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Research Article

Impact of the Exploitation of Natural Resources on the Vegetation Dynamics and Management of the Mountain Phytodiversity of the Kaélé Subdivision, Far-North Cameroon

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Abstract: A survey was conducted in the localities of Lara, Boboyo and Midjivin, subdivision of Kaele, Division of Mayo-Kani, Far North Region, to determine the impact of the exploitation of mountain resources on the dynamics of their vegetation and sustainable peasant management of the phytodiversity of these hills. Interviews were conducted with 600 people including farmers, forest and wildlife managers, and environment and nature protection officers. The spatio-temporal dynamics of the landscapes around the mountain vegetation were studied from the diachronic analysis of three Landsat TM satellite images of 1988, Landsat ETM + 2003 and Landsat OLI_TIRS of 2018, supplemented by verification missions on field. According to surveys, it should be noted that fuel wood collection for energy with 38.5% in Lara, 35.5% in Midjivin and 33.5% in Boboyo; timber (34.67%), fruit (15.50%) and gravel (13.50%) were the main anthropogenic activities responsible for deforestation and degradation of the mountains vegetation. For biodiversity management measures, 41.16% of the population advocates the use of natural resources. The most population 44% in Boboyo, 40% in Lara and 39.5% in Midjivin recommend the creation of sacred forests for conservation of biodiversity, monitoring awareness of the population and sustainable exploitation of natural resources. The most used vegetable species as wood energy are *Combretum collinum* (80.82 ± 6.80), *Terminalia brownii* (73.59 ± 12.82), *Anogeisus leiocarpus* (59.79 ± 0.97), *Combretum glutinosum* (58.44 ± 2.10), *Ficus abutilifolia* (42.60 ± 2.37). The analysis of landsat satellite land-use images demonstrates and appropriately confirms the decline in vegetation cover over the years. The wooded savanna increases from 232,025 ha in 1988 to 232.025 ha in 2003 and to 170.4 ha in 2018 on Lara hill; from 101.33 ha in 1988 to 59.50 ha in 2003 and 25.44 ha in 2018 on Boboyo Hill; the wooded savannah rose from 210.00 ha in 1988 to 148.61 ha in 2003 and 125.17 ha in 2018 on the hill of Midjivin.

Keywords: Sustainable Management, Biodiversity, Lara, Boboyo, Midjivin.

INTRODUCTION

Sustainable management of natural resources is a global concern. Natural resources are under abusive and destructive human pressures. In many countries, deforestation affects ecosystems, degrades water resources and agricultural land. This compromises food security and worsens community poverty (CBD, 2000). Every year, we observe more than 50 to 100 times the extinction rate of species in the world that is higher than the natural extinction rate (CBD, 2000; GIZ, 2008). The Convention on Biological Diversity estimated in 2000 that 54,000 plant species and 5,200 animal species were facing extinction, mainly because of human activity (CBD, 2000). The Sahelian ecosystems for them suffer a very strong degradation due to the precarious climate and the strong anthropization (Tchobsala, 2011).

Mountains and hills (mountain ecosystems) are an important reservoir of water, energy and biodiversity. In addition, they contain essential resources such as minerals, forestry and agricultural products, and recreational services. As large ecosystems within the complex ecology of our planet, they are essential to the survival of the global ecosystem. However, mountain ecosystems are changing rapidly. They are exposed to accelerated soil erosion, landslides and rapid loss of habitat and genetic diversity. On the

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human level, poverty is widespread among mountain people and knowledge of indigenous people is lost. Therefore, proper management of mountain resources and socio-economic development of their population justify immediate action (Assi-Kaudjhis, 2011). Indeed, the persistence of destructive factors such as fire, agriculture, mining, hunting and clearing, only accentuate the process of degradation of the existing forest system and the loss of its biological diversity (IKermoud, 2000). The increase in the population living around the mountains and hills on the one hand and the receding savannah plains on the other hand impose a strong pressure to harvest the natural resources of the hills leading to the imbalance and fragmentation of the habitat nature of biodiversity and loss of some fragile species, (Assi-Kaudjhis, 2011). The ecosystems of mountains and hills are very sensitive to any ecological imbalance caused by human activity or by nature. Specific information on ecology, the potential of natural resources and socio-economic activities is essential. The mountain ecosystems of Cameroon and those of the far north do not escape this sad reality. This is why knowledge of the state of play, the creation of a database on the vegetation of the hills for a proper management of the natural resources of these hills and for a socio-economic development of their population justify an action immediate.

MATERIAL AND METHODS

Study site

The Far North region is one of the ten regions of Cameroon and one of the most populated, located in the north of the country and bordering Chad and Nigeria. Its chief town is Maroua. Its population (and thus its density) has experienced a very strong evolution, from 2 721 500 inhabitants in 2001 to 3 111 792 at the 2005 census. Its density has increased from 40.7 to 90.8 inhabitants per km² between 1974 and 2005 censuses.

The study was conducted in the Kaélé subdivision precisely in the townships of Lara, Boboyo and Midjivin. The commune of Kaélé marries the administrative division of the district of Kaélé and is in the Mayo-Kani division, Extreme-North-Cameroon Region. Created by Presidential Decree No. 060/81 of 31 December 1960, the borough is bounded on the north by the commune of Mindif, on the south by the Republic of Chad, on the east by the commune of Guidiguis, on the south-west by the municipality of Guider and to the West by the commune of Moutourwa. It has an area of 1,785 square kilometers and its current population is 126,376. Its main town Kaélé is the chief town of the Mayo-Kani division, it is south of Maroua chief town of the Far North Region about 100 km (PCD Kaélé, 2013). The three hills on which this study is conducted are located in Lara, Boboyo and Midjivin villages respectively. These different hills are shown on the map below.

