. The four cardinal points represent the main treatments and the 1000 m x 20 m plots constitute the repetitions. In each plot of 1000 mx 20 m, all species were inventoried and then determine the number of individuals, species, genera and families. The height of the trees, the DBH (at 1.30m from the ground) and the diameter of the tassel were measured respectively with the clinometer and / or tape measure.

Characterization of flora and method of data analysis

►The Value Index of Ecological Importance (IVIE) is the sum of relative density, relative frequency and relative overlap (Kebyei, 2013). IVIE (%) = FR + DR + DeR, IVIE: Value of Ecological Importance Index; FR: Relative frequency; DR: Relative dominance; DeR: Relative density.

Relative density or relative abundance is the ratio of absolute abundance or absolute density to the total number of individuals in the community multiplied by 100.

DeR = absolute density * 100 / N, DeR: relative density; N: individuals of the community multiplied.

Dominance concerns the recovery of individuals of each species and is expressed as a percentage.

Absolute dominance is the ratio of the total basal area of the species (STTe) to the total basal area of the sample (STTE). DA = STTe / STTE. Relative dominance or relative recovery is the ratio of the total basal area of the species (STTe) to the total basal area of the community (STTC) multiplied by 100 (Magurran, 1988). DR = STTe / STTC x100

►Density, is given by the formula: D = N / S; N = number of the species of the study environment; S = area occupied by the species.

►The basal area, also called basal area, is the sum of tree trunk surfaces at 0.30 m (Rondeux, 1993). It is expressed per unit area (m^2) and is calculated using the following formula: $St = \Sigma C^2 / 4\pi$, St = basal area, expressed in m^2 / ha; C = circumference of individuals at 30 cm from the ground, measured in meters.

Specific diversity is analyzed using diversity indices (Magurran 1988, Coker 1992).Indeed, several types of mathematical formulas make it possible to calculate these indices. Among them, those that have been chosen and in common use are:

► Shannon index, the Shannon-Weaver index is an index used to measure biodiversity. This index is an indicator of species richness. It is given by the formula: H '= -Σ Pi ln Pi, H' = Shannon Biodiversity Index; i = One species of the environment, p (i) = Proportion of a species i relative to the total number of species (S) in the study medium (or specific diversity of the medium) which is calculated as follows: p (i) = ni / N where ni is the number of individuals of the species and N is the total number of individuals, all species combined (Shannon and Weaver, 1949).

►Simpson Index

The Simpson Index is a formula for calculating the probability that two randomly selected individuals in a given environment are of the same species.

D = Σ Ni (Ni-1) / N (N-1), D: Simpson's index; Ni: Number of individuals of the given species; N: Total number of individuals. The index will vary between 0 and 1. The closer it gets to 0, the higher the chances of getting individuals of different species. Beside these two indices, one can calculate the equilibrium of Pielou (E) which is the inverse of the Shannon index.

Methods of statistical analysis of the data

Analysis of variance was used to compare transects (cardinal points), distances from Camp and their interactions (cardinal points x distances). ANOVAs were followed by Duncan's test to compare averages if these ANOVAs were significant. Principal component analyzes (PCA) were used to determine species dispersion on each of the cardinal points (North, South, East and South). These analyzes were performed using the Stat-graphics plus 5.0 software (ANOVA, Duncan's test), Xl-stat pro (ACP) and Excel 2016 (plot the histograms).

Results

Perception of refugees on the state of camp vegetation dynamics

Among the many impacts observed by refugees in this study are the absence of fallow (100%), the decline in crop yield (80%), the increase in cultivated area (41.67%), drastically reduced vegetation cover (100%), severe soil degradation (91.66%) and reduced water resources (71.66%) (Figure 2).

