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# Research Article
# Plant Use and its Impact on the Evolution of Woody Plant Formations in Diamaré, Far North of Cameroon

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## Abstract

**Background and Objective:** Against a backdrop of climate change and strong population growth, natural resources are under considerable pressure from human activity. This aims to contribute to the understanding of the use of woody plant species and the perception of the dynamics of the woody stand of the forest massifs of the Diamaré Department in the Far North of Cameroon. **Materials and Methods:** The methodology was based on socio-economic surveys carried out based on questionnaires in previously established forms. As 264 people were interviewed an average of 66 per site. The statistical data collected were analyzed using R software version 4.2.1 and the chi-squared test to compare the means. **Results:** Individual interviews with local populations showed that the majority of actors exploiting natural resources are men (73%) aged between 40 and 50 years, including farmers (87.8%), herders (62.07%) and traders (33.2%). The most exploited woody species were *Balanites aegyptiaca* (96.25%), *Acacia nilotica* (88.37%), *Tamarindus indica* (96.12%), *Azadirachta indica* (82.6%), *Piliostigma thonningii* (69. 9%), *Acacia seyal* (62.75%) were the most used species. These species are used for food, medicines and handicrafts, leading to a reduction in forest area. **Conclusion:** The perception of the vegetation dynamics by the residents showed that 89.3% of the people see that the areas of natural formations have decreased. These species are used for food, medicines and handicrafts, leading to a reduction in forest area.

Key words: Local perception, dynamics, pharmacopeia, woody settlement, Diamaré

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Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

The ecologically fragile Far North Region of Cameroon regularly experiences prolonged periods of drought and significant anthropogenic pressure due to exponential population growth[1]. Natural resources are facing pronounced anthropogenic pressures leading to dysfunctional ecosystems and biodiversity losses[2]. Resource degradation, particularly in the Sudano-Sahelian Zone of Cameroon, is caused by human activity, bushfires and climate change[3-5]. This vulnerability contributes to the degradation of vegetation cover, leading to ecological disruption, lower crop yields, falling farm incomes and food insecurity. Bush fires are an important factor in the destruction of vegetation cover[6]. In the Sahelian Zone of Cameroon in general and in the Far North in particular, fire is used to destroy weeds in the fields or to enlarge the cultivable area. Insecurity in this part of the country, due to its proximity to Nigeria, has caused significant material and human damage[7]. Many villages are expanding and new settlements are being established in an anarchic manner. As populations increase, they need more resources and natural spaces for their various activities (pastoral, agricultural, wood exploitation), which leads to unprecedented anthropic pressure on plant resources. The decrease in forest area is mainly the result of clearing linked to the extension of cropland caused by the practice of slash-and-burn agriculture or cattle ranching[8]. Many studies have been carried out on the dynamics of the vegetation of the Far North (Diamaré Department), but there has been a lack of local perception of plant resources. Local knowledge provides a better understanding of the nature of environmental processes and is an indispensable complement to science[9]. It is therefore, important to intensify work at the local level to guide decision-making for sustainable natural resource management. This study aimed to contribute to the local understanding of woody use and stand dynamics in the Diamaré District. The degradation of vegetation can be a threat to the Sahelian ecological balance of economic activities.

## MATERIALS AND METHODS

The current study was launched on 02 May, 2022 and completed in March, 2023 on the use of plant resources and their impact on the dynamics of plant cover.

**Study sites:** The Department of Diamaré is one of the six departments that make up the Far North Region (10°56' to 10°96' North, 13°54' to 13°58' East) with a surface area of 4665 km$^2$. The department of Diamaré is located in the heart of the Far North Region. Its population is around 713,653 inhabitants, representing 22.93% of the population of the Far North[10]. Agriculture is the main activity, employing around 60% of the working population, mainly on family farms. It also plays an irreplaceable role in the creation of income in the countryside[1] followed by livestock farming, which represents an essential source of income for 30% of the rural population and for many ethnic groups, livestock is the primary means of wealth accumulation. The vegetation of Diamaré is made up of wooded, shrubby and herbaceous savannahs, forest galleries and a thorny steppe[11]. The vast grasslands cover the periodically flooded areas and the wooded savannahs and dry open forests in the highland areas[12]. The Diamaré plain has a Sudano-Sahelian climate and annual rainfall varies between 435 and 810 mm, characterized by a long dry season from October to June and a short rainy season between July and September.