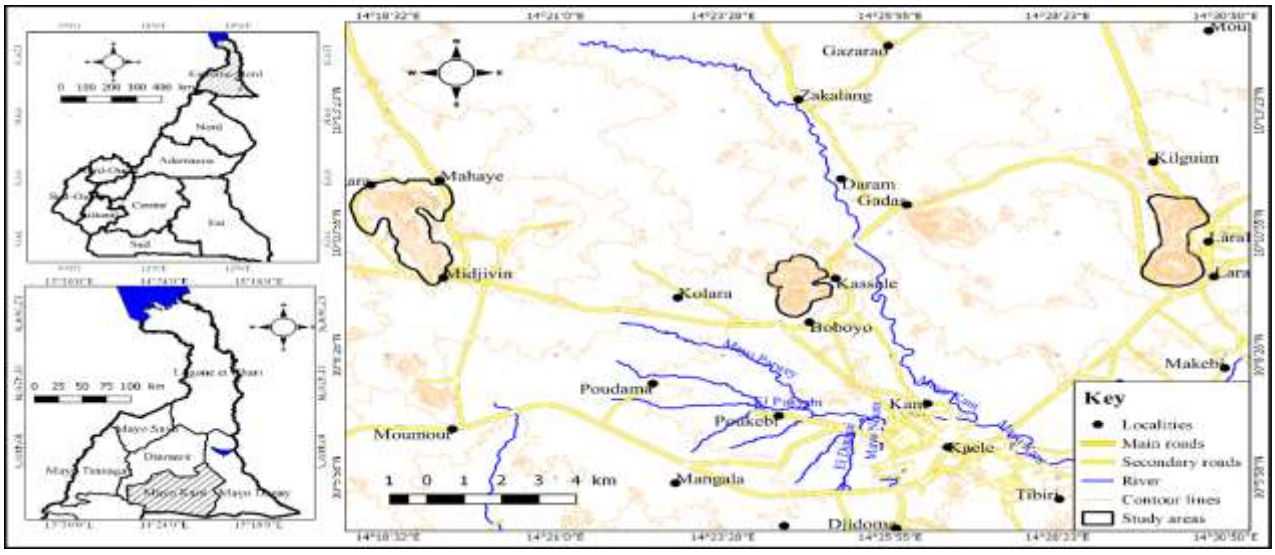

Figure 1: presents the map of the study area

The Sudano-Sahelian climate dominates the study environment. It is characterized by two seasons. A long dry season of eight (08) months, from October to May and a short four (4) month rainy season that covers the months of June to September. Effective rainfall for agricultural practices extends from July to September. The distribution of rainfall over time remains the main factor determining the occupation of spaces by crops; they vary between 700 and 900 mm per year. The dry season is characterized by a temperature which varies between the cold (November-January) and the heat scorching heat (February to May). The average temperature is 28.1°C with a minimum of 18°C in January and the maximum of 40°C in April and May. The average rainfall amplitudes are 809 mm per year (Fotsing, 2009). The regression of rainfall over the years and the duration of the rainy season and rainfall are recorded (Lienou *et al.*, 2003).

The soils are essentially granitic discordant or alkaline and alluvial. They are usually sedimentary formations. The textures of these soils vary from sandy to clayey, sandy-clayey and clay-sandy. These soils are ferruginous and ferralitic (Donfack, 1993).

The relief of the Kaélé Commune is made up of 95% of the plains, 1% of the plateaus and 4% of the mountains. (Source: Annual Activity Report P. 32-33, Delegation of Kaélé Agricultural District) (PCD, 2013). Located in the semi-arid zone, all rivers of the Commune have an intermittent regime. They are flooded in July, August and September and partially dry during the dry season. Other rivers like Boboyo Lake keep their water all year round and flow from west to east. Most of these mayos take their sources in Chad. The principal rivers of the Commune are Mayo-Kani, Mayo-Zapazon and Mayo-Gamrey. Alongside these rivers, there are flood areas in Kani, Gadas, Piwa, Pukwei, Mindjil. (Source: Annual Activity Report P. 32-33, Kaélé Agriculture District Delegation).

The most common types of vegetation are shrubby savannas and wooded savannahs with plant species dominated by *Anogeissus leiocarpus, Balanites aegyptiaca, Guiera senegalensis, Piliostigma thonningii, Acacia seyal, Ziziphus mauritiana, Acacia albida, Acacia nilotica* and *Acacia senegal* (Letouzey, 1968.) The vegetation is predominantly grassy and dotted with woody formations. The dominant herbaceous species are grasses.

The fauna of the Kaélé plain is made up of various species. Carnivores, hyenas (*crocuta crocutta*), wild cats (*felix silvestris*), foxes (*canuis aurus*), warthogs, rodents, guinea fowl and reptiles (Kaélé commune) are noted.

The main ethnic groups encountered were the Moundangs, the Guidars, the Tupouris, the Guizigas, and the Peuls, with the Moundangs as the majority group.

