

Research Article

Footprints of Edge Communities' Exploitation of a Plant Species (*Guiboutia Copallifera*) Within Its Distributional Range in Sierra Leone

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Abstract

This study investigates the impact of human activity on the diversity, abundance, and species composition of trees in southwestern Sierra Leone's Kasewe Forest Reserve. The specific objectives are to assess the historical use of *Guiboutia copallifera* in relation to the reserve and examine community relations with this species. Primary data were collected through a floristic inventory and key informant interviews, focusing on the use of forest land and floral resources. A total of 1,294 living specimens from 74 tree species and 12 lianas, belonging to 61 genera in 27 families, were recorded in the study. The most dominant species were *Guiboutia copallifera*, followed by *Nesogordonia papaverifera*, *Memecylon normandii*, and *Gmelina arborea*. Other species recorded at lower levels include *Homalium africanum*, *Lindackeria dentata*, *Pentadesma butyracea*, and *Santiria trimera*. Additionally, 675 stumps from 42 genera in 29 families were identified, with 88 trees showing harvesting marks. The study also recorded 147 old charcoal pits and 76 new charcoal pits. In the Kasewe Forest Reserve, 13 patches of *Gmelina arborea* plantations, along with 26 old and 11 new farms, were recorded. The study revealed that rapid anthropogenic activities and poor forest management have led to a decline in tree diversity. Edge communities remain crucial for the reserve's health, management, and future. Traditions, culture, and customs play a key role in the reserve's services and products, but the full historical use of the area is poorly documented. These findings highlight the urgent need for effective forest development and a recovery plan for degraded areas.

Keywords

Land-use History, Anthropogenic Disturbance, Plant-use History, *Guiboutia Copallifera*, Forest Degradation, Species Diversity, Charcoal Production

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1. Introduction

Rapid population growth in Africa became prominent in the 20th century, with Africa's population increasing 3.7 times by 2000, compared to 2.5 times globally [1]. The share of Africans in the world population has continued to rise in the 20th and 21st centuries [1]. Forest history studies typically rely on historical data, focusing mainly on recent centuries, which limits their coverage of the most recent human history [2].

Past utilization of forest resources is crucial for understanding forest history and predicting the future. Combining archaeological and palynological data can enhance knowledge of demographic changes, settlement dynamics, and vegetation history, offering a broader perspective for future forest studies. There is growing demand from researchers and decision-makers for the integration of Traditional Ecological Knowledge (TEK) with traditional conservation practices [3, 4]. Customs and rituals, central to indigenous African communities, are key social behaviors performed by individuals or specialists [5]. For example, the Makhadzi of the Tshidzivhe clan conduct annual winter rituals to pray for rain, peace, and to thank ancestors for a good harvest, involving the dispersal of traditional beer and tobacco in the forest. Similar practices have been observed in Zimbabwe [6] and Ghana [3].

In Zimbabwe, breaking taboos can result in death or disaster affecting an entire village [6], while in Ghana, ancestors may impose punishments like illness, including fever, abdominal pain, limb swelling, diarrhea, fractures, and accidents [7]. Other punishments for violating taboos include infertility for women or being struck by an invisible snake [3].

Indigenous knowledge (IK) is primarily held by impoverished, informally educated populations facing significant environmental changes. Despite this, IK provides functionality and adaptability for these communities [8]. The Yao people, for example, observe bird behavior, plant blooming, and patterns in the sky to understand their environment [8]. Local knowledge helps communities adapt to environmental changes, with forest products used for food, medicine, and fuel in the past, and natural ecosystems harvested to improve living standards today [9, 8].

In Sierra Leone, rural communities rely on forests, wetlands, farmland, and communal lands for various biological resources, including wood, firewood, food plants, wild vegetables, spices, fruits, forage plants, and materials for construction and crop improvement [1].

Humans rely on plant and animal-derived medicines for health, highlighting the need to protect forest diversity. Reviewing species diversity, composition, abundance, and historical use is essential for effective forest management and species assessment, helping identify ecologically beneficial forests [10]. A greater variety of tree species increases ecological niches and associated species [11]. Therefore, information on tree species composition, density, and species-rich communities is crucial when planning biodiversity protection [12].

