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# ANTHROPOGENIC ACTIVITIES AND SUSTAINABILITY OF FOREST RESOURCES: CASE OF COMMUNITY FORESTS IN SIGLE/CENTRAL-WEST, BURKINA-FASO

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**Resumo**

*Atividades antropogênicas e sustentabilidade dos recursos florestais: caso das florestas comunitárias em Siglé/Centro-Oeste, Burkina Faso*. Os ecossistemas florestais de Burkina Faso estão sofrendo perturbações naturais e antropogênicas que ameaçam sua sustentabilidade. O presente estudo visa investigar prácticas humanas que representam uma ameaça à sustentabilidade das florestas comunitárias na comunidade de Siglé, na região Centro-Oeste de Burkina Faso. Para tal, foi recorrido ao método misto (qualitativo e quantitativo), que consistiu na implementação de questionários, entrevistas e lista de observações de campo. Com base nas análises dos dados recolhidos, foi possível destacar dez (10) práticas que ameaçam a sustentabilidade dos recursos florestais na região Centro-Oeste de Burkina Faso. Sendo que as que constituem maior ameaça, as florestas, são: i) coleta de frutas; ii) os incêndios florestais, a expansão da área de cultivo e o pastoreio, com pontuações variando entre 2,59 a 3,5 na escala de Likert. Essas atividades precisam ser regulamentadas pelas autoridades comunitárias para o desenvolvimento harmonioso dos espaços florestais no município.
*Palavras-chave* : Comunidades rurais, Degradação florestal, Vulnerabilidade dos ecossistemas e Pressão antrópica

**Abstract**

Forest ecosystems from Burkina Faso are suffering from natural and anthropogenic disturbances that threaten their sustainability. This study aims to investigate human practices that pose a threat to the sustainability of community forests in the community of Siglé, in the Centre-West region of Burkina Faso. A mixed method (quantitative and qualitative), that consisted to survey questionnaires, interviews and field observations was employed. Ten practices that threaten the sustainability of forest resources were observed. The practices that pose the greatest threat to the forests were: i) Harvesting of fruits; ii) forest fires, expansion of the cultivation area and grazing, with average scores ranging from 2.59 to 3.5 on the Likert scale. These activities need to be regulated by the community authorities for the harmonious development of forest spaces in the municipality.
*Keywords*: Rural communities, Forest degradation, Ecosystem vulnerability and Human pressure

## INTRODUCTION

The depletion of the natural resources through human pressures date from the anthropogenic era and tends even to exacerbate in now days (Green *et al.*, 2013). In Africa, natural resources, particularly forests, are undergoing significant degradation. These resources are impacted not only by climatic variations but also by anthropogenic practices that compromise their sustainability (Bele *et al.*, 2015). Such practices include industrial mining (Giljum *et al.*, 2022), extensive agriculture and other forms of subsistence farming (Fritz *et al.*, 2022; Curtis *et al.*, 2018), as well as the increase in urban population (DeFries *et al.*, 2010), selective logging, forest fires of anthropic origin, and grazing (Bustamante *et al.*, 2015). Giljum *et al.* (2022) revealed that industrial mining, through the expansion of extraction sites and residue storage facilities, has led to the loss of 213 km² and 99 km² of forest in Ghana and Côte d'Ivoire, respectively. Curtis *et al.* (2018) identify extensive agriculture as the main driver of deforestation in sub-Saharan Africa. Additionally, Bele *et al.* (2015) noted that inappropriate land use has resulted in increased deforestation, forest degradation, and biodiversity loss, thereby compromising the forests' ability to provide ecosystem services (Armenteras *et al.*, 2022).

The forest resources of Burkina Faso are not immune to these disturbances. They are just as threatened as those of other regions (TIAMIYU *et al.*, 2023). These threats are due to climate deterioration but also, and above all, the result of human actions. These actions include most of the oldest economic activities, such as agriculture, livestock, logging, among others. While clearing and abusive cutting are pointed as the main threats to the forest by certains authors, Mbayngone *et al.* (2008), observed that population growth, clearing land for shifting cultivation, grazing, forest fires, harvesting timber and non-timber forest products, and degradation of climatic conditions as various constraints threatening the sustainability of forest areas. Although the threat of human factors on the sustainability of forest ecosystems is generally recognized, it is essential to conduct in-depth

studies in specific areas to highlight the particular characteristics of these anthropogenic factors and to develop appropriate solutions to address them. Indeed, numerous scientific studies at various spatial scales have identified several human factors threatening the sustainability of forest resources (Fritz *et al.*, 2022). However, these factors diverge and are often contradictory, resulting in the inefficacy of the proposed solutions in practice (Bernhard *et al.*, 2024). This study is thus relevant. Its main objective is to propose conservation solutions that will contribute to the sustainability of forest resources in the rural commune of Siglé in central-western Burkina Faso. Specifically, it aims to identify and analyse human actions that compromise the sustainability of forest areas in the commune and propose solutions to mitigate the adverse consequences of these actions on the forest capital. Our main hypothesis is that residents living near the study forests conducts activities that can undermining the sustainable use of the of forest resources.