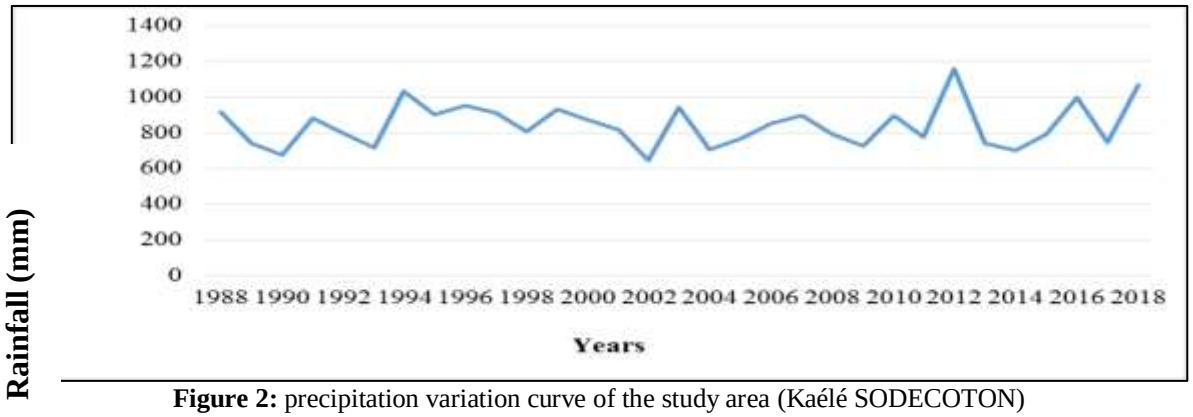

Figure 2: precipitation variation curve of the study area (Kaélé SODECOTON)

Methodology

Surveys in the form of a semi-direct interview (Mary and Besse, 1996). This study mainly concerned the riparian populations of the three hills. For a good cohesion of our survey results and for the sake of clarity several groups influencing the management and exploitation of natural resources were considered, including traditional leaders, loggers (timber seller), traditional doctors, farmers.

We conducted the survey in the three localities from November 2018 to January 2019; a total of 600 people was interviewed, with 200 people per location. It should be noted that around each hill (locality) are arranged villages or neighborhoods, it is in these different neighborhoods or villages that took place from top to bottom our interviews.

Evolution of the population of the localities

In addition to the difference between the respondents and the distribution of these in the villages and neighborhoods, the age and gender criteria were taken into account in this study. Our survey sheets included questions with closed, semi-closed or open questions, concerning the perception of the population of the resources exploited on the hills, the evolution of the vegetation and management of these natural resources of these hills. Local names of plant species cited by respondents were determined using field determination keys (Arbonnier 2009) and verification at the national herbarium.

It should be noted that the help of people with a mastery of the area and language was of great importance.

Acquisition and processing of images

The Landsat series is part of a group of medium-resolution satellites, adapted to the observation of resources and the environment. The period chosen for downloading the satellite images corresponds to the start of the dry season, more precisely in November. During this time of year, the trees have not yet lost all their leaves and this period is recommended for the acquisition of satellite images (Jensen, 1983). He claims that the images uploaded in this period are of good quality and reduce imperfections due to changes in

vegetation phenology and the dissimilarity of soil moisture. During this period the factors that can alter the quality of the image such as clouds (cloudiness) is reduced and the vegetation cover and the chlorophyllian activity are still moderate.

RESULTS

Characteristic of the sample

Age range of respondents

The figure shows the proportion of forest resource operators in different age groups. People under the age of 50 have a higher percentage in all three villages. These results showed that the operators of the natural resources of the mountains were mostly young, and that the actors of the exploitation of the resources of the hills are the physically fit persons because this activity requires enough physical efforts and breath to climb in height.

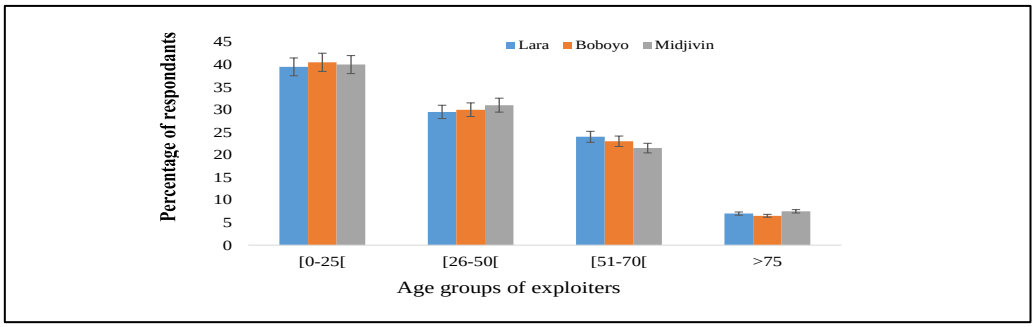

Figure 3: Age ranges of Resource Operators

Activities on the mountains

Figure 4 shows the different activities practiced on the mountains. This figure showed that firewood cutting was the most represented activity in the three villages with 38.5% in Lara, 35.5% in Midjivin and 33.5% in Boboyo, followed by exploitation of gravel 28% in Midjivin, 27% in Lara and 25% in Boboyo. Then follow the pharmacopoeia and picking. The least important activities were livestock, agriculture and tourism.