### Methods

**Data collection systems:** The population's view on the modification and degradation of plant formations will be based on ethnobotanical surveys complemented by direct field observations. These surveys were inspired by Quemin[13] accelerated participatory research method (MARP). It is carried out based on questionnaires in previously established forms. The questionnaires are semi-structured with closed (yes/no), open (deliberately answered from one's point of view) and open-ended (answers are proposed to the respondents) questions. The main headings of the questionnaires are the identity of the respondent, the practices of agriculture, wood cutting and the perception of the population on the dynamics of the vegetation cover, the factors of the degradation of vegetation formations. The number of people to be interviewed was defined according to the size of the population and was divided by district. People aged 30 years or more were targeted because they are most likely to give us reasonable information on the evolution and change observed in woody vegetation over the past two decades.

For the sample to be representative of the selected population (at least 30), the sample size must be determined. The sample size is determined using the statistical formula for Lorentz sample estimation[14]:

$$n = \frac{t^2 \times p\,(1-p)}{e^2}$$

Where:

n = Sample size

t = Estimated confidence rate for the proportion (t = 95% corresponds to 1.96 read from the student-fisher centered normal distribution table)

p = Proportion of the target parent population (at least 30) for our study it is 36.04% (BUCREP, 2010)

e = Estimated margin of error for the proportion (5% margin of error)

$$n = \frac{(1.96)2\times 0.3604(1\text{-}0.3604)}{0.005^2} \cong 264 \text{ persons}$$

In this study, 264 people will be surveyed, for an average of 66 people per site.

**Statistical analysis:** The collected data were processed and analyzed using XLSTAT 2007 version and Microsoft Excel 2013 version software. Descriptive statistics and tables were used for data analysis and the $\chi^2$ test was used to test the statistical significance of variations at the 0.05 level of probability.

## RESULTS AND DISCUSSION

### Socio-economic characterization of stakeholders

**Distribution by gender:** The distribution of forest resource users at the sites according to gender. It can be seen that the majority of the actors exploiting the forest resources were men (73%), representing, respectively 78.7, 77.2, 71 and 65% in the localities of Ndoukoula, Pétté, Maroua III and Méri as shown in Fig. 1. This can be explained by the fact that the man is the head of the family and therefore answers for all. In addition, the exploitation of timber in the localities is mainly entrusted to them. In Meri, the culture allows women to fetch firewood, unlike other women who have to stay at home and wait for their husbands, hence the slightly lower percentage compared to other localities. Men were involved in most activities that require strength and energy. The exploitation or search for forest resources is always done by men in different districts. According to customs and religions, the woman is supposed to do the housework. According to Ozer[15], the concentration of people of rural origin in the cities is impressive and creates an almost inescapable pressure around the urban poles. Tchobsala *et al.*[16] reported the same findings in Ngaoundéré in the exploitation of wood where men were actors. The analysis of variances shows a very significant difference ($72.75 \pm 6.02^a$, $28.5 \pm 5.32^b$, $0.00368<0.05$) between the two sexes. These results were close to those of GIZ[17] in the Far North of Cameroon where men are responsible for timber exploitation.

**Age distribution:** The operators were distributed according to age in Fig. 2. Individuals aged between 40 and 50 are more present in the whole study area and those between 70 and 80 are less represented. Individuals under 40 years of age are less present because they are mainly active in urban centers. In Pétté (48.4%) and Ndoukoula (45%), there is a high number of individuals between 40 and 50 years of age, this can be explained by the fact that these areas are far from the city and the dominant activities are agriculture and timber trade. These results were similar to those of Jonathan *et al.*[18] in the Ngaoundéré cliff forest landscape. Older people (70-80 years) are poorly represented due to the physical exhaustion they face. The exploitation of firewood is a profitable sector in the locality of Pétté and Ndoukoula, thus constituting a production basin for the urban centers. According to MINFOF,