## MATERIALS AND METHODS

### Study Area

The Siglé village is within the Boulkiemdé province in the central-west region (Figure 1). It is located between 12°33'26" North latitude and 1°53'13" West longitude. The area is bordered by the urban commune of Boussé and the rural commune of Nanoro to the north; the urban commune of Boussé and the rural commune of Laye to the east; the rural commune of Sourougbila to the south; and the rural communes of Kindi and Pella to the west.

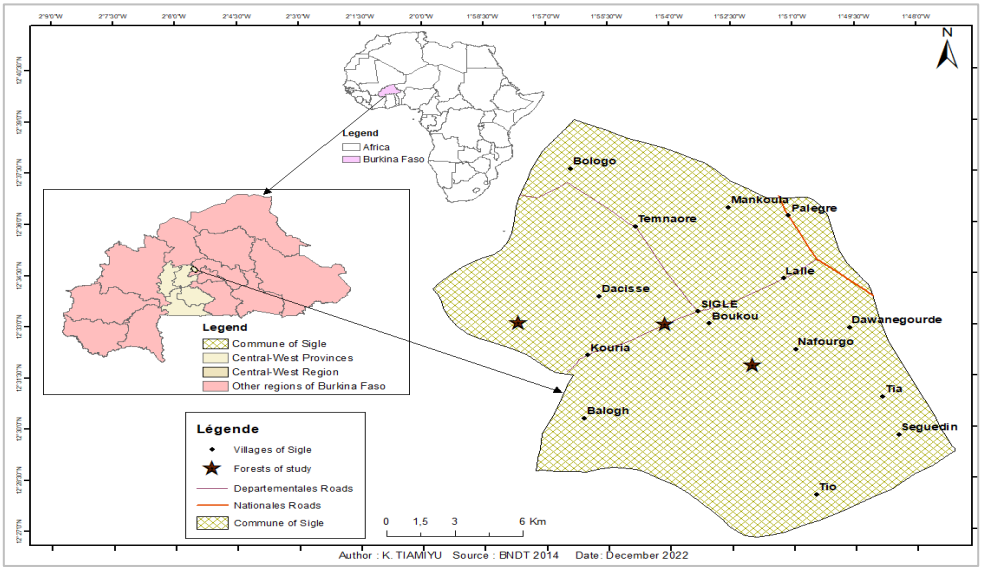


Figure 1 - Study area localisation
Figura 1 - Localização da área de estudo

The municipality experiences a semi-arid climate characterized by a relatively short rainy season from June to September and a long dry season from October to May (Yanogo *et al.*, 2023). The recorded amounts of water in the municipality over 2016 to 2020 range between 627 and 714.8 mm/year, with an average of 696.88 mm/year over these five years. The forest capital of the municipality consists of six forests created and managed by the municipality with financial support from National Land Management Program 1&2, of which three are selected for the present study: the Nafourgo, Dassissé, and Siglé forests.

Agriculture and livestock rearing are the two main activities in the area. These activities are characterized by an extensive production system, the use of rudimentary and low-yield tools, which struggle to feed the entire population of the municipality. Maize, millet, and cowpea are the main crops cultivated by the farmers, while livestock is predominantly composed of sheep and cattle (Communal Development Plan, 2019). Most of these productions were intended for self-consumption. In addition to these activities, the population engages in forest exploitation, which serves as a palliative strategy to address food insufficiency. This exploitation involves non-timber forest products such as fruits, leaves, and seeds (Yanogo *et al.*, 2023). Hence, the importance of this study.

### Data collection method

Both primary and secondary data were used in this study. Secondary data was gathered through literature review. This literature review primarily focused on scientific articles (Bernhard *et al.*, 2024; Fritz *et al.*, 2022; Mbayngone *et al.*, 2008; ...), doctoral theses (Jiagho, 2018), and to a lesser extent on grey literature (Commune of Siglé Development Program, 2019). It helped to establish the existing knowledge on the research

topic, to refine it and fine-tune the objectives. It also served to discuss the revealed results. Primary data was collected from a carefully selected sample through questionnaires, interview guides, and an observation checklist. The choice of households to be surveyed was based on a reasoned choice using three (03) defined criteria: being a resident near the community forests of Siglé, harvesting some provisioning ecosystem services in the community forests of Siglé, and live in the community for more than 19 years. Sampling size was determinate through the following formulas:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

where n = sampling size; N: total population size (560); e = margin of error (5%)

Thus, the population to be surveyed is:

$$n = \frac{560}{1+560(0,05)^2} = 233 \quad (2)$$

A total of 233 households were surveyed for this study using specially designed survey forms. The surveyed households were distributed among the communities where the survey conducted, which are listed in Table 1 below. The surveys were conducted in June 2020.