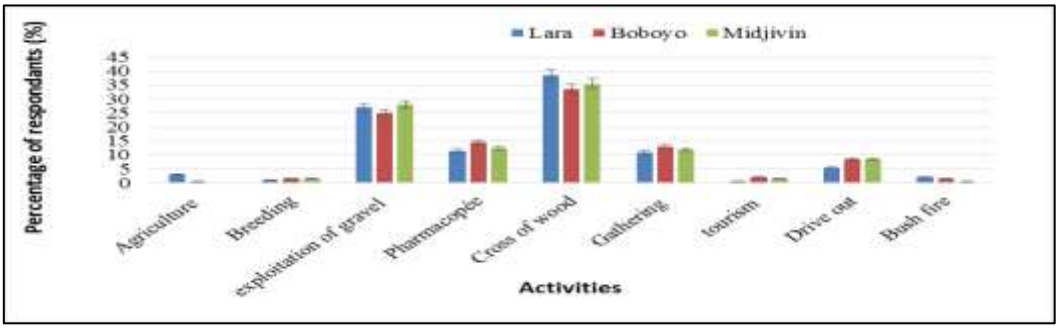

Figure 4: Activities practiced on the mountains according to the villages

(a) Prospecting trace (b) Field at the foot of the Lara hill

Photo 1: *Survey trail and field at the foot of Lara Hill*

Resources exploited by the population

Figure 5 below shows the different natural resources exploited on the mountains according to the villages. From this graph it appears that energy wood, fruits, gravel and game were the main natural resources most exploited. Timber and grading with respectively an average of 34.6% and 13.50% in the three villages were the most degrading activities in the hills. In

addition, the collection of a species of insects consumed and sold on market places in the village Lara was a resource harvested on the Lara Mountains. The least important resources were the roots, straw, honey and flowers or petals of certain species consumed or used in the traditional pharmacopoeia.

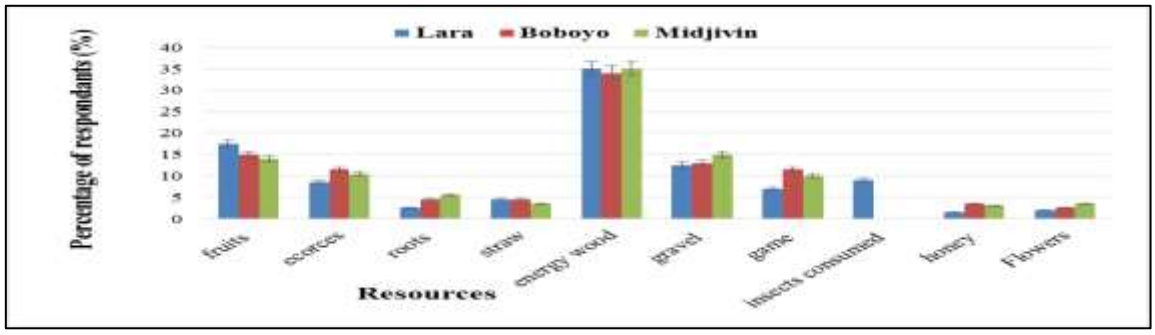

Figure 5: Resources operated on hills by locality

Photo 2: *Haematostaphis barteri* fruits (A), *Ficus ingnes* fruits (B) Edible insects (C)

Species used as firewood

Table 1 shows the different woody species used as fuel wood by the populations living near the mountains. Some species in order of appreciation were cited by the operators as firewood: *Combretum collinum* (80.82 ± 6.80), *Terminalia* sp. (73.59 ± 12.82), *Anogeissus leiocarpus* (59.79 ± 0.97), *Combretum glutinosum* (58.44 ± 2.10), *Ficus abutilifolia* (42.60 ± 2.37).

Table 1: Species used as firewood

Species	Lara	Boboyo	Midjivin	Averages and Standard deviation
Anogiessus leiocarpus	91.25^{i}	88.33^{i}	90.05^{i}	**89.87 ± 1.46**
Ficus ingens	25.25^{de}	23^{de}	33.31^{de}	**27.19 ± 5.42**
Ficus abutilifolia	45.33^{f}	40.98^{f}	41.5^{f}	**42.60 ± 2.37**
Terminalia brownii	88.34^{h}	67.44^{h}	65^{h}	**73.59 ± 12.82**
Grewia bicolor	21^{d}	19.05^{d}	17.67^{d}	**19.24 ± 1.07**
Croton pseudopulchellus	17^{bc}	13^{bc}	13.45^{bc}	**14.48 ± 2.19**
Lannea schimperi	9^{a}	7.55^{a}	5.05^{a}	**7.20 ± 1.99**
Combretum collinum	88.67^{h}	76.88^{h}	76.9^{h}	**80.82 ± 6.80**
Combretum glutinosum	56.06^{g}	60.08^{g}	59.17^{g}	**58.44 ± 2.10**
Combretum molle	33.05^{e}	31.03^{e}	38.88^{e}	**34.32 ± 4.07**
Detarium microcarpum	2^{a}	1.05^{a}	2.66^{a}	**1.90 ± 0.80**
Ziziphys mauritiana	13.09^{b}	11.77^{b}	13.94^{b}	**12.93 ± 1.09**
Average and Standard deviation	**33.31 ± 30.54**	**36.68 ± 29.58**	**38.13 ± 29.17**	**3855 ± 2.10**

Figures with the same letters on the same column are not significantly different at the indicated threshold.
Numbers with the same letters on the same line are not significantly different at the indicated threshold.