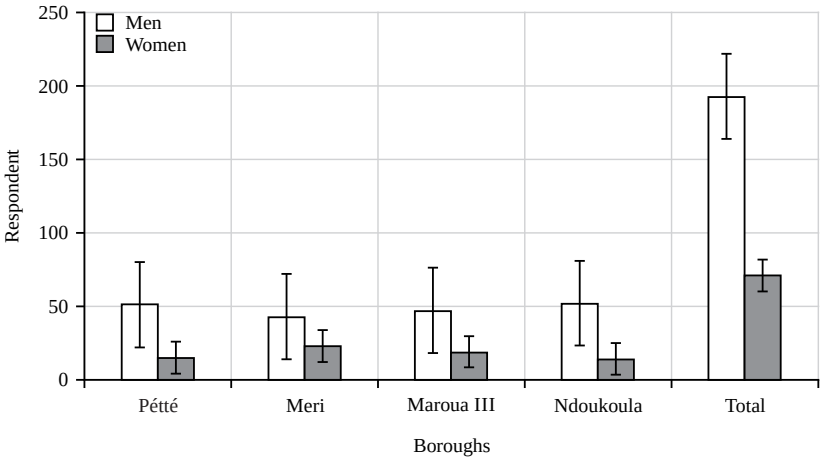


Fig. 1: Distribution of farmers by gender

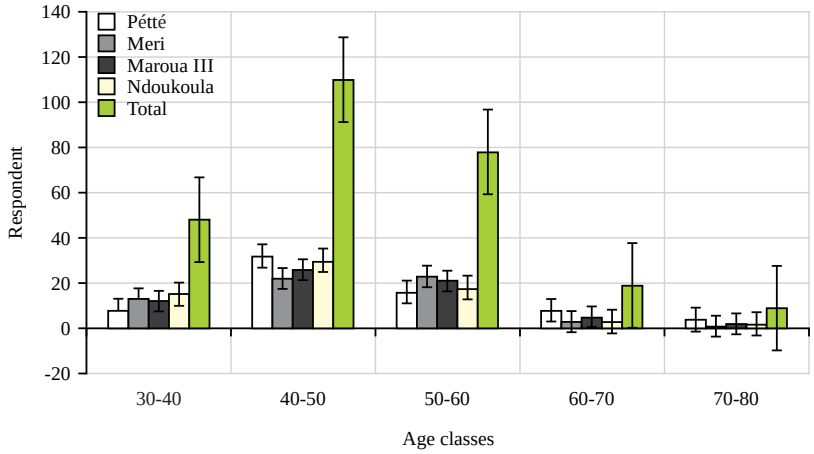


Fig. 2: Age distribution of farmers

Table 1: Distribution of operators according to activities (%)

| | District | | | | |
|---|---|---|---|---|---|
| Actors | Pétté | Ndoukoula | Maroua III | Meri | Mean |
| Farmers | 89.00 | 96.40 | 78.00 | 87.80 | 87.8±7.35[a] |
| Fishers | 10.20 | 0.70 | 0.00 | 0.00 | 2.72±4.99[b] |
| Hunters | 7.50 | 5.90 | 1.10 | 0.80 | 3.82±3.38[c] |
| Traders | 35.00 | 28.60 | 43.00 | 26.20 | 33.2±7.51[d] |
| Breeders | 82.50 | 70.80 | 62.50 | 32.50 | 62.07±21.35[e] |
| Artisans | 2.60 | 1.50 | 5.60 | 1.20 | 2.72±2.00[f] |
| Mean | 37.8±38.84[a] | 33.98±40.57[a] | 31.7±34.18[b] | 24.75±33.99[b] | 32.05±5.48 |

Means followed by the same letter are not statistically different at the 5% level

83% of Cameroon's population depends on woody biomass as an energy source and in rural areas, it is often the only available energy source, the potential wood energy supply for the region is estimated at 1.13 million cubic meters per year equivalent to 792,374 tons of wood. The flexibility and corruption of local administrative authorities encourage people to abuse the available plant resources[19]. The comparative analysis shows a highly significant difference ($p<0.01$) between age groups. The youngest are rarely interested in logging in our districts, they limit themselves to gathering or grazing their herds, hence their lower numbers. Kodji *et al.*[20] obtained different results in the Minawao locality where plant resource exploitation is practiced by younger individuals.

**Distribution according to the activity of the farmers:** The different activities practiced in the study area vary according to the individual. Table 1 showed that 87.8% of the actors exploiting natural resources are farmers and cultivate millet, maize, sorghum, beans, onions and some tubers, followed by livestock farmers (62.07%) and traders (33.2%). The main reason for these results was that the main source of income for many families is land cultivation, which is practiced throughout the year. In the off-season, Karal fields dominate the cultivation of crops, with some market gardening and vegetable gardening. Other activities such as hunting and fishing are not profitable in the four districts because of the lack of game and water for fishing. Trade is a substitute activity for agriculture for most of the local people, but given the economic situation and the lack of security, small local businesses prevail. Handicrafts are poorly practiced in the three districts of Pétté, Ndoukoula and Méri. This is due to the manufacturing techniques that are difficult to acquire and it is practiced from generation to generation in the families. They make shoes, traditional clothes, bracelets and many others. Current results differ from those of Ibrahim *et al.*[21], in a refugee camp in Eastern Niger where livestock farming provides most of the food they need to survive This discrepancy can be explained by the settlement conditions of this population. Trade in these areas is often associated with the sale of timber. The least represented were hunters (3.82%), artisans (2.72%) and fishermen (2.72%). The absence of certain activities in the locality, such as Meri and Maroua III, can be observed. This low representation was because these activities are less lucrative and are practiced seasonally. The analysis of variances shows a non-significant difference between