Table 1 - Total surveyed and sample effort Communities Adjacent to Community Forests
Tabela 1 - Total pesquisado e esforço amostral Comunidades adjacentes às florestas comunitárias

| Communities Adjacent to Community Forests | Population size | Surveyed Populations | Sampling effort (%) |
|---|---|---|---|
| Dassissé | 190 | 95 | 50 |
| Nafourgo | 46 | 38 | 82 |
| Siglé | 324 | 100 | 30 |
| Total | 560 | 233 | 41 |

Source: Field survey, June 2020, and author's calculations

This table reveals an overall sampling effort of 41%. However, this effort varies from one locality to another, with the highest recorded in Nafourgo (82%) and the lowest in Siglé (30%). This variation is explained by the availability and willingness of households to respond to the questionnaires developed for this study. The questions addressed the following points:

- Do you harvest products from the forest?
- How do you harvest them / what is your method of harvesting?
- What practices do you believe can threaten the forest?

These questions were crucial to identify anthropogenic practices that compromise forest resources. Additionally, respondents were asked about the degree of threat posed by these practices with the following question: what is, in your opinion, the degree of threat these practices pose to forest resources? They were asked to assign a score of 1 to 4 to different anthropic practices that could compromise the sustainability of the forest capital according to their degree of threat: 1 = not threatening; 2 = slightly threatening; 3 = threatening, and 4 = very threatening.

In addition to these surveys, interviews were conducted with 12 resource persons, including 3 forest management committee leaders from each locality, the Secretary General of the Siglé municipality, the head of the Siglé departmental water and forest service, and the only traditional healer in the area. Discussions with the forest management committee leaders and the head of the departmental water and forest service focused on the practices of local residents that threaten forest sustainability. The interview with the traditional healer aimed at identifying the products used in preparing medicinal recipes and their sources. The interview with the Secretary General of the municipality mainly covered the socio-demographic characteristics of the commune and provided access to the municipal development plan (PCD) report. These interviews aimed to be as exhaustive as possible in identifying practices threatening the sustainability of forest resources.

Direct observation was conducted simultaneously with the surveys by three teams, each consisting of two people. It involved observing the interactions of local residents with the forests. As a result, agricultural fields were observed near the forests of Nafourgo and Dassissé and within the Siglé forest. The surveys and interviews were conducted over a 29-day period in June 2020. The local language (Mooré), was the main language used for communication was the local language.

**Comparing anthropogenic actions that threaten the sustainability of forest across the studied forests**

The Kruskal-Wallis non-parametric test was applied to compare the various anthropogenic actions that threaten the sustainability of forest resources across the studied forests. The Kruskal-Wallis test is a non-parametric

statistical method that assesses differences between three or more independently sampled groups on a single continuous variable that is not normally distributed (Kruskal & Wallis, 1952). According to MacFarland (2016), this test is appropriate when there is a significant difference in the number of subjects for each comparative sample and when the data are ordinal and do not meet the precision requirements of interval data. The significance threshold is generally set at 0.05 (Datatab Team, 2024). If the significance level is greater than 0.05, the null hypothesis is accepted (the corresponding cell is highlighted in green); otherwise, the null hypothesis is rejected (the corresponding cell is highlighted in red). The test was conducted using SPSS software.

**Assessment of the vulnerability of the most exploited species**

The vulnerability of the five most utilized species was studied based on the work of AGBO *et al.*, 2017. According to their approach, vulnerability assessment takes into account two factors: Frequency of Use (FU) and Number of Use Categories (NU). It also incorporates parameters such as the plant organ used, collection method, stage of development, and species availability in the environment. However, in this study, due to insufficient information on species availability and stage of development, only the number of use categories, frequency of use, and organ harvesting method are used to estimate their vulnerability. The species in question are *Boscia angustifolia*, *Balanites aegyptiaca*, *Ximenia americana*, *Detarium microcarpum*, and *Saba senegalensis*. These species have been identified as the most exploited in the study area by the work of Tiamiyu, 2020.