Sustainable management methods advocated by respondents

Figure 6 shows the biodiversity management measures proposed by the local population and the services in charge of forests and the environment. This

figure showed that 41.16% of the population recommends the creation or addition of sacred forests, 44% in Boboyo, 40% in Lara and 39.5% in Midjivin and monitoring awareness of the population with an average of 19.5% in the villages, 20.5% in Boboyo, 19.5% in Lara and 18.5% in Midjivin. The sustainable exploitation of the natural resources of the mountains and the limitation of the exploitation zones follow the first two measures. The least represented measures are the development, deployment of eco-guards, transformation of these mountains into sanctuaries or protected areas, popularization of alternative energies to limit logging. In addition, the installation of firebreaks all around the hills to avoid the bush fire is represented only in the locality of Lara this would be explained by the fact that the population of Lara is used to doing this practice for fight the stock market fire. Statistical analyzes reveal a significant difference between the different measures (P = 0.0000) but there is no significant difference between the various management measures recommended by the populations living near the mountains, only for the practice of the firewall in the village Lara.

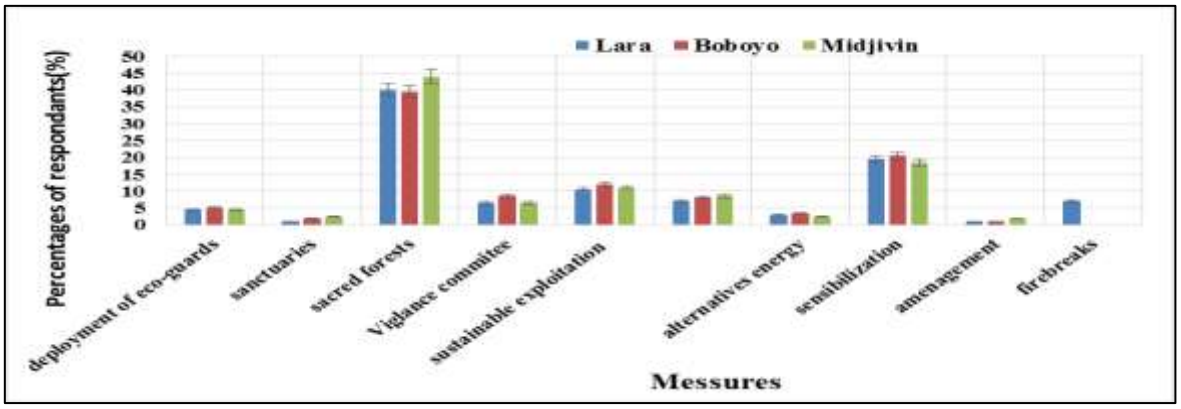

Figure 6: Biodiversity management methods proposed by the local population

Dynamics of vegetation or Impact of human activities on vegetation or hills. Figure 7 shows the land-use dynamics of the Lara (A), Boboyo (B) and Midjivin (C) mountains and the state of evolution of the 1988 urban fabric (1), 2003 (2) and 2018 (3) in the Kaélé subdivision, Cameroon.

Deforestation does not affect all vegetation strata in the same way, the lower zones suffer the effects of exploitation. The vegetation of the hills undergoes a regressive evolution because of the phenomenon of the deforestation accentuated by the climatic phenomena, but there is progression of other types of plant formation to the detriment of others, the denser parts (savannah with trees) become sparse (shrub savannah or bare soil). However, the satellite images below clearly show changes in vegetation over time.

Figures 7A show the evolution of deforestation on Lara Hill. From these images it appears that there is a loss of the area of savannah at the expense of other forms of land use. Besides the fact that there is a regression of the vegetation on the hill it is clearly visible that the urban fabric of the locality has increased, thus increasing the space of the cultures all around the hill. The images of 1988 perform few tasks but it is undoubtedly noticed that there is an increase of the spots over time on the images of 2003 and 2018. The tasks become heterogeneous. On the image of 2018 the areas of crops, bare and rocky soils have increased and are very visible.

Figure 7B shows the state of evolution of deforestation on Boboyo Hill. The images show that there is loss of the area of the savannah raised at the expense of shrub savannah, bare and rocky spaces. At the edge of the hill we notice the loss of the shrub savanna at the expense of the space of cultures. It is also visible that the built space has increased all around the hill on the east side, the two main villages at the bottom of the hill have increased in size due to the increase of the population thus causing the increase of the spaces of crops all around the hill. The images of 1988 perform few tasks but it is undoubtedly noticed that there is an increase of the spots over time on the images of 2003 and 2018. The tasks become heterogeneous. On the image of 2018 the spaces of crops, bare and rocky soils have increased and are very visible.

Figure 7C shows the state of evolution of deforestation on Midjivin Hill. We note here that unlike the hills of Lara and Boboyo, the western part of the hill is the most exposed to the pressure of exploitation. The satellite images below clearly show changes in vegetation over time. It appears from these images that there is loss of the area of the savannah. The urban fabric of the locality has increased, thus increasing the space of crops all around the hill. The images of 1988 perform few tasks but it is undoubtedly noticed that there is an increase of the spots over time on the images of 2003 and 2018. The tasks become heterogeneous. On the image of 2018 the spaces of crops, bare and rocky soils have increased and are very visible.