Table 2: Most popular woody species in the locality (%)

| Species | Part used | District | | | | Mean |
|---|---|---|---|---|---|---|
| | | Pétté | Ndoukoula | Maroua III | Meri | |
| *Balanites aegyptiaca* | Leave, wood, fruit | 100 | 100 | 100 | 85 | 96.25±7.5[a] |
| *Acacia nilotica* | Wood, fruit | 85 | 96 | 94.5 | 78 | 88.37±8.4[b] |
| *Tamarindus indica* | Wood, fruit | 100 | 98 | 100 | 86.7 | 96.12±6.48[a] |
| *Piliostigma thonningii* | Bark | 62.5 | 54 | 78.4 | 85 | 69.97±14.23[c] |
| *Celtis integrifolia* | Leave, wood | 95 | 15.2 | 5.2 | 1.4 | 29.20±44.25[d] |
| *Diospyros mespiliformis* | Wood, fruit | 52 | 9.00 | 37 | 75 | 43.25±27.7[e] |
| *Hyphaene thebaica* | Leave, wood | 85 | 28.3 | 10 | 5.5 | 32.20±36.55[f] |
| *Ziziphus mauritiana* | Leave, wood, fruit | 65 | 22 | 68.2 | 80 | 58.80±25.36[g] |
| *Azadirachta indica* | Wood, fruit | 95 | 70.6 | 95 | 100 | 82.65±17.4[h] |
| *Borassus aethiopium* | Fruit | 52 | 24 | 10.5 | 5.8 | 23.07±20.76[i] |
| *Adansonia digitata* | Leave, fruit | 32 | 35 | 9.5 | 1.5 | 19.50±16.53[j] |
| *Anogeissus leiocarpus* | Leave | 25 | 12.5 | 36 | 2 | 18.87±14.78[k] |
| *Acacia seyal* | Wood | 84 | 65 | 78 | 24 | 62.75±27.02[l] |
| *Ficus sycomorus* | Wood, fruit | 40 | 39 | 22.5 | 69.5 | 38.12±11.8[m] |
| *Vitex doniana* | Wood, fruit | 29 | 52 | 8.5 | 35 | 31.12±18[f] |
| Mean | | 67.95±27.54[a] | 47.98±32.4[b] | 50.22±38.3[c] | 48.62±36.52[b] | 53.69±9.55 |

Means followed by the same letter are not statistically different at the 5% level

activities and localities. These results were similar to those of Seignobos and Iyébi-Mandjek[12], who define agriculture and livestock as the main activities of the population. The increase in population leads to the extension of fields or the conquest of new land, which translates into the reduction of forest area[22].

## Use of plant resources by residents

**Woody species exploited:** The list of woody species exploited by residents were presented in Table 2. It emerges that *Balanites aegyptiaca* (96.25%), *Acacia nilotica* (88.37%), *Tamarindus indica* (96.12%), *Azadirachta indica* (82.6%), *Piliostigma thonningii* (69.9%), *Acacia seyal* (62. 75%) were the most used species followed by *Ziziphus mauritiana* (58.8%), *Diospyros mespiliformis* (43.25%), *Hyphaene thebaica* (32.2%), *Celtis integrifolia* (29.2%) in the area. These species were valued by the population either for their fruits, leaves, or wood. Households appreciate more the wood of *Balanites aegyptiaca* and *Acacia seyal* and the fruits of *Tamarindus indica* and *Azadirachta indica*. For the less valued woody species, the bark is used in the pharmacopeia. These results were similar to those of Baye-Niwah *et al*.[23] in the peripheral agrosystems of the city of Maroua where local species such as *Tamarindus indica*, *Balanites aegyptiaca*, *Ziziphus mauritiana* are valued for making pestles, mortars, dead hedges and leaves for animal feed. Overall, there is no significant difference in the use of woody species in the Diamaré district. The frequency of use of these species varies according to the importance that local people attach to their use; For example, *Celtis integrifolia* is used much more in the district of Pétté for its leaves with a frequency of 95%, *Diospyros mespiliformis* and *Ficus sycomorus* were valued in the district of Méri for their sweet fruits with frequencies of 75 and 69.5%, respectively, in the Ndoukoula sector, the species *Vitex doniana* is valued for its fruits and wood with a frequency of 52%. There were also species exploited but at low frequencies such as *Hyphaene thebaica*, *Piliostigma thonningii*, *Borassus aethiopium* and *Anogeissus leiocarpus*. For Froumsia *et al*.[24] this exploitation has an impact on economies and flourishing in the Sahelian Zone.