Knowledge of biological resource use persists among the poor in rural areas near forests and wetlands, but it remains poorly assessed and documented. Research on the forest reserve has focused primarily on diversity, volume, and DBH, with limited study of species like *G. copallifera* and its composition. Systematic comparative data on the prevalence and economic impact of tree species in Sierra Leone's forests are scarce, and written evidence, including travelers' accounts and government documents, is minimal. National historical resources like the National Archives and Sierra Leone Museum lack evidence on the use of this species as a foreign exchange earner in the colonial era and this forest reserve.

The history of gum copal harvesting from *G. copallifera* in the Kasewe Forest Reserve is not documented in existing archives. A search for historical records in regional, district, and community archives yielded no results. Due to this lack of written evidence, the study relies on field data to explore past utilization of the site and species. The study aims to: 1) evaluate the historical utilization of *G. copallifera* in relation to the Kasewe Forest Reserve, and 2) assess community relations with the species within the reserve.

2. Materials and Methods

2.1. Study Area

The study was conducted in and around the Kasewe Forest Reserve. The reserve is located on the border between Tonkolili and Moyamba District in the south-central portion of Sierra Leone approximately 170km east of Freetown, and adjacent to the Bo-Freetown highway. This lowland forest gives way to medium-altitude forest on the slope and peaks of the Kasewe hill ridges (altitude range approximately 100 to 500m). Kasewe Forest Reserve (centered on 8°18'53"N 12°15'43"W) is approximately 2,331 ha in size [6]. The dominant vegetation is tropical forest but the Reserve contains a mosaic of moist semi-deciduous forest, evergreen forests and savanna [6]. The hills are made up of a volcanic intrusion standing up to about 500m above the surrounding plains and serve as an important water catchment area for all communities around the reserve [7, 8].

2.2. Methods

Communities boarding the forest reserve were visited and consultation with authorities were held. The purpose of the visit was fully explained to the community leaders and authorities. The purpose was to collect information on the utilization pattern of the forest reserve and *G. copallifera* species in their communities before the forest patch was declared as a government reserve. I enquired to know whether there are still individuals in these communities that are still alive who worked (as labours or harvesters) in the forest during the peri-

od when this species was harvested for gum copal.

The method used for data collection was based on semi-structured interviews and field visits. Interviews were conducted after obtaining informed consent (IC) from the interviewees. In many cases, a variety of techniques were used for selecting informants with traditional knowledge regarding the use of this species during the period when it was been harvested for gum [13].

The full names and residential addresses of former harvesters or family members of workers residing in these communities were exhaustively identified and registered with the help of local administrators, local people, translators and field assistants. Individuals who were indicated to know and witness the practice of harvesting this species were considered as informants for this study. A total of six (6) individuals were identified. Semi-structured interviews were then employed and field observations made to collect historical and practical data with the help of local language translators and field assistants.

In the ecological assessment past and current use pattern of the forest and the species of interest were recorded. All farming sites were recorded and divided in to old and new farms. New farms are those currently under cultivation while old farms are those that have been harvested while the study was been conducted. Assessment of existing plantations within the forest reserve were also conducted noting the number of plantations patches and the species composition of each plantation. Charcoal processing sites within the reserve were assessed, each identified sites were categorised into old or new charcoal processing site. In the new sites, if logs have not been set on fire, the logs can be identified to species level, while photo of log can be used for later identification if it is not possible in the field [14].

2.3. Vegetation Sampling and Measurement

In terms of stumps and gum copal harvesting marks on existing trees, four representative sampling sites were selected based on

land use pattern (Farming, charcoal burning, gardening and logging). These sites were chosen because they are relatively representing the various human activities ongoing in the reserve and the better protected aspect of the reserve. Rectangular plots were chosen as they tend to include more of the within-plot heterogeneity, and thus be more representative than square or circular plots of the same area. For intensive data collection of plant species assemblages and harvesting remains located in an ecotone of disturbance across the forest, four sites were identified as representatives. Sites 1 and 2 were degraded area of the reserve where human activities are highly evident. Intensive logging was followed by charcoal burning and then farming. Tree stumps are still evident as are charcoal pits, farms and vegetable gardens; there are small plantations of *Gmelina arborea*. Sites 3 and 4 are located in the well-preserved sections of the reserve where human presence and activities are lower. Canopy cover is very good with intermittent openings due to natural disturbances [15].