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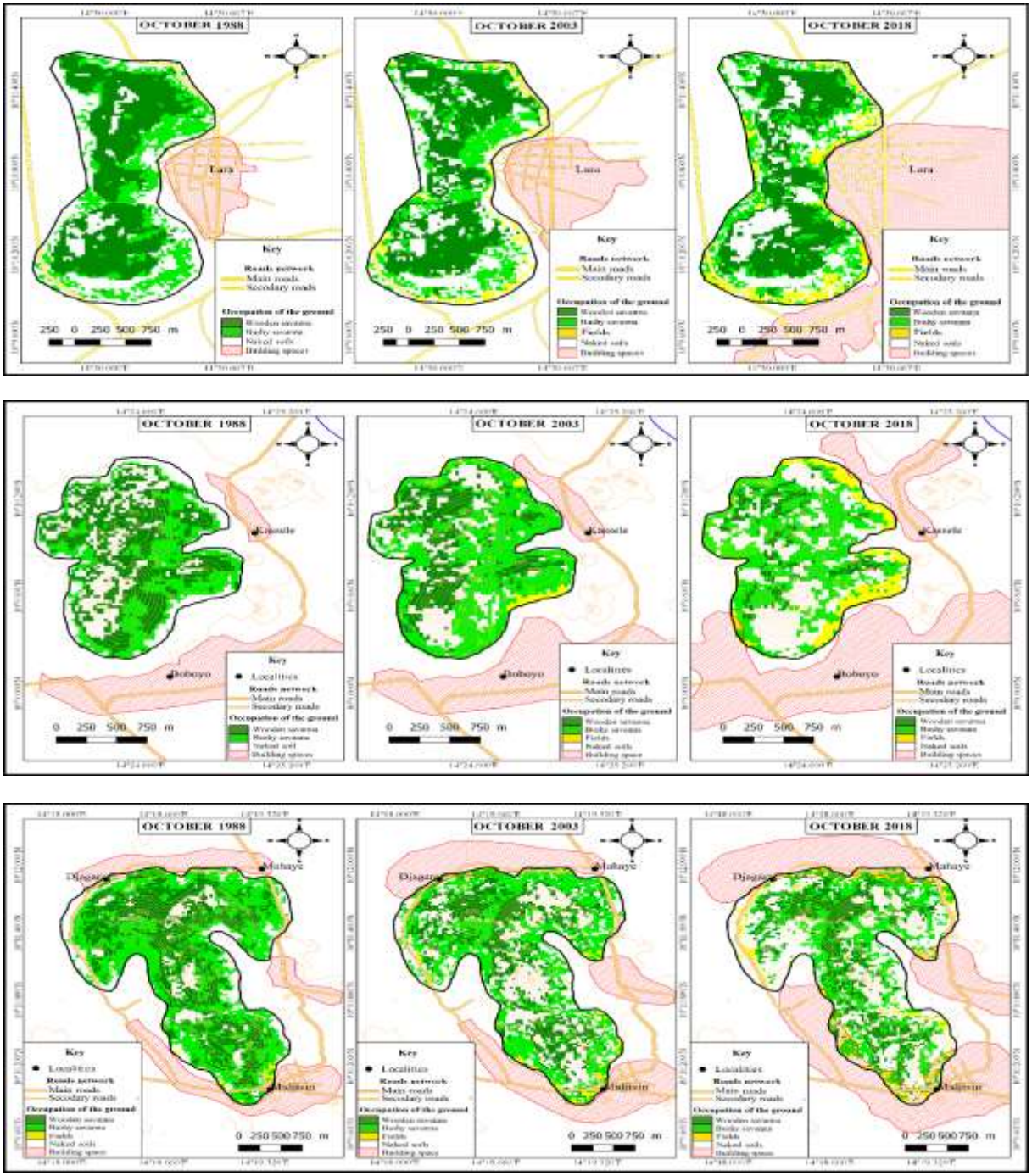

Figure 7: Dynamics of land use in the Lara (A), Boboyo (B) and Midjivin (C) mountains of 1988 (1), 2003 (2) and 2018 (3) in the Kaélé district, Cameroon.

Table 2 shows the evolution of the area (in ha and in %) of land cover on the Lara, Boboyo and Midjivin hills from 1988 to 2018.

For the hill of Lara, the surface occupied by the tree and shrub formations is lost at the edge of bare and rocky soil and spaces of cultures over time. Indeed, we note that between 1988 and 2018 for the savannah raised from 232.03 ha (44.18%) in 1988 to 198.7 ha (37.83%) in 2003 then to 170.4 ha (32.45%) in 2018; a loss of about 61.63 ha (11.73%) for the thirty years, an annual loss of about 2.50 ha. The shrub formations increased from a slight increase from 133.55 ha (25.43%) in 1988 to 136.24 ha (25.94%) in 2003 before

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being reduced to 113.95 ha (21.7%) in 2018, a loss of 19.6 ha (3.73%) in thirty years with an annual loss of 0.65 ha. On the other hand bare soils, the rocks go from 159.62 (30.39%) ha in 1998 to 167.96 ha (31.98%) in 2003 then to 177.44 ha in 2018 (33.79%) an increase of 17.82 ha (3.4%) in thirty years an annual increase of 0.59 ha. Cropland has increased from 0 ha in 1988 to 22.29 ha (4.24%) in 2003 63.4 ha (12.07%) in 2018, an increase of about 63.4 ha or 7.83%. There is an evolution rate of 2.11 ha per year.

For Boboyo hill it is indicated in this table 2 that the area occupied by tree and shrub formations also decreases. Indeed, we note that savannah raised from 101.33 ha (41.18%) in 1988 to 59.50 ha (24.10%) in 2003 to 25.03 ha (10.31%) in 2018. We note the loss of 76.3 ha or 30.87% of the tree formation of this hill. There is a loss rate of about 2.54 ha per year. Tree shrubs increased from 67.86 ha (27.58%) in 1988 to 111.28 ha (45.08%) in 2003 before declining to 95 ha (38.52%) in 2018, an annual evolution rate of 0.90 ha. This can be explained by the fact that tree formations would be transformed into a more sparse formation, the shrub savannah. The bare soil increased from 76.86 ha (31.24%) to 54.07 ha (21.91%) in 2003 then to 51.01 ha (20.79%) in 2018, an annual loss of 0.86 ha. This loss of bare soil is due to the fact that shrub savannah has increased and colonized these bare soils. The cropping areas increased from 0 ha (0%) in 1988 to 21.3 ha (8.91%) in 2003 to 75.01 ha (30.39%) in 2018, an increase of 75.01 ha in thirty years with an annual growth rate of about 2.50 ha.