The parts valued from woody plants were similar in the four localities. Wood (73%) is the most valued, followed by fruit (66.7%) and leaves (40%). Wood is the main source of energy for households in rural and even urban areas and for others, it is a source of income to cover family needs.

**Woody species used as a food source:** Table 3 shows the list of woody species used as a food source in the Diamaré Department, with a total of 12 species providing most of the products for consumption by local people. The list varies according to the district. The most popular species were *Ziziphus mauritiana* (100%), *Tamarindus indica* (100%), *Balanites aegyptiaca* (100%), *Celtis integrifolia* (95.15%), followed by species such as *Diospyros mespiliformis* (92.87%), *Hyphaene thebaica* (86%) and *Ficus sycomorus* (80.5%). Some species such as *Borassus aethiopium* (52%) are much more consumed in the Districts of Pétté, *Ficus thonningii* (92%), *Sclerocarya birrea* (52.60%) and *Vitex doniana* (62%) in Méri and in Ndoukoula *Vitex doniana* (65.40%) is the most popular. Of the four districts, Méri consumes more NTFPs on average 76.17%. Kebyei *et al*.[25] reported similar results in the N'Djamena fuelwood supply basin in Chad citing *Ziziphus*

Table 3: List of species used in feeding (%)

| Species | District | | | | Mean |
|---|---|---|---|---|---|
| | Maroua III | Pétté | Meri | Ndoukoula | |
| *Balanites aegyptiaca* | 100 | 100 | 100 | 98 | 99.50±1[a] |
| *Borassus aethiopium* | 5.50 | 52 | 3.50 | 1.50 | 15.62±24.3[b] |
| *Celtis integrifolia* | 100 | 100 | 85 | 95.60 | 95.15±7.07[a] |
| *Diospyros mespiliformis* | 98 | 75 | 100 | 98.50 | 92.87±11.94[c] |
| *Ficus sycomorus* | 70 | 86 | 92 | 74 | 80.50± 10.24[d] |
| *Ficus thonningii* | 15 | 34 | 92 | 24.80 | 41.45±34.58[e] |
| *Hyphaene thebaica* | 86 | 100 | 82 | 76 | 86.00±10.19[f] |
| *Sclerocarya birrea* | 36.50 | 18 | 52.60 | 25.40 | 33.12±15.04[g] |
| *Tamarindus indica* | 100 | 100 | 100 | 100 | 100.00±0[a] |
| *Vitex doniana* | 34.80 | 42.50 | 62 | 65.40 | 51.17±14.86[h] |
| *Ximenia americana* | 12 | 85 | 45 | 64 | 51.50±30.98[h] |
| *Ziziphus mauritiana* | 100 | 100 | 100 | 100 | 100.00±0[a] |
| Mean | 63.15±39.29[a] | 74.37±29.93[b] | 76.17±29.99[b] | 68.6±34.19[a] | 70.57 ± 5.90 |

Means followed by the same letter are not statistically different at the 5% level

Table 4: List of species used in the pharmacopoeia (%)

| Species | District | | | | Mean |
|---|---|---|---|---|---|
| | Maroua III | Pétté | Meri | Ndoukoula | |
| *Acacia nilotica* | 68.50 | 49 | 65 | 25 | 51.82±19.82[a] |
| *Azadirachta indica* | 98 | 100 | 72 | 100 | 92.50±13.69[b] |
| *Faidherbia albida* | 44.50 | 55.20 | 65.50 | 70.50 | 58.92±11.53[c] |
| *Tamarindus indica* | 85 | 67.40 | 84.20 | 69.10 | 76.42±9.47[d] |
| *Ziziphus mauritiana* | 46.50 | 68.50 | 80.60 | 59.60 | 63.80±14.39[e] |
| Mean | 68.5±23.46[a] | 68.02±19.68[a] | 73.46±8.70[b] | 64.84±26.93[c] | 68.70±3.56 |

Means followed by the same letter are not statistically different at the 5% level

*mauritiana*, *Balanites aegyptiaca*, *Tamarindus indica* and *Diospyros mespiliformis* as the most used woody species in human food. These results can be explained by the fact that the majority of households in rural areas depend on NTFPs to meet their family needs due to poverty. The food species are mostly accessible to the population, with empirical knowledge, some families consume these forest resources as an alternative to the lack of nutrients or vitamins in the cultivated food. The fruits of *Sclerocarya birrea* and the leaves of *Ziziphus mauritiana* are also used in the domestic breeding of small ruminants. Current results were in agreement with those of Baye-Niwah *et al.*[23] in the peripheral agrosystems of the city of Maroua in Cameroon where several of the above species are used by the population. Similarly, Froumsia *et al.*[24] reported similar results in the Kalfou reserved in Cameroon. In sum, the value, significance and importance of the species used in consumption depends on the localities.