At each site, two hectares plot (100m x 100m) were laid at 400 m apart and subdivided into ten (10) subplots each measuring 50m x 20m. A total of 80 sampling subplots (50 m x 20 m) were systematically established for the enumeration of trees and stumps. Trees ≥ 10 cm DBH were enumerated in each subplot. These were inspected for presence or absence of harvesting marks. The presence/absence, coverage, density, abundance of *G. copallifera* trees with harvesting marks was estimated in each plot and sub-plot [16]. Existence of stumps within these subplots were inventoried and identification to species level was attempted [17]. Plant specimens, leaves, flowers, fruits and tree barks were collected in triplicate during sampling. Plants are carefully arranged as they are placed in the press to maximize preservation of diagnostic features. Leaves, flowers, and fruits are spread out so that they do not overlap and can be observed from different perspectives. The confirmation of identified plant species was done by plant experts at the Njala Herbarium (Sierra Leone National Herbarium) lodged at the Department of Biological Sciences, Njala University.

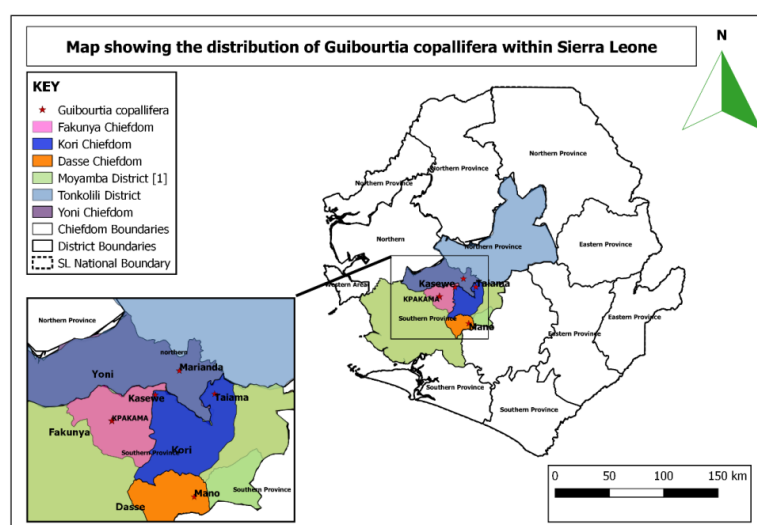


Figure 1. Map showing study Area.

2.4. Data Analysis

Majority of the analyses on this data were done in R version 3.6.2 (R Core 2020). The plot level data involving the average value of trees, stumps density, charcoal pit and farming site were calculated by averaging or totaling the individuals in the plot. The frequencies of tree size (DBH), stump, plantation plots and farming sites are presented in histograms with median values for the four sites. The harvesting marks for *G. copallifera* was analyzed using a graphical representation of living trees with or out marks and tree frequencies in histograms. The average values of harvesting marks, charcoal pits, plantation plots, tree numbers, and farming plots were compared for the site.

3. Results

Knowledge of Harvesting of Gum Copal

There are no written records of harvesting or sales of gum copal. But there are few old people in and around Moyamba Junction who took part, as children or young men (family labour), in gum copal harvesting. All the six informants were men, the youngest being in their 60's (Table 1). Only one of the informants went to primary school and all of them are farmers.

Table 1. Characteristics of the Former Gum Copal Harvesters.

Categories	Variables	Number of Informant	Percentage of Informant (%)
Sex	Male	6	100
	Female	0	0
Religion	Traditionalist	0	0
	Christians	2	33.33
	Muslim	4	66.67
Formal Education	Primary	1	16.67
	Secondary	0	0
	None	5	83.33
Age-Groups	60–69	2	33.33
	70– above	4	66.67

Harvesting Permit/Permission

In the past, harvesters of gum needed permission from local chiefs or landholding families before entering the forest, particularly in Moyambawo. The Department of Forestry was not involved in the gum harvesting since the forest was not yet declared a reserve. Harvesting rights were granted for

a year, with permits renewed before each dry season. Money was collected before allocating harvesting sites, and the community chiefs and elders controlled the proceeds. These were then distributed to landholding families based on their land share. The gum trade attracted people from across the country, as long as traditional obligations were met.