Table 2 - Parameters for Assessing Vulnerability of Plant Species
Tabela 2 - Parâmetros para Avaliação da Vulnerabilidade de Espécies Vegetais

| Scales | Low (scale=1) | Medium (scale=2) | High (scale=3) |
|---|---|---|---|
| Frequency of Use (FU) | FU < 20% | 20% ≤ FU < 60% | FU ≥ 60% |
| Number of Use Categories (NU) | NU < 2 | 2 ≤ NU ≤ 4 | NU ≥ 5 |
| Used Plant Organs | Leaves, latex | Fruits, branches | Wood, roots, seeds, barks, flowers |
| Collection Method | Collection | -------- | Gathering, cutting |
| Development Stage | Old or senescent | Adult | Young |
| Availability in the Environment | Abundant | Less abundant | Rare |

Source : adapted from Agbo *et al.*, 2017, p.735. Note: FU = is the frequency of use while NU = Number of use

**Analysis of the village perception of the degree of threat posed by anthropogenic actions on the sustainability of forest resources**.

The analysis of the village perception of the degree of threat posed by anthropic actions on forest resources was carried out using the Likert scale. The Likert scale is a psychometric scale that allows measuring the perception of groups of people of a given phenomenon or fact (Sack, 2020). Several authors have used it in their studies. This scale is flexible and can be adapted to the context of the study for which it is used. For the present case, respondents were asked to assign a score of 1 to 4 to different anthropic practices that could compromise the sustainability of the forest capital according to their degree of threat: 1 = not threatening; 2 = slightly threatening; 3 = threatening, and 4 = very threatening. The average score of each activity was then calculated and interpreted according to the following range:

- Average score € [1 ;2] ≈ less significant threat/+
- Average score € [2.01 ;3] ≈ significant threat/++
- Average score € [3.01 ;4] ≈ highly significant threat/+++

This interpretation range was established based on the work of Anthony (2021) and adapted from Tiamiyu and Yanogo 2023. Three calculation steps were used to obtain the average scores:

- The product of the frequency of each response option by its corresponding score on the Likert scale:

$F \times S_c$ (3)$\sum F x s_c$= Total Score (4)

- The quotient of the total scores by the number of respondents:

$(\Sigma F \times s_c) \ / \ N$ = Average Score (5)

With F: frequency of citation; Sc: score on the Likert scale; N: number of respondents

## RESULTS

**The anthropogenic actions of local residents that could compromise the sustainability of forest resources.**

Table 3 presents the anthropogenic action that threatening the sustainability of the studied forests. Some of these actions are common to all three forests, while others are specific to one or another forest, as indicated in the table.

Table 3 - Directory of anthropogenic actions that can threaten forest sustainability
Tabela 3 - Diretório de ações antropogênicas que podem ameaçar a sustentabilidade florestal

| Hypotheses null | Signification |
|---|---|
| The distribution of "Agriculture expansion" is identical across the three forests. | 0.000*** |
| The distribution of "Forest fires" is identical across the three forests | 0.000*** |
| The distribution of "Proximity to fields and settlements" is identical across the three forests | $0.957^{NS}$ |
| The distribution of "Grazing" is identical across the three forests | 0.000*** |
| The distribution of "Harvesting of NTPs (fruits)" is identical across the three forests | $0.242^{NS}$ |
| The distribution of "Destructive harvest (cutting or pruning)" is identical across the three forests | $0.245^{NS}$ |
| The distribution of "Bark stripping" is identical across the three forests | $0.106^{NS}$ |
| The distribution of "Uprooting" is identical across the three forests | 0.004** |
| The distribution of "Destructive harvesting (Tree felling)" is identical across the three forests | 0.000*** |
| The distribution of "Gravel extraction" is identical across the three forests | 0.010* |

**Note:** NS, *, **, *** = non-significant, significant at 1%, 0.1% and 0% respectively

According to this table, four anthropogenic activities have an identical distribution across the three forests studied. This means that these activities are recognized by the residents of all three forests as threats to the sustainability of forest resources. These activities are: Proximity to fields and settlements, Harvesting of NTPs (fruits), Destructive harvest (cutting or pruning), and Bark stripping. The remaining six activities, however, do not have a uniform distribution across the three forests, indicating that they are identified as threats by the residents of one or two forests, but not by those of all three forests. These activities are: Agriculture expansion, Forest fires, Grazing, Uprooting, Destructive harvesting (Tree felling) and Gravel extraction The identified actions by the respondents do not have the same frequency of citation, as evidenced by the figure 2.