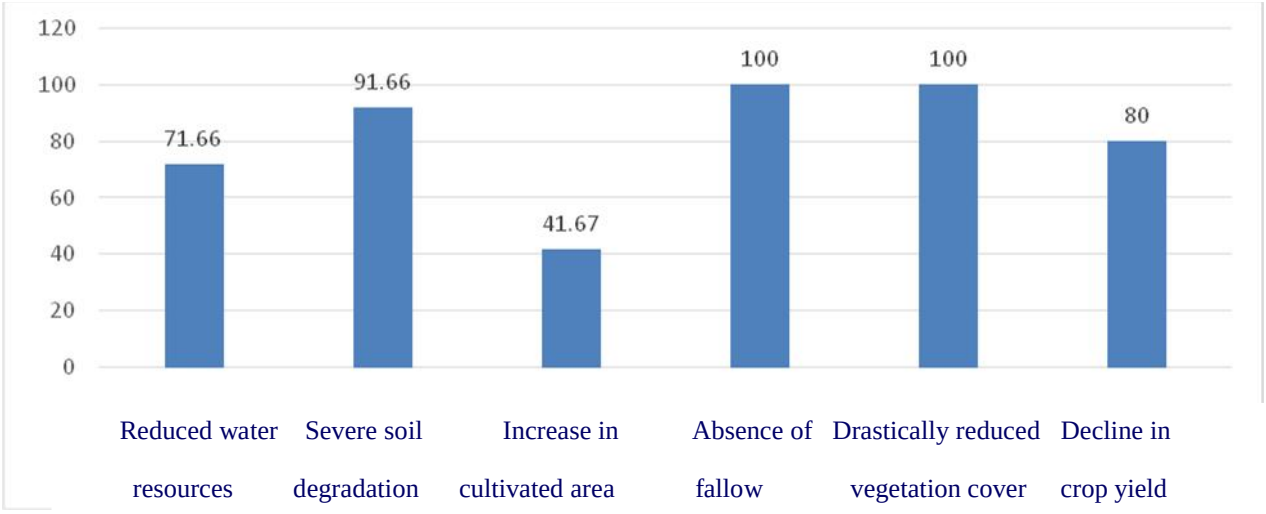

Figure 2: Refugee Perception of Soil Condition and Vegetation

Floristic composition of vegetation

Of the 24 hectares of our study, 954 woody individuals were counted and distributed in 30 species, 23 genera and 14 families (Table 1). More than one moves away from the Camp, the biodiversity increases, ie 196 individuals, 18 species, 14 genera and 10 families one kilometer from the Camp, 307 individuals, 23 species, 19 genera and 11 families two kilometers from the Camp and 451 individuals, 26 species, 23 genera and 14 families three kilometers from Camp.

Table 1: Floristic composition in species, genera and families of vegetation

	Distance from Camp			Cardinal Points			
	D1	D2	D3	North	South	East	West
Individual	196	307	451	248	247	128	331
Species	18	23	26	18	12	10	20
Genres	14	19	23	16	21	9	15
Families	10	11	14	12	12	8	14

D1 = Distance to 1 kilometer, D2 = Distance to 2 kilometers, D3 = Distance to 3 kilometers, N = North, S = South, E = East, W = West

Index and floristic diversities

Table 2 presents the values of Shannon indices (H '), Pielou equitability (E) and the Simpson index (D) of ligneous trees in shrubby savannah at the Minawao refugee camp. The Shannon index is weak, ranging between 0.09 and 3.4. Equitability also varies considerably between 0.02 and 0.56. For the Simpson Index, it ranges from 0.11 to 0.50.

Table 2: Indices and floristic diversities

Index	North			South			East			West			Average
	D1	D2	D3	D1	D2	D3	D1	D2	D3	D1	D2	D3	
H'	0.09	3.4	2.59	2.33	2.71	2.66	1.75	1.2	2.57	2.55	2.39	2.73	2.25±0,86
E	0.02	0.56	0.35	0.41	0.42	0.4	0.33	0.24	0.44	0.41	0.35	0.38	0.36±0,13
D	0.52	0.11	0.22	0.21	0.17	0.19	0.31	0.5	0.24	0.28	0.29	0.2	0.27±0,12

Woody heights

The height of the woody trees recorded varies between 0.35 m and 15, 50 m. The class [0-1 [is the most represented regardless of the distance to the refugee site, 78.91% to one kilometer from the Camp, 61.09% to two kilometers from the Camp and 52.69% to three kilometers from the Camp. Camp (Figure 3). On the other hand, in class ≥10, it is difficult to find trees, ie 0% at one kilometer, 2.25% at two kilometers and 14, 28% at three kilometers from the Camp.