Traditional Ceremony

Gum harvesting is preceded by traditional ceremonies organized by community leaders, where harvesters and community members gather to honor their gods, spirits, and ancestors with kola nuts, wine, and food. Participation in the ceremony is mandatory for all those granted harvesting permission. During the ceremony, the elders, guided by their gods, set the official start date for the harvesting season.

Allocation of Tapping / Harvesting Site

Each harvester is allocated a specific portion of the forest, for which the specific size cannot be determined by the informants. Areas within the forest are allocated partly based on the amount of money paid to the authorities. Some harvesters would hold several patches paying for each patch separately. This right to harvest had to be renewed each year.

Status and Numbers of the Plant Species Harvested for Gum Copal

G. copallifera, the species harvested for gum copal, was not cultivated in Kasewe Forest Reserve, though small experimental plantings occurred in Tiama, Moyamba, and Kenema, most of which were cleared. Degraded areas in Kasewe were previously planted with *Gmelina arborea* and some timber species like Terminalia and Teak. Kasewe is the only known location in Sierra Leone where *G. copallifera* was harvested for gum copal.

Method of Harvesting Gum copal

Harvesting gum involves the climbing of the trees above 30 cm DBH using a similar technique to that used in climbing oil palms tree as such tapping stops at the first major branch. Once the tapper reaches this point a hoe like instrument (an adze) called a “hisstle” is used to slash or cut around the trunk in a circular manner from top to bottom (Several cuts are made on the trunk). The climber descends the tree as he cuts the bark in the circular manner. While this is happening the area around the base of the tree is carefully cleared of leaves and debris so that the gum that comes out the tree can be easily collected later. Several trees can be processed in a single day. After tapping or slashing the bark, the trees are allowed to rest for about three weeks to allow the gum to dry on the trees before harvesting will start. At the end of the three weeks, harvesting resumes by climbing the tree and dislodging the solidified gum.

Participation of Women and Children in the Process

Women and children played a key role in the harvesting process. They were responsible for the gathering and collection of the solidified gum from underneath the trees while the climber is harvesting. Moreover, the transportation of the gum from the forest to the communities was their collective

responsible. They also had to clean and polish the gum as the price is a function of colour and cleanliness of the gum.

Season and Incidents Associated with Harvesting Process

Harvesting of the gum only occurs during the dry season due to the fact that the trees are very slippery during the raining season for the individuals climbing the trees. Secondly, the gum can easily be washed away by rain water from the bark of the tree before it solidifies. Gum copal harvesting from the trees is also a very risky job. This process was fraught with lots of accidents due to individual climbers falling off trees. Several incidents of broken arms and legs and even deaths were reported by the informants.

Primary Processing

Women and children were responsible for cleaning and grading of the gum. Gum was sorted into “whole tears” and

smaller pieces, then the gum was separated by colour (lighter colour is more desirable) and then any pieces of bark and other foreign materials were removed with spoons or sharp knife.

Marketing of the Gum

The cleaned and polished gum were either sold to middle man who visited the villages in search of gum copal or taken to Yonibana, which used to be a business centre and train depot until 1972. Highly polished gums fetched more money than the crude types. Measurements, size and cost could not now be ascertained (none of informants were involved in the actual sales). The fact that some informants in their 60's still remember something about the trade suggests that it is persisted in some form despite the ban.

4. Ecological Data

Sampling sites

Table 2. Conditions prevailing at each site.