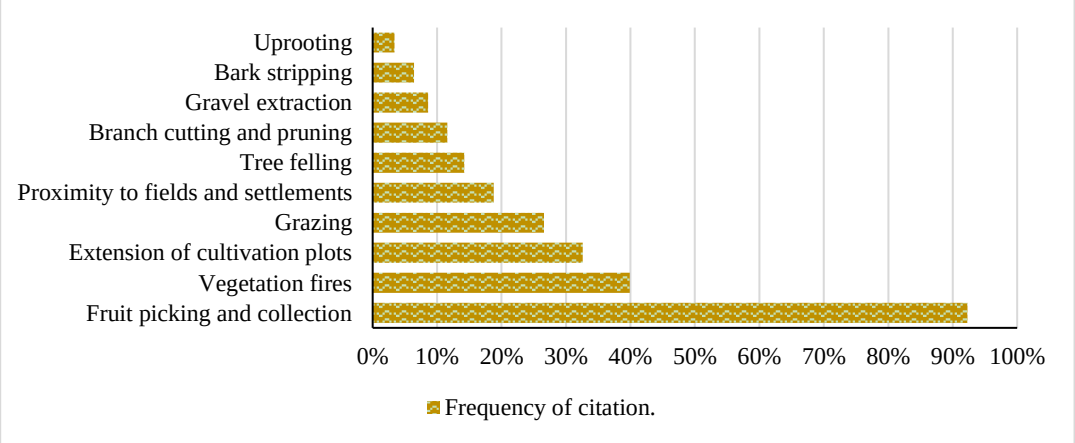


Figure 2 - Frequency of citation of anthropogenic actions threatening forest sustainability the anthropogenic action that threatening the sustainability of the studied forests
Figura 2 - Frequência de citação das ações antropogênicas que ameaçam a sustentabilidade florestal e das ações antropogênicas que ameaçam a sustentabilidade das florestas estudadas.
Source: Field data processing

Upon examining figure 2, fruit picking and collection, forest fires, and the extension of cultivation plots are, in descending order, the practices of local residents that pose a threat to the forests, with citation frequencies of 92.3%, 39.9%, and 32.6% respectively. On the other hand, uprooting, bark stripping, and gravel extraction are

the least emphasized practices by the residents of the studied forests. These practices have citation frequencies of 3.4%, 6.4%, and 8.6% respectively. Each of these practices influences forest resources differently.

**Agriculture expansion and vegetation fires as the main threat forest**

The study area is experiencing an expansion of cultivated plots. Forest areas are at risk of being encroached upon by agricultural fields to meet the additional food requirements resulting from population growth. Indeed, the number and area of fields near the study forests have increased from 2012 to 2020. The number has risen by 5 for the Siglé forest and by 2 for the Dassissé forest. As for the Nafourgo forest, the cultivated plot area has experienced a slight increase of 1.6 hectares according to the forest management committee leaders.

Another method of land preparation in the study area is the use of vegetation fires according to the interviewees. This practice poses a significant threat to woody plants. Vegetation fires were mentioned by 39.9% of the respondents as a threat to forest sustainability. This fact is indeed a reality in the study area.

**The proximity of agricultural fields and the "tranquility" of the forest canopy**

The pressure on NTFPs is exacerbated by the proximity of agricultural fields and human settlements (anthropized zones) to forests. Some parts of certain fields are even located inside the forests. This proximity of settlements and agricultural fields to forests does not bode well for the sustainability of these forests. Firstly, it can lead to significant pressure on the forests. In fact, due to the relatively short distance between the occupants of these settlements and the owners of the agricultural fields, the latter may prefer to go to the forest for any needs they have even if these needs can be met outside the forest. "As the Moaga proverb says, the goat grazes where it is tied." This proximity can also lead to the abusive use of forest products by the owners of these settlement units.

**Livestock, a hindrance to the harmonious growth of woody vegetation**

Livestock, through grazing and the wandering of animals, poses a threat to the vegetation cover of the forested areas in the study area. In fact, the herders frequently allow their animals to graze even within the forest. Once inside these forests, the animals trample on the regrowth, graze on the herbaceous plants, and browse on the vegetation. Our field observations have allowed us to witness animals roaming within the Nafourgo forest.

**Forest exploitation and forest sustainability**

**Collection and harvesting**

They are widely practiced for fruit harvesting. For certain species, collection is done as simply as possible as they are shrubs and herbaceous plants. This is the case with *Saba senegalensis* and *Ximenia americana*. However, for other species, it is necessary to wait for the fruits to fall to gather them (*Vitellaria paradoxa*) or climb the tree to pick the fruits (*Lannea microcarpa*). Besides these modes of collection, they are Girdling and branch removal, Bark removal**,** Uprooting and logging and the extraction of gravel**.**

**Vulnerability of the most exploited species**

The analysis of vulnerability assessment parameters for the most used species in the study area reveals that all five species have a moderate vulnerability for the parameters of FU and NU. The vulnerability becomes high for the parameters of organs used and collection method for all species except *Saba senegalensis*, which has a moderate vulnerability for the parameter of organs used. These results are documented in Table 4.