On the Midjivin hill, savannah savannah rose from 210.00 ha (35.16%) in 1988 to 148.61 ha (24.86%) in 2003 to 125.17 ha (20.95%) in 2018, a loss of about 84.83 ha, ie loss rate of 2.83 ha per year. The shrub formations increased from 272.01 ha (45.54%) in 1988 to 227.61% ha (38.13%) in 2003 and then to 174.33 ha (29.2%) in 2018, a loss of about 97.68 ha in, thirty years. There is an annual regression rate of 3.26 ha. On the other hand, the bare soil, the rocks and the growing areas have increased in size over the years. The bare soils and the rocks, go from 87.34 ha (14.62%) one passes to 153.23 ha (25.23%) in 2003 then to 222.28 ha (37.21%) in 2018, in thirty years one records an increase of 134.94 ha or a rate annual evolution of 4.50 ha. The cultivation space has increased from 27.96 ha (4.68%) in 1988 to 67.86 ha (11.37%) in 2003 to 75.53 ha (12.64%) in 2018, an increase of 7.96 ha is an annual devolution rate of 1.59 ha.

Table 2: Evolution of the area (in hectares and %) of land cover on the Lara, Boboyo and Midjivin hills from 1988 to 2018

Soil cover	Area in 1988		Area in 2003		Area in 2018		Progression/regression (ha)			Rate of evolution (%)			Annual rate of evolution	
	ha	%	ha	%	ha	%	1998/2003	2003/2018	1998/2018	1998/2003	2003/2018	1998/2018	ha	%
Lara hill														
Tree Savannah	232.03	44.18	198.7	37.83	170.4	32.45	-33.33	-28.3	-61.63	-6.,35	-5.38	-11.,73	-2.50	-0.39
Shrub Savannah	133.55	25.43	136.24	25.94	113.95	21.7	2.69	-22.29	-19.6	0.51	-4.24	-3.73	-0.65	-0.12
Bare soil and rocks	159.62	30.39	167.96	31.98	177.44	33.79	8.34	9.48	17.82	1.59	1.81	3.4	0.59	0.11
Cultivated lands	0	0	22.29	4.24	63.4	12.07	22.29	41.11	63.4	4.24	7.83	12.07	2.11	0.40
Total	525.19	100	525.19	100	525.19	100								
Boboyo hill														
Tree Savannah	101.33	41.18	59.4	24.1	25.03	10.31	-41.93	-34.37	-76.3	-17.08	-13.79	-30.87	-2.54	-1.03
Shrub Savannah	67.86	27.58	111.28	45.08	95	38.52	43.42	-16.28	27.14	17.5	-6.56	10.94	0.90	0.36
Bare soil and rocks	76.86	31.24	54.07	21.91	51.01	20.79	-22.79	-3.06	-25.85	-9.33	-1.12	-10.45	-0.86	-0.35
Cultivated lands	0	0	21.3	8.91	75.01	30.39	21.3	53.71	75.01	8.91	21.48	30.39	2.50	1.01
Total	246.05	100	246.05	100	246.05	100								
Midjivin hill														
Tree Savannah	210	35.16	148.61	24.86	125.17	20.95	-61.39	-23.44	-84.83	-10.3	-3.91	-14.21	-2.83	-0.47
Shrub Savannah	272,01	45.54	227.61	38.13	174.33	29.2	-44.4	-53.28	-97.68	-7.41	-8.93	-16.34	-3.26	-0.54
Bare soil and rocks	87.34	14.62	153.23	25.64	222.28	37.21	65.89	69.05	134.94	11.02	11.57	22.59	4.50	0.75
Cultivated lands	27.96	4.68	67.86	11.37	75.53	12.64	39.9	7.67	47.57	6.69	1.27	7.96	1.59	0.27
Total	597.31	100	597.31	100	597.31	100								

DISCUSSIONS

The operators of the natural resources of the hills are mostly young people (under 50 years of age). These results corroborate those of Tchingsabé (2007) and Haiwa *et al.*, (2016) who showed that young people are the most active in the exploitation of plant

resources. There is no significant difference between villages (P = 1,000), but between age groups the analysis of variance reveals a significant difference (P = 0.01).

The most represented activities on the hills of Lara, Boboyo and Midjivin were firewood cutting, gravel mining, traditional pharmacopoeia and harvesting of non-timber forest products. The least important activities were livestock, agriculture and tourism. Our results do not corroborate those of Haoua *et al*., (2016), who found that agriculture, military activities and hunting are the main activities degrading the vegetation of Mount Ngaoundal. There is no statistical difference between the sites, but the variance analysis reveals a significant difference between the reported activities (P <0.05). This result corroborates those of Landy (2000), who has proved that excessive cutting of firewood in Sahelian zones was important. This result is also similar to that of MINFOF (2014) which shows that in the Far North region of Cameroon (95.4%) the population uses wood for energy in households despite the will of the public powers of the country. reasonably reduce the use of wood for energy by promoting domestic gas. Apart from the use of plants in terms of food and medicine, they also have an artisanal virtue. Several parts of the plants are used in the crafts, either to transform a raw material or for the manufacture of certain tools.