Conditions	Site 1	Site 2	Site 3	Site 4
Canopy cover	Opened and scattered	Opened and scattered	Closed	Closed
Ground cover	Farm plants	Farm plants	Lot of leaf litters	Lot of leaf litters
Bare ground	70 %	65%	Herbs and leaf litters	Herbs and leaf litters
Human interference	80%	85%	>5%	>5%
Logging	Ongoing	Ongoing	Selective (in the past)	Selective (in the past)
Fire incident	Regular	Regular	Seldom	Seldom
Stumps density	High	High	Very low	Very low

Site 1: Is a degraded area of the reserve where human activities are highly evident. Intensive logging was followed by charcoal burning and then farming. Tree stumps are still evident as are charcoal pits, farms and vegetable gardens; there are small plantations of *Gmelina arborea* (an introduced species that coppices vigorously and is sometime invasive). Fire has been repeatedly used as a management tool and the vegetation cover is limited to individual trees, scattered thickets and grasses. Canopy cover is opened and scattered; ground cover is dominated by farm plants. Bare ground is about 70 % while human interference almost 80%. The case of logging is ongoing and fire incident is a regular occurrence in this reserve with stumps density very high (Table 2).

Site 2: Is a degraded area, where logging, charcoal burning, hunting, pole harvesting and farming activities are present. Vegetation cover is similar but denser than site 1. Canopy cover is opened and scattered; ground cover is dominated by farm plants. Bare ground is about 65 % while human inter-

ference almost 85%. The case of logging is ongoing and fire incident is a regular occurrence in this reserve with stumps density very high (Table 2).

Sites 3 and 4: Are located in the well-preserved sections of the reserve where human presence and activities are lower. Canopy cover is very good with intermittent openings due to natural disturbances. In these sites, stumps of large trees were observed and demonstrate selective logging in the past. Canopy cover is closed, ground cover is dominated by leaf litters. Bare ground is covered with herbs and leaf litter, while human interference is less than 5%. The case of logging was selectively done in the past which has been stop for ages and fire incident is seldom in this patch with stumps density been very low (Table 2).

Stump Density of Plants Within the Sites

Kasewe Forest is a gazette forest reserve and was established before Independence, but unfortunately there is no comprehensive and detailed document on the reserve like

many forests in the country. In order to get a rough picture of it past, physical remains were examined in the forest and local people were interviewed.

On the four experimental sites, site 2 recorded nearly two

thirds of all the stumps (66.96%), (Figure 2). Other evidences of disturbance are; farming, stacks of boards by the track sides, bundles of bush-poles, bags of charcoal and so on.

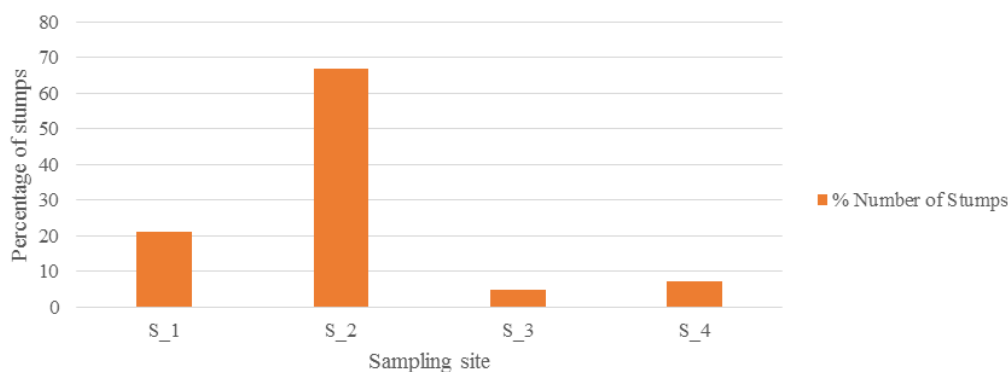


Figure 2. Percentage of Stumps Per Site.

A total of 675 stumps were recorded within the sites belonging representing 42 genera in 29 families. Nearly one-third (30.5%) of the identified stumps belong to *Guiboutia copallifera*, followed by *Nesogordonia papaverifera* (24.1%) (Figure 3). The first four frequently (most) exploited plant species accounted for over 72% of species harvested in the past within the reserve. *Guiboutia copallifera*, *Nesogordonia papaverifera*, *Trema orientale*, *Memecylon normandii*, *G. copallifera* and *N. papaverifera* are vulnerable while *T.*

orientale and *M. normandii* are listed as Least concern in the IUCN redlist category. The other frequently harvested species are; *Gmelina arborea*, *Anisophyllea laurina*, *Margaritaria discoideus*, *Diospyros heudelotii*, *Mammea africana* and *Oxyanthus racemosus* (Figure 3). *Guiboutia copallifera* is the preferred target species by charcoal burners as it produces “iron coal” that is durable, long-lasting and hard which last longer in stoves and has less wastage in transport even with rough handling.