Table 4 - Vulnerability of species based on evaluated parameters
Tabela 4 - Vulnerabilidade das espécies com base nos parâmetros avaliados

| | *Boscia angustifolia* | *Balanites aegyptiaca* | *Ximenia americane* | *Detarium microcarpum* | *Saba senegalensis* |
|---|---|---|---|---|---|
| Average frequency of use (FU) | Moderate | Moderate | Moderate | Moderate | Moderate |
| Number of use categories (NU) | Moderate | Moderate | Moderate | Moderate | Moderate |
| Used organs | High | High | High | High | Moderate |
| Main collection method | High | High | High | High | High |

Source : Field data processing

**Village perception of the severity of local residents' actions on the sustainability of forest resources**

The perception of the residents of the studied forests regarding the degree of threat posed by the listed actions on the sustainability of forest resources varies. The table 5 illustrates the different anthropogenic actions and their level of threat to the sustainability of forest resources, evaluated on the Likert scale.

Table 5 - Degree of threat of anthropogenic actions on the sustainability of forest resources according to the village perception
Tabela 5 - Grau de ameaça das ações antropogênicas sobre a sustentabilidade dos recursos florestais de acordo com a percepção da aldeia.

| **Anthropogenic Actions** | Score 1 F | **FxSc1** | Score 2 F | **FxSc2** | Score 3 F | **FxSc3** | Score 4 F | **FxSc4** | Total score | Mean score | **Observation** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Extension of cultivation plots | 57 | **57** | 42 | **84** | 71 | **213** | 63 | **252** | 606 | **2.6** | ++ |
| Forest fires | 66 | **66** | 69 | **138** | 52 | **156** | 46 | **184** | 544 | **2.33** | ++ |
| Proximity to fields and settlements | 98 | **98** | 87 | **174** | 48 | **144** | 0 | 0 | 416 | **1.79** | + |
| Grazing | 75 | **75** | 23 | **46** | 56 | **168** | 79 | **316** | 605 | **2.59** | ++ |
| Fruit picking and collection | 182 | **182** | 37 | **74** | 13 | **39** | 1 | **4** | 299 | **1.28** | + |
| Branch cutting and pruning | 103 | **103** | 59 | **118** | 36 | **108** | 35 | **140** | 469 | **2.01** | ++ |
| Bark stripping | 83 | **83** | 20 | **40** | 93 | **279** | 39 | **156** | 558 | **2.39** | ++ |
| Uprooting | 3 | **3** | 14 | **28** | 82 | **246** | 134 | **536** | 813 | **3.49** | +++ |
| Tree felling | 6 | **6** | 17 | **34** | 88 | **264** | 122 | **488** | 792 | **3.40** | +++ |
| Gravel extraction | 37 | **37** | 109 | **218** | 87 | **261** | 0 | **0** | 516 | **2.21** | ++ |

Legend: += less significant; ++= significant; +++= highly significant.
Source: Field data processing

According to this table, two Uprooting and tree felling has very significant degree of threat; while extension of the cultivation plots, forest fires, grazing, branch cutting and pruning, bark stripping and gravel extraction, imposing a significant degree of threat, and the rest two practices (proximity to fields and settlements and fruit picking and collection) have a less significant degree of threat. The figure shows these actions according to their degree of threat.

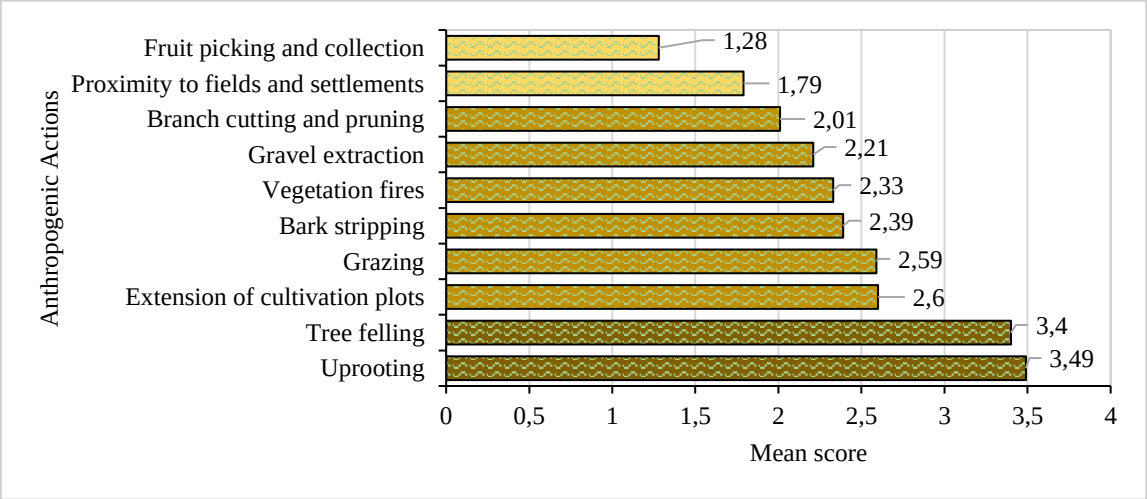


Figure 3 - Anthropogenic Actions by Degree of Threat
Figura 3 - Ações antropogênicas por grau de ameaça
Source: Field Data Analysis