**Woody species used in the pharmacopeia:** In the different districts, several species were used for treatment. Table 4 shows the five species used in the traditional pharmacopoeia. *Azadirachta indica* (92.5%), *Tamarindus indica* (76.42%) and *Ziziphus mauritiana* (63.5%) are the most used to treat various light tropical diseases, followed by *Faidherbia albida* (58.92%) and *Acacia nilotica* (51.82%). Many people use *Azadirachta indica* to treat stomach aches, allergies, colic in infants and many other diseases. The district of Méri (73.46%) uses more woody plants in the pharmacopoeia followed by Maroua III (68.55%), Pétté (68.02%) and Ndoukoula (64.84%). The use of plants in health care has been inherited from their ancestors, given the costly modern medicine many people fall back on plants making some species vulnerable. Current results were close to those of Kebyei *et al.*[25], in the N'Djamena fuelwood supply basin in Chad who reported almost the same woody species in disease treatments. The importance given to species in the pharmacopeia comes from the initiation that is done at the grassroots level. It is difficult to know the therapeutic virtues of woody species because it is still held as a secret. The analysis of variance shows a non-significant difference ($p<0.05$) in the use of forest resources in the district to treat diseases. Some respondents find it difficult to confide in the virtues of these species but given its complementarity to modern medicine, this gives confidence in the use.

Table 5: List of species used as fuelwood (%)

| Species | District | | | | Mean |
|---|---|---|---|---|---|
| | Maroua III | Pétté | Meri | Ndoukoula | |
| *Acacia gerrardii* | 35 | 39.7 | 52.4 | 32 | 39.77±8.99[a] |
| *Acacia hockey* | 98 | 74 | 82 | 98 | 88.00±12[b] |
| *Acacia nilotica* | 100 | 94 | 65 | 70.2 | 82.30±17.28[c] |
| *Acacia senegal* | 2.9 | 5.8 | 75 | 45.8 | 32.37±34.50[d] |
| *Acacia seyal* | 100 | 96 | 100 | 97 | 98.25±2.06[e] |
| *Acacia sieberiana* | 37.2 | 52.4 | 54.8 | 46 | 47.60±7.86[f] |
| *Anogeissus leiocarpus* | 75.8 | 72 | 62.5 | 58 | 66.92±8.03[g] |
| *Azadirachta indica* | 69 | 64 | 36 | 47.9 | 54.22±15.12[h] |
| *Balanites aegyptiaca* | 100 | 100 | 76 | 98 | 93.50±11.70[i] |
| *Khaya senegalensis* | 2.8 | 3.6 | 2.4 | 1.4 | 2.55±0.91[j] |
| *Tamarindus indica* | 12 | 19 | 27 | 35 | 23.25±9.94[k] |
| *Terminalia glaucescens* | 0 | 12 | 1.2 | 4.1 | 4.32±5.39[l] |
| *Ziziphus mauritiana* | 18.6 | 46 | 67 | 84.7 | 54.07±28.45[h] |
| Mean | 50.1±41.42[a] | 52.19±34.62[a] | 53.94±29.85[a] | 56.00±34.50[b] | 53.05±2.51 |

Means followed by the same letter are not statistically different at the 5% level

Table 6: List of species used in handicrafts (%)

| Species | District | | | | Mean |
|---|---|---|---|---|---|
| | Maroua III | Pétté | Meri | Ndoukoula | |
| *Daniellia oliveri* | 14.60 | 32 | 42.50 | 12.40 | 25.37±14.39[a] |
| *Diospyros mespiliformis* | 75 | 66.40 | 79.80 | 59.80 | 70.25±8.90[b] |
| *Hyphaene thebaica* | 55 | 27 | 14 | 48 | 36.00±18.88[c] |
| *Piliostigma thonningii* | 79 | 64 | 75.40 | 82.70 | 75.27±8.08[d] |
| *Sterculia setigera* | 58.30 | 18.50 | 21.50 | 54.60 | 38.22±21.13[c] |
| *Tamarindus indica* | 98 | 76.40 | 63 | 70.40 | 76.29±15.06[d] |
| Mean | 63.31±28.47[a] | 47.38±24.35[b] | 49.36±27.80[b] | 54.65±24.04[c] | 53.67±7.11 |

Means followed by the same letter are not statistically different at the 5% level