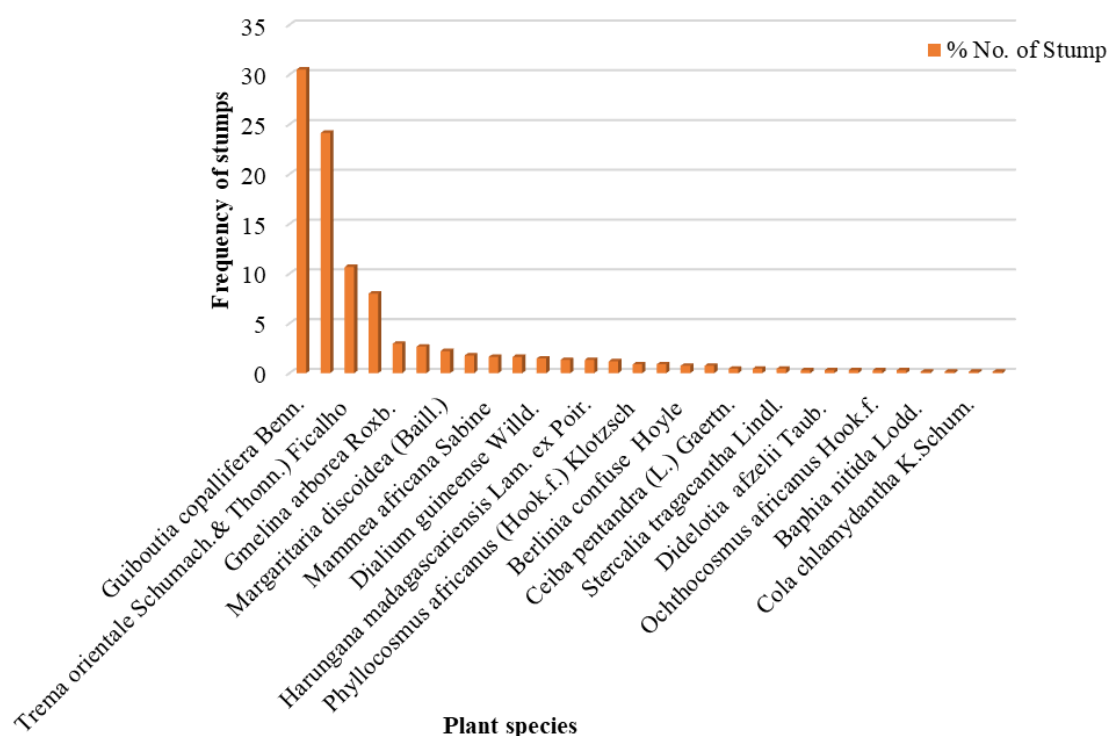


Figure 3. Identification of Stumps to Tree Species.

Harvesting Marks on *G. copallifera* Trees in the Forest Reserve

Harvesting of *G. copallifera* for copal gum leaves marks on the bark of the tree, these can persist for many years as scars. Harvesting of the gum copal from the trees was done through slashing the bark of the trees so that the sap from the tree can solidifies as time progress. The scars do not resemble those on rubber trees, but instead look like knife marks on the barks. There are still a good number of living *G. copallifera* trees on

sites 3 and 4 (228 and 208) and far fewer on plots 1 and 2 (89 and 78) (Figure 4). Harvesting marks were observed on 36 trees on site 3 (15.8 %) and 25 (12.9 %) on site 4, with 15 and 12 trees in sites 1 and 2 (16.9% and 15.4%) (Figure 4). The absence of harvesting marks in majority of this tree species in the sites lends credence to the fact that harvesting in this forest has not been practiced over a long period of time and only the largest trees bear scars.