## DISCUSSION

The conducted surveys have identified various human activities that have the potential to undermining the long-term viability of the studied area. Some of these practices, as listed, have previously been identified by Gnahoré et al (2021) as determinants of vegetation degradation in Banco National Park in Côte d'Ivoire. These include wood cutting, uprooting, bark stripping, vegetation fires, and unregulated settlements near the park. Nogueira *et al.* (2024) pointed out smallholder agriculture, clear-cutting charcoal, abandoned land and regrowth as the main forest change drivers in the Miombo landscape from Mozambique. The table 3 emphasizes a significant anthropogenic threat to CFS compared to the other two forests, as it is affected by all the revealed anthropogenic factors. This finding is supported by Tiamiyu *et al.* (2023). These authors have indeed demonstrated a regressive dynamics of vegetation cover in CFS, characterized by the appearance of degraded areas and bare soils within the forest's occupancy units.

According to Houghton *et al.* (1985), traditional agriculture has a negative impact on the forest ecosystem. It destroys and transforms vegetation cover and reduces wildlife potential. According to these authors, it remains the primary cause of deforestation. N'guessan *et al.* (2019) also highlighted the expansion of cultivated fields as one of the anthropogenic practices contributing to the destroy the vegetation cover in the Agbo1 classified forest in Benin.

Much more localized in the Sudanian phytogeographical domain, vegetation fires are a reality in Burkina Faso. Approximately 30 to 40% of the country's herbaceous cover area is burned annually (MBAYNGONE and al. 2008). Schneibel and al. (2017) revelled recurring fires as a main driver of forest degradation in dry forest in South-Central Angola This phenomenon negatively impacts productivity and disrupts the floristic composition of the forest canopy. Slash-and-burn practices disturb the biodiversity of forest ecosystems, alter the microclimate of the area, and expose the soil to various erosion agents. JIAGHO (2018) supports this idea and reveals that uncontrolled bushfires are one of the most threatening anthropogenic factors leading to the degradation of flora and woody vegetation in the peripheral zone of Waza National Park in Cameroon. However, farmers support the advantageous role of fire in the restoration of vegetation cover. For them, burning contributes to soil fertility through ash and promotes the development of new shoots (TIAMIYU, 2024). This position of the farmers is also supported by BALLE *et al.* (1998), who argue that early fires are a preventive tool that helps combat late fires and consider them a forest management tool. They emphasize, however, the need for management actors to understand the behavior of different species towards fire while considering management objectives for its effectiveness (TIAMIYU, 2024). According to OUATTARA *et al.* (2016), Ballouche (2005) supports that fire promotes the flourishing of herbaceous plants, particularly grasses, by creating a sufficiently aerated space for their development, allowing them to benefit adequately from sunlight. Therefore, the impact of vegetation fires on plant cover is not systematic but rather relative (TIAMIYU, 2024).

Livestock, through grazing and the wandering of animals, poses a threat to the vegetation cover of the forested areas in the study area. According to Okomo (2002) this threat is manifested through the modification of the floristic diversity of the area. This modification is characterized by a decrease in the number of palatable woody species and the emergence of woody species unsuitable for animal consumption. The trampling of animals prevents the germination or growth of small shoots and makes the soil rough or compacted. This significantly reduces the regeneration capacity of forest species. Okomo (2002) made the same observation. According to him, grazing, through trampling, renders the soil unsuitable for the development of vegetation cover.

Collection and harvesting are not insignificant for the exploited species. When these harvesting methods are systematic and repeatedly carried out, they compromise the regeneration of the species involved (Zima *et al.*, 2018). The realities of the study area are such that there is significant pressure on NTFPs (Non-Timber Forest Products). The study area is experiencing a strong population growth, with a density increasing from 57.68 inhabitants/km² in 2006 to approximately 97.68 inhabitants/km² in 2020 (PCD of Siglé, 2019). The local economic not favourable. Consequently, these populations rely on forest resources for their subsistence. YANOGO *et al.* (2023) have revealed that the households living near these forests exploit forest resources, consuming a portion and selling another. These authors explain that the consumed portion (mainly NTFPs) helps compensate for the nutrition deficiency in their diet. The monetized portion increases their source of income, thereby improving their living conditions. These findings reinforce the concern of a potential over exploitation of forest resources in the study area.