**Woody species used as fuel wood:** The various woody species in Diamaré that are valued for their wood in the production of domestic energy were presented in Table 5, a total of 13 species were identified. *Acacia seyal* (98.25%), *Balanites aegyptiaca* (93.5%), *Acacia hockii* (88%) are the most used, followed by *Acacia nilotica* (82.3%) and *Anogeissus leiocarpus* (66.92%). The wood is used 50% on average in the whole study area. *Acacia nilotica*, *Anogeissus leiocarpus*, *Azadirachta indica* are more prized for their wood in Maroua III District with frequencies of 100, 75.8 and 69%, respectively, in Pétté *Terminalia glaucescens* is added to those mentioned above in the Méri district, the use of *Acacia senegal* as firewood with a high frequency makes the difference with the other districts, the frequency of use of *Ziziphus mauritiana* is very high in the Ndoukoula sector. The use of these different woody species reflects the anthropic pressure on these trees in the Diamaré Department. The use of fuelwood depends on the availability and dominance of these woody species in the locality. Current results were not far from those of Sani *et al.*[26] in the Mozogo-gokoro National Park of northern Cameroon where these species are cited among those used for energy production. The analysis of variance shows a significant difference between the uses of woody species in the four districts. Jonathan *et al.*[18] reported different findings to our results in the Ngaoundéré cliff forest landscapes where *Isoberlinia doka*, *Anogeissus leiocarpus* and *Daniellia oliveri* are presented as the plant species commonly used for fuel wood.

**Woody species used in handicrafts:** Handicrafts are a source of income for families, but they require appropriate knowledge and techniques. Table 6 shows the species used as raw material after the surveys. A total of five woody species constitute the raw material of artisans in the Diamaré department. *Tamarindus indica* (76.29%), *Piliostigma thonningii* (75.27%) and *Diospyros mespiliformis* (70.25%) are used in the manufacture of mortars, pestles, Koranic slate, etc., followed by *Sterculia setigera* (38.22%) and *Hyphaene thebaica* (36%), which were used to make traditional mats and brooms in Maroua III and Ndoukoula Districts. Maroua III (63.31%) uses more wood in handicrafts followed by Ndoukoula (54.65%), Pétté and Méri use less. These results can be explained by the fact that farmers in different districts can find easily accessible raw materials for manufacturing in the plant resource. The same observation was reported by Konsala *et al.*[27] in Mbam and Djerem in Cameroon where