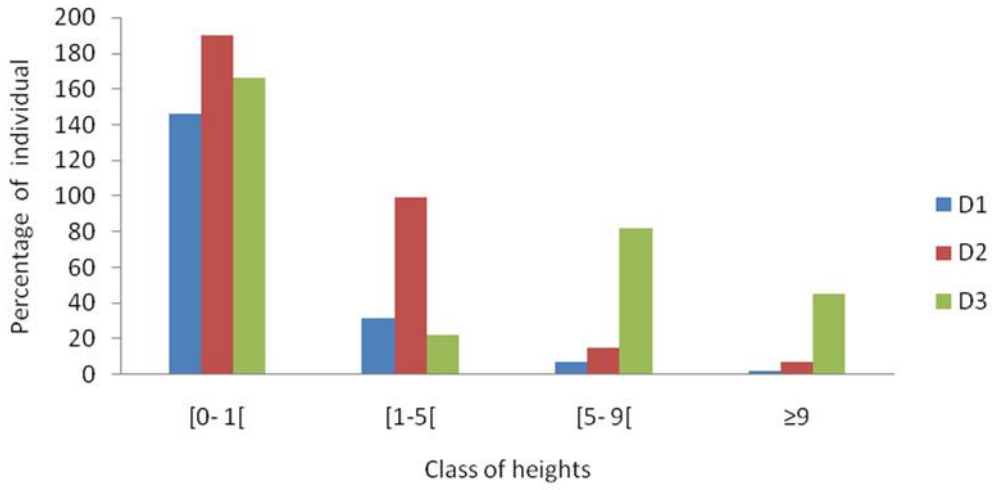

Figure 3: Height of the woody trees

Ecological importance of species in Refugee Camp

In the site, 954 individuals distributed almost exclusively between *Acacia nilotica* (18.86%), *Acacia albida* (12.99%), *Annona senegalensis* (12.26%), and *Ziziphus mauritiana* (8.9%). These four species represent 53.01% of the total size of the site. The density is 40 individuals / ha. The relative density varies between 0.01% and 15.66%. *Acacia albida* is the most dominant species (50.45%) (Table 3).

Table 3: Floristic composition (number of individuals, frequency, density, dominance and Importance Value of Curtis) within species.

Species	NI	DeR	FR	DR	IVIE	Species	NI	DeR	FR	DR	IVIE
Acacia albida	124	26.56	12.99	50.45	90.01	*Diospyros mespiliformis*	14	2.30	1.46	0.64	4.42
Acacia ataxacantha	29	1.03	3.03	0.17	4.24	*Entada africana*	7	0.24	0.73	0.11	1.09
Acacia nilotica	180	2.82	18.86	10.13	31.82	*Fadogia ledermani*	1	0.71	0.10	0.09	0.91
Acacia seyal	31	2.66	3.24	0.28	6.20	*Ficus glumosa*	4	0.96	0.41	0.021	1.40
Adansonia digitata	12	2.66	1.25	0.85	4.77	*Ficus sur*	8	2.64	0.83	0.05	3.54
Annona senegalensis	117	1.77	12.26	1.70	15.74	*Ficus sycomorus*	1	0.69	0.10	0.27	1.07
Anogeissus leiocarpus	51	8.20	5.34	7.56	21.12	*Hymenocardia acida*	1	0.25	0.10	0.00	0.35
Azadirachta indica	53	12.13	5.55	8.07	25.76	*Khaya senegalensis*	18	0.03	1.88	0.07	1.99
Balanites aegyptiaca	71	0.89	7.44	1.41	9.75	*Parkia biglobosa*	21	2.14	2.20	0.18	4.53
Boswellia dalzielii	43	7.54	4.50	6.33	18.38	*Piliostigma thonningii*	6	0.26	0.62	0.05	0.95
Boswellia papyrifera	8	1.00	0.83	0.01	1.85	*Sclerocarya birrea*	6	0.01	0.62	0.09	0.73
Ceiba pentadra	2	0.37	0.20	0.05	0.63	*Tamarindus indica*	40	15.66	4.19	1.27	30.13
Combretum glutinosum	2	2.21	0.20	0.10	2.52	*Terminalia macroptera*	9	0.89	0.94	0.06	1.90
Commiphora africana	7	0.24	0.73	0.04	1.01	*Terminalia glaucescens*	1	0.13	0.10	0.03	0.27
Daniellia oliveri	3	0.62	0.31	0.03	0.96	*Ziziphus mauritiana*	85	2.24	8.90	0.75	11.91
						Total	954	100	100	100	300

NI = number of individuals; FR = Relative frequency; DeR = Relative density; DR = Relative dominance; IVIE = Value Index of Ecological Importance

Diameters of ligneous

The savannah is dominated by individuals with a diameter of less than one centimeter (Figure 4). This class is very represented in this savanna (25 individuals / ha). Woody trees with a diameter greater than or equal to one centimeter are less numerous in the vegetation. This result shows the abundance of discards in this savannah, whose graph looks like "L".