**Girdling and branch removal**

The impact of these methods depends on how the collector approaches them. Two scenarios can be observed in the study area. In the first scenario, collectors, using a "pole" or a "stick," selectively remove leaves and/or fruits (especially *Parkia biglobosa*). According to Leboulo (2012), this approach has a lesser impact on the plants involved. In the second scenario, branches are completely ripped off from the trees in the case of large trees, or the leafy stem is simply uprooted for shrubs (*Guiera senegalensis*). According to Leboulo (2012), this practice is very dangerous and detrimental to the survival of the exploited species. This is justified by the fact that the collector takes with them the organs that could facilitate the regeneration of the species.

**Bark removal**

*Detarium microcarpum, Ximenia americana, Boscia angustifolia*, and *Balanites aegyptiaca* are the most affected species by bark removal in the study area. This practice, also revealed by Rabiou *et al.* (2019) in the Diffa Region of Niger, threatens the survival of these stripped species. Regeneration becomes difficult due to rapid drying. This will result in significant mortality of these species and their gradual disappearance.

The severity of the impact of bark removal varies according to several factors. The technique and frequency of harvesting, the morphology of the stripped species, the specific organ that is stripped, and the quantity of bark removed determine the severity of the impact of this method. Some harvesters prefer bark from stems or plants to treat illnesses, while others prioritize bark from tree trunks for the preparation of medicinal recipes to treat less severe illnesses (as observed in the study area). If the bark is harvested from a portion of the stem (rather than the entire circumference), healing is still possible as the elaborated sap can still circulate through the unstripped parts. However, the possibility of healing is mainly dependent on the species' physiology and the timing of the operation. When bark removal is repeated multiple times on the same stem, healing can be difficult or even impossible.

Solefack & Kinjouo (2017) conducted an assessment of species recovery after bark removal in the Southwest region of Cameroon. They observed the enlargement of the wound after bark removal before regeneration began three

months later. And two years later, the observed plants survived the bark removal. The survival of the exploited plants is believed to be related to the physiological state of the species, which is inevitably linked to anatomy. Bark harvesting significantly reduces or slows down the stem's thickness growth to promote the renewal of the harvested bark surface. This allows for the resumption of sap circulation and the rapid restoration of the species' protective functions. According to Hahn-hadjali & Thiombiano (2000) cited by Agbo *et al.* (2017), intensive bark removal leads to a loss of vigor in plant species. Trees subjected to this harvesting method struggle to perform their physiological functions to the best of their abilities (Agbo *et al.*, 2017).

**Uprooting and logging**

In the study area, logging is a frequent practice in the three forests according to the respondents. Since none of the three forests have fences, accessing them becomes easy for anyone who wants to. Thus, 14% of the respondents mentioned abusive logging as a practice threatening the different forests. One of them pointed out that: "this forest is very useful to us. When I graze my herd and I get hungry, I go in to pick some wild fruits to relieve my hunger. And sometimes, I come across a few individuals cutting wood." When asked about his attitude towards this, he replayed: "So far, I have never told anyone about this because I do not want any trouble with anyone. I prefer to graze my herd peacefully." The cut wood is used for various purposes. Some use it for roofing constructions (especially granaries), others for commercial sheds, and others use it as a source of energy.

**The extraction of gravel**

We observed traces of gravel extraction in two forests (Siglé and Dassissé). These extractions are not harmless practices for these forests. Indeed, to extract these aggregates, the extractors dig into the forest soil, thus destroying a part of the vegetative cover. Additionally, the collection of these aggregates using vehicles such as tricycles and carts hampers the growth of seeds that are in the process of germination. This hinders forest regeneration.

## CONCLUSION

- The activities of the local communities in the forest areas of Siglé commune pose a threat to the sustainability of these spaces.
- While some of these activities, such as fruit picking and harvesting, have less impact on forest resources, others, such as tree felling, uprooting, and bark stripping, accelerate their degradation.
- Based on the findings of this study, several solutions can be implemented to minimize the adverse consequences. To this end, the communal authorities can, among other actions:
  - Delimit and mark buffer zones around the forests in collaboration with the population, within which agriculture and grazing are strictly prohibited;
  - Organize early fire campaigns in collaboration with the population to minimize the risk of large fires that could ravage the forest.
- Creating buffer zones around these forests could reduce encroachment.
- Regulating forest exploitation and providing training to local communities on sustainable techniques for harvesting forest products would help prevent their degradation and ensure their long-term viability.

All in all, the first specific objective, which aims to identify the anthropogenic actions compromising the sustainability of the studied forests, has been achieved. The identification of these actions has made it possible to propose some potential solutions to improve the sustainability of these forest areas. Additionally, the second specific objective has also been achieved.

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