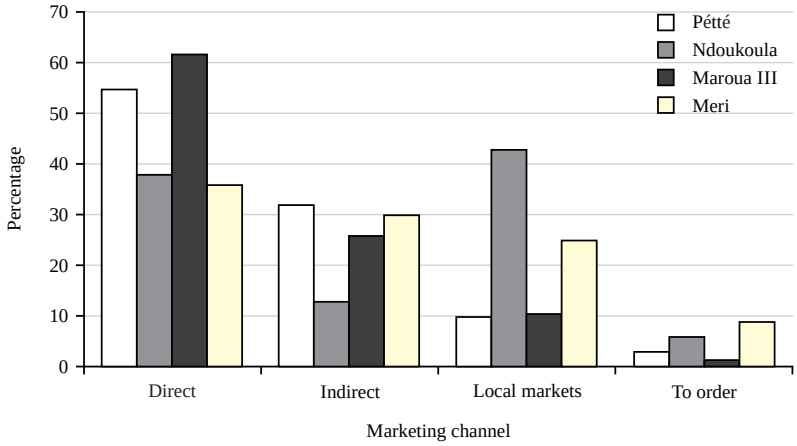


Fig. 3: Marketing channels in the study area

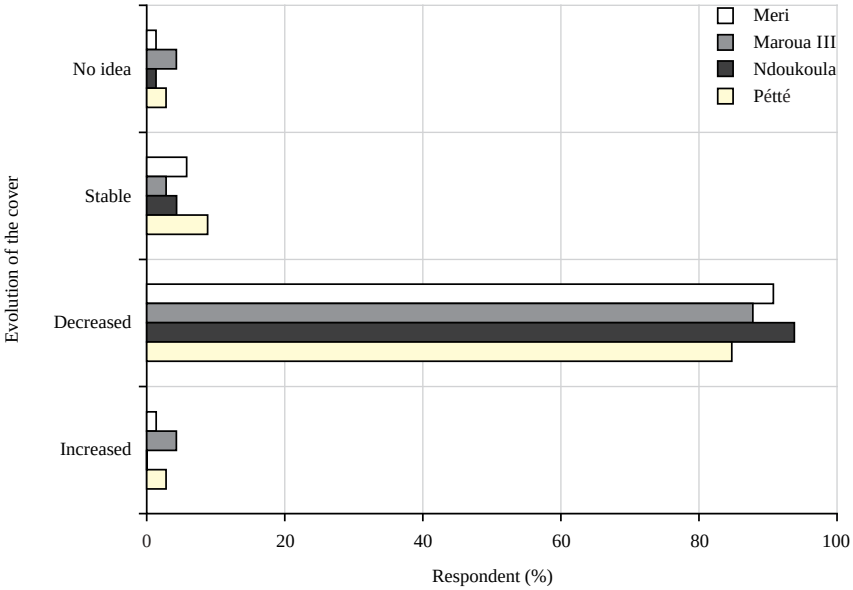


Fig. 4: Variation in vegetation cover

several woody species are used to make objects such as masks, mortars, statutes and many others. Baye-Niwah *et al.*[23] in the town of Maroua found similar results in the use of some of the species mentioned in handicrafts. Analysis of variance shows a significant difference ($p<0.05$) between the districts in the use of woody plants in handicrafts.

**Forest product marketing circuit:** Timber is marketed in all districts directly, i.e., from the collector to the consumer without intermediaries. Figure 3 shows the marketing circuit. It can be seen that operators in Pétté (55%), Maroua III (62%) and Méri (36%) sell their products directly to consumers, on the other hand, in Ndoukoula (48%) it is sold much more on local markets. The collectors are often people living on the outskirts of the urban centers, who come to deliver their wood directly using bicycles, motorbikes or even cars for the better off. Delivery can be made in markets or at home. For NTFPs (leaves or fruit), marketing is indirect, as the flow of these products is slower, collectors deliver to residents, who then resell to consumers.

**Farmers' perception of the dynamics of vegetation formations:** The perception of the extent of vegetation cover in the department was shown in Fig. 4. It shows that 89.3% on average consider that the area of natural formations has decreased, 5.7% think that it has remained stable, while a few

people (2.2%) see an increase. The increase in population is putting significant pressure on ecosystems. Overgrazing and certain agricultural practices are responsible for the degradation of savannahs and even forests. As far as woody species are concerned, the same observations were made in the four study sites. The decrease in plant formations observed by the majority of the population can be explained by the demographic boom that the department experienced following the insecurity observed in the border zone with Nigeria. The reduction in the majority of plant cover is accelerated by the anthropisation of the environment through the extension of fields and housing, plus an increased demand for firewood by households. The species that have increased according to the vulnerability index are *Balanites aegyptiaca*, *Azadirachta indica* and *Acacia seyal* on the other hand species such as *Celtis integrifolia*, *Ximenia americana*, *Vitellaria paradoxa* tend to decrease over time. The same observation was made by Hiernaux *et al.*[22] in the Burkinabe Sahel where the majority of surveys (81) mention a regressive trend in plant cover. This was in line with and confirms the statistical data from the mapping which shows a considerable reduction of natural formations in favor of anthropogenic formations. The Diamaré department is an ecologically fragile area, with increasing aridification of the environment and mortality of woody species leading to a decrease in biodiversity[28]. Natural formations (forest galleries, savannahs) are increasingly being replaced by housing and fields[29].

**Limitations and implication:** In the Sahelian Zone, particularly Diamaré, local people depend mainly on forest resources, so it was relatively difficult to obtain information on the use of woody species and their impact on the dynamics of the vegetation cover. The methodology based on surveys of local people was not easy because they considered us to be agents of the state. Some of the people we interviewed gave hasty answers to get rid of us. This delayed our work on the land and prevented us from developing normally.

## CONCLUSION

The people who exploit forest resources are mainly men in the four districts. These different species of woody plants are valued for their fruit, leaves, or wood. This phenomenon has led to a reduction in the vegetation cover in Diamaré. The residents draw most of their resources from the vegetation formations, this dependence should push the public authorities to set up rational and sustainable management systems to preserve the ecosystems.

## SIGNIFICANCE STATEMENT

The objective of this study was to contribute to the understanding of the use of woody species and the perception of the impact on the dynamics of woody formations. The socio-economic surveys showed that the actors exploiting the natural resources were mostly men and farmers. The most exploited woody species are *Balanites aegyptiaca*, *Acacia nilotica*, *Tamarindus indica*, *Azadirachta indica*, *Piliostigma thonningii* and *Acacia seyal* are the most used species. The perception of the impact on vegetation dynamics by the residents showed a decrease in the vegetation cover areas. As a bioclimatic regulating system, plant formations are subject to both demographic and climatic pressures, which can have a perceptible impact on the state of the plant cover. This study could guide decision-making for sustainable resource management.

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