In addition, many resources were harvested, energy wood, fruits, gravel and game. But the energy wood with an average percentage of 34.67% in the three villages and gravel exploitation are the activities that degrade the structure and vegetation of these hills the most. In addition, the collection of a species of insects consumed and sold on market places is a resource harvested on the Lara Mountains. The least important resources are the roots, straw, honey and flowers or petals of some species consumed or used in the traditional pharmacopoeia. Our results corroborate those of Haoua *et al.,* (2016) and Landy (2000), who find that energy wood is the main product harvested on Mount Ngaoundal. Statistical analysis found a significant difference between different resources (P <0.05). But between the sites, only for the insects consumed in the village Lara, there is a highly significant difference, this for the reason that one exploits this species only on Mount Lara this could be explained for cultural reasons and the questions conservation of culture habits bequeathed by the ancestors.

For methods of biodiversity conservation, the surveyed population recommends the establishment or addition of sacred forests. Monitoring the awareness of the population, the sustainable exploitation of the mountain's natural resources and the limitation of the exploitation zones follow the first measures. The least represented measures were the development, the deployment of the eco-guard, the transformation of these mountains into sanctuary or protected areas, the popularization of alternative energies in order to limit the cuts of wood. In addition, the installation of firebreaks all around the hills to avoid the fires of fire is only represented in the locality of Lara this would be explained by the fact that the population of Lara is used to doing this practice to fight the stock market fire. These results are partly in agreement with the work of Haoua *et al*., (2016) eco-guards (31.40%) Vigilance Committee (12.12%) Awareness raising (11.52%)

Degradation does not affect all vegetation layers of hills in the same way, the feet of these hills was more affected because of their exposures and accessibility to the population. The vegetation of these hills undergoes a regressive evolution because of the anthropic action accentuated by the rarities of the rains, but there is progression of the savanna shrub to the detriment of the savannah raised, the denser parts (savannah raised) become sparse (shrub savannah or bare soil). Also, satellite images clearly confirm changes in vegetation over time. There is loss of wooded area. Besides the fact that there is regression of the vegetation on the hill, it is clearly visible on the images that the urban fabric of the terroirs bordering these hills has increased, thus causing the increase of the space of the cultures all around the hills. Hills. The images of 1988 present few tasks but it is undoubtedly noticed that there is an increase of the spots over time on the images of 2003 and 2018. On the image of 2018 the spaces of cultures, bare grounds and rocks have grown and are very visible. This result does not agree with that of Yanda (2007) in eastern Cameroon, which shows that increased rainfall levels favor the evolution of vegetation towards forests.

CONCLUSION

The increase in the population living around the Lara, Boboyo and Midjivin hills imposes a strong pressure to harvest the natural resources of mountains, thus leading to the imbalance and fragmentation of the natural habitat of biodiversity and the loss of certain fragile species. The actors of the plant resource exploitation are the people so the age is less than or equal to 25 years. Cutting firewood is the most represented activity in the three villages with 38.5% in Lara, 35.5% in Midjivin and 33.5% in Boboyo, followed by gravel mining 28% in Midjivin 27% in Lara and 25% in Boboyo. Then pharmacopoeia and picking. The little-known activities are livestock farming, agriculture and tourism. The tree species most exploited by the populations as firewood are: *Combretum collinum* (80.82 ± 6.80), *Terminalia brownii* (73.59 ± 12.82), *Anogeissus leiocarpus* (59.79 ± 0.97), *Combretum glutinosum* (58.44 ± 2.10), *Ficus abutilifolia* (42.60 ± 2.37). It can be seen on the Lara hill that between 1988 and 2018 for wooded savannah we go from 232.03 ha in 1988 to 198.7 ha in 2003 to 170.4 ha in 2018. The shrubs grow from 133.55 ha in 1988 to 136.24 ha in 2003 before being reduced to

113.95 ha in 2018. For bare soil and rocks, in 1988 it has an area of 159.62 in 1988 ha it passes to 167.96 ha in 2003 then to 177.44 ha in 2018. The Cropland has increased from 0 ha in 1988 to 22.29 ha in 2003 and 63.450 ha in 2018. The wooded savannah of Boboyo Hill increased from 101.33 ha in 1988 to 59.40 ha in 2003 to 25.03 ha in 2018. The shrubs from 67.86 ha in 1988 to 111.28 ha in 2003 before falling to 95 ha in 2018. For bare soil and rocks, in 1988 we have an area of 76.86 ha we go to 54.07 ha in 2003 and 51.30 ha in 2018. The cultivation spaces have gone from 0 ha in 1988 to 21.99 ha in 2003 and to 75.01 ha in 2018. The wooded savannah of the Midjivin hill passes from 210.00 ha in 1988 to 148.61 ha in 2003 to 125.17 ha in 2018. The shrubby formations increase from 272.01 ha in 1988 to 227.91 ha in 2003 and 174.43 ha in 2018. The bare soils and the rocks, in 1988 one has a surface of 87.34 ha one passes to 153.23 ha in 2003 then to 222.28 ha in 2018. The spaces of cultures went from 27.96 ha in 1988 to 67.96 ha in 2003 to 75.53 ha in 2018. For a sustainable approach to the sustainable management of the natural resources of these hills, it would be advisable to promote and popularize actions for the conservation of these resources in order to establish a good sustainable and conservative resource management policy.

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