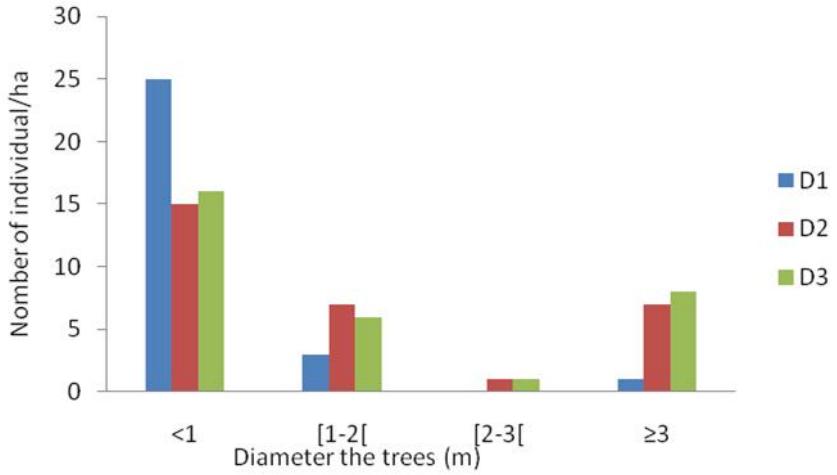

Figure 4: Diameters of ligneous trees

D1 = Distance to 1 kilometer from Camp; D2 = Distance to 2 kilometers from Camp; D3 = Distance to 3 kilometers from Camp

Basal area of species

Table 4 presents the basal area of the different species encountered in our study site. *Acacia albida* has the highest basal area value (294.97m^2 / ha) followed by *Tamarindus indica* (106.77m^2 / ha) and *Azadirachta indica* (83.89m^2 / ha). *Hymenocardia acida* is the one with the small basal area (0.01m^2 / ha).

Table 4: Basal area of different species

Species	BA (m^2/ha)	Species	BA (m^2/ha)	Species	BA(m^2/ha)
Acacia albida	294.97	*Boswellia papyrifera*	65.87	*Ficus sycomorus*	2.83
Acacia ataxacantha	1.82	*Ceiba pentadra*	0.10	*Hymenocardia acida*	0.01
Acacia nilotica	59.26	*Combretum glutinosum*	0.53	*Khaya senegalensis*	0.44
Acacia seyal	1.66	*Commiphora africana*	1.12	*Parkia biglobosa*	1.08
Adansonia digitata	5.01	*Daniellia oliveri*	0.41	*Piliostigma thonningii*	0.58
Annona senegalensis	17.68	*Diospyros mespiliformis*	0.34	*Sclerocarya birrea*	0.57
Anogeissus leiocarpus	78.65	*Entada africana*	6.70	*Tamarins indica*	106.77
Azadirachta indica	83.89	*Fadogia ledermani*	1.17	*Terminalia macroptera*	0.69
Balanites aegyptiaca	8.27	*Ficus glumosa*	0.54	*Terminalia glaucescens*	0.02
Boswellia dalzielii	65.87	*Ficus sur*	0.59	*Ziziphus mauritiana*	4 .40

BA = basal area (m^2 / ha)

Dispersion of ligneous plants in the site

Figure 5 shows the Principal Component Analysis (PCA). The representation of the surveys and species on the factorial plane of axes 1 and 2 makes it possible to group woody species having similar characteristics. The analysis is based on the three axes F1, F2, F1 and F2 eigenvalues percentages respectively 34.79%, 17.93% and 52.72%.

We note that the North point and the East point have a strong correlation that is to say present very similar species (Figure 5A). There is a highly significant correlation between the East and the South point of the Camp. These last two points have very similar species. Unlike, the West point of the Camp is very out of step with the other points of the Camp but close to the North point. As for the species, it is found that the majority of them are grouped at the origin of the axis form a cloud of points (Figure 5B, however, *Annona senegalensis*, *Acacia nilotica*, *Azadirachta indica* and *Ziziphus indica* have a very different dispersion. other species.

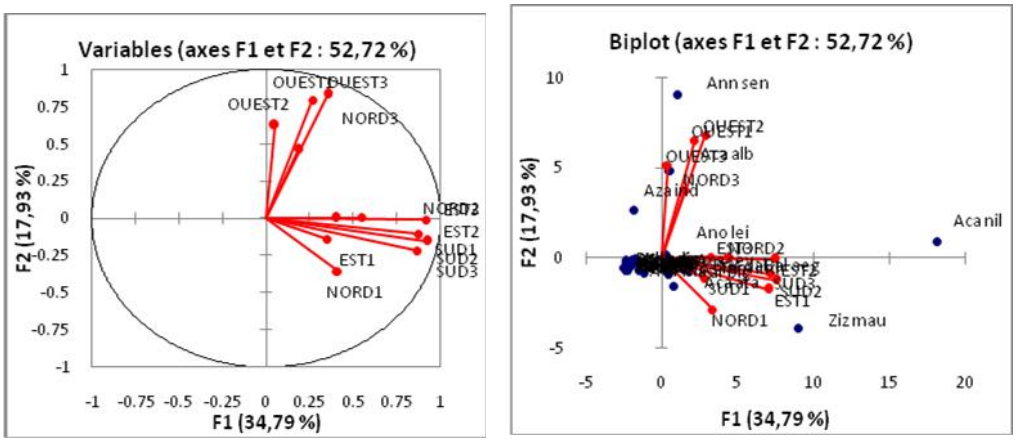

Figure 5: PCA of the presence of species in the various site surveys
A-Dispersion of the cardinal points B-Dispersion of the ligneous species

Impacts listed on the site by refugees

Table 5 presents the impacts identified in the Camp by the refugees surveyed. From this analysis, it can be noted that 100% of respondents are aware of soil degradation, 100% confirm the disappearance of plant species, 100% of refugees note the advance of the desert and 88, 25% note the decline in productivity agricultural.

Table 5: Impacts inventoried at the Camp by refugees (%)

Nature of impacts	plant species	Degradation of soils	Desertification	Decrease in agricultural productivity
Percentage of responses	100	100	100	98.33

Factors influencing plant cover in Camp

Table 6 gives details of factors influencing vegetation cover, their degree of importance and their implications. This analysis shows that the high density (32.83%) of refugees in the Camp could be the main cause of the disappearance of the species in this site. The duration of the camp could also be a factor that increases the impact of refugees on the vegetation cover (25.83%) and other influencing factors are not to be neglected.

Table 6: Factors Influencing Environmental Impact

Factors influencing	Degree of importance (%)	Implications
Refugee Density at Camp (64,000 refugees)	32.83	The longer, the density, the greater the pressure on vegetation.
Lifetime of Camp (4 years)	25.83	The longer, the life of the site, the more important and visible impacts are.
Separation of refugees from their income	22.50	The less refugees have other sources of livelihood, the more they draw on natural resources.
Opportunity for access to generating activities	18.83	Little option to generate income leads refugees to use natural resource

Sustainable management of the plant cover in Camp

Table 7 presents site vegetation management methods by NGOs and the government. The development of a research project on deforestation in the Camp (53.69%) (45.1% by the LWF, 60.88% by the Cameroon Plan, 75% by the UNHCR, 10.15% by the MINADER, 60% by MINFOF and 71% by MINEPDED) are the most important means of management of vegetation cover by the government and NGOs. The second means of sustainable management at the Camp is training on wood cutting (49, 16%). Reforestation (31.71%) is the fourth means of management. Waste collection at Camp and the tax increase for natural resource sellers at the Camp are not to be overlooked. Unlike other actors, MINADER (16.76%) does not actively contribute to the maintenance of biodiversity.

Table 7: Sustainable vegetation management plan proposed by NGOs and the Cameroonian government (%)

Management Plan Proposed by Governments and NGOs	LWF	Plan Cameroon	HCR	MINAER	INAFOF	MINEPDED	Average
Development of a research project on deforestation at Camp	45.11	60,88	75	10.15	60	71	53.69±23,72
Establishment of local fire brigades in Camp	0	0	0	56	73	69	33±36,58
Reforestation of local species	80	60	0	0	15	25,26	31.71±31,40
Waste collection project	0	0	5	0	48	50,33	17.22±24,82
Tax increase on the sellers of natural resources at Camp	0	0	0	0	8	0	1.33±3,26

Discussion

Refugees are aware of their impacts on the vegetation cover. The lack of farming techniques, the constructions in the Camp, the lack of proper consideration of soils by the actors (refugees, NGOs, government) would be the causes of these observed impacts. These results corroborate those of Black (1996) in Zaire, which showed a degradation of the plant cover, a decrease of agricultural yield and the increase of erosion phenomenon around the site of the refugees because the NGOs and the government are bent on human life and deforestation in the sites. Similarly, Biswas and Quiroz (1995) reported that severe soil erosion and gully formation in camps near Bukavu, Zaire, cited as reasons the lack of earthworks, sanitation and land clearing by farmer's refugees. With regard to floristic composition, it appears that the number of individuals, species, genera and families increases as one moves away from the refugee settlement site. This result would be the consequence of the pressure of the refugees on ligneous trees.

According to the cardinal points, the East is the poorest in biodiversity, because it is a part used for agriculture by the refugees. Black (1996) found in a refugee camp in Sierra Leone that the pressure on the vegetation is twice as severe as that of the indigenous people. Fairness is low, ranging between 0.02 and 0.56 compared to the works of Tchobsala (2011) in the peri-urban savannah of Ngaoundéré where the Fairness varies between 0.3 and 0.42 and those of Biba (2012) in the Wakwa zone with a fairness between 0.26 and 0.44. This shows us a low biodiversity. At the Minawo site, trees do not have all the height ranges because of logging, clearing, firewood production and services. Poura (2011) found the same result in the Central African refugee camp in eastern Cameroon where he found more shrubs when he approached the refugee camp. But this result contradicts that of Tchobsala *et al*. (2015) who found a "bell-shaped" structure in the vegetation of the Sudanian zone at Ngaoundere. The abundance of discards in this savannah, whose appearance of the graph of line diameters resembles "L" materializes a large number of the rods of the future and very few adult stems. The cause could be the pressure of the refugees on the plant cover because the adult stems are cut for useful purposes. These results corroborate those of Tchobsala (2011) in the peri-urban savannas of Ngaoundere which showed that the vegetation consists mainly of individuals with a diameter between 10 and 20 cm. This difference observed between the results will be due to the difference between the study sites. *Acacia albida* has the highest basal area value (294.97m2 / ha). This shows that it is the best adapted species in this area and less used by refugees. Very similar work was obtained by IPCC (2007) which showed that more than one formation undergoing anthropization less is its diameter of the tassel and consequently the basal area of this plant formation. Dispersion of ligneous in the site shows that the majority of species are grouped at the origin of the axis form a cloud of points. This shows that the site is poor in species and less diverse. They are therefore mostly accidental species. Nevertheless, *Annona senegalensis*, *Acacia nilotica*, *Azadirachta indica*, and *Ziziphus indica* show a very shifted dispersal from other species, which is justified by their abundance and high diversity at this site. Among the impacts of the refugees listed in the site, there is soil degradation; the disappearance of plant species and the decline in agricultural productivity are the most represented. The consequences of these impacts could lead to desertification and climate change. These results corroborate those of Tchobsala *et al.* (2016) who have shown that logging is 100% a cause of desertification and 90% of climate change. The high density (32.83%) of refugees in the Camp could be the main cause of the disappearance of the species in this site. This result is in line with that of Florence (2009) in eastern Chad, who found that IDPs use resources in their host country more than in their own country. The majority of camp refugees have no knowledge of sustainable management. The lack of sustained awareness could be the result of this ignorance about environmental management, because the majority for the majority is to meet their immediate needs without worrying about the future generation. Going the same way, Samantha and Bolivard (2017) found in the same site that the lack of awareness promoted by NGOs and the government is the cause of the ignorance of the refugees on the way of resource management in the Minawao Camp.

Conclusion

It appears that a humanitarian crisis involving migration flows leads to degradations of vegetation cover with visible impacts on natural resources. These impacts are even more accentuated in the fragile zones than the Sahel. Timber cutting (51.16%) is the main factor affecting the impact of refugees on the plant cover, with 99% of refugees having their sources of energy wood. The analysis of influencing factors and their impact shows the fragility of the context of the Minawao Camp in the face of environmental issues: the density of refugees, the lack of regulation of own income resources.

The shrub savannah of Minawao dominated by the species *Acacia albida* (50.45%), covers an area of 31 900 ha. It sequesters an average of 3.57 tC / ha. The impact study of the refugee settlement of the Minawao Camp in the Far North of Cameroon shows the difficulty of the humanitarian organizations to translate the policies and strategies for the protection of the plant cover, especially since they place the case of the environment in the background.

Efforts are being made by some NGOs and the government for reforestation and environmental sanitation in the Minawao site, the pressure of the 64,000 refugees fleeing Boko Haram abuses persists. These impacts are significant on vegetation. So it is time to take immediate action so that these impacts do not become irreversible.

Acknowledgments

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