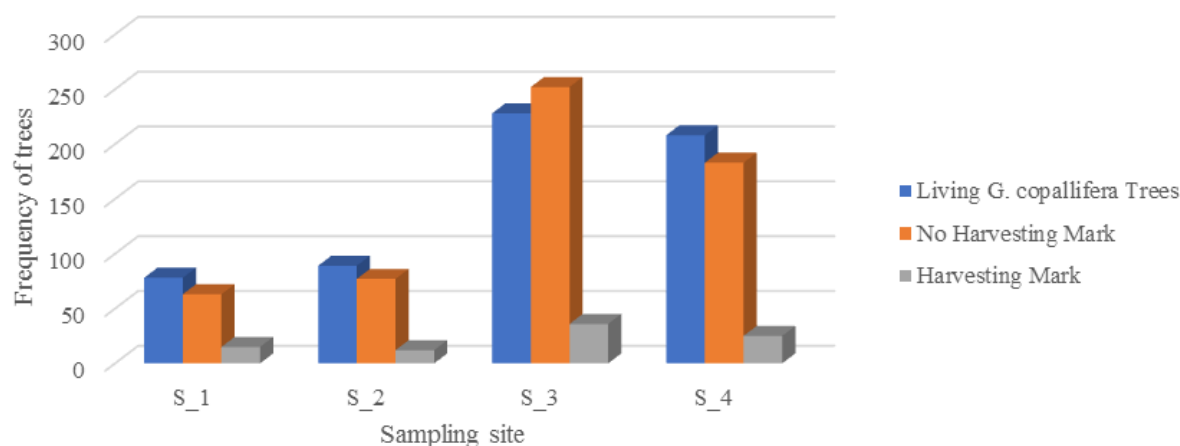


Figure 4. Trees with Harvesting Marks.

Existence of Charcoal Pits in the Sites

Kasewe forest reserve has become a major supply point for Freetown charcoal markets and trade in charcoal is one of the most viable livelihood activities for edge communities. This is especially true of the youth and “strangers” who have difficulty in accessing good quality farm land, but it has led to massive land clearing. There are no attempts by the burners to replant or encourage new growth in any way. Old pits are

distinctive and easy to observe, new coal burning pits are very common. Site 1 had the highest numbers (75) of old pits, with 34 new charcoal pits. Sites 2 has more new pits (42), but fewer old ones (Figure 5). There is evidence of a few (4 and 2) very old pits on Sites 3 and 4, but fortunately not new ones and these sites still hold good secondary forest with good canopy cover (Figure 5).

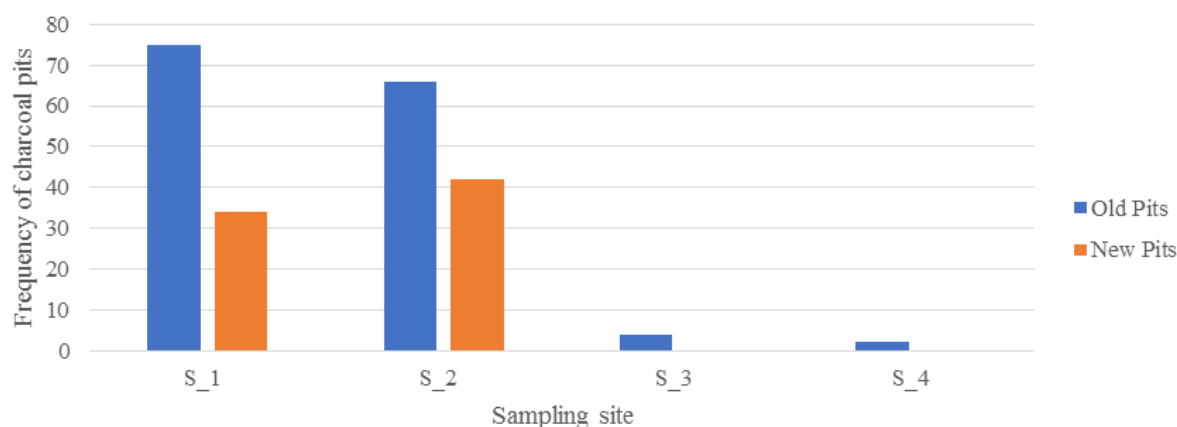


Figure 5. Number of New and Old Pits.

Presence of *Gmelina arborea* Plantations

There are still a good number of *G. arborea* plantations within the reserve. *G. arborea* trees were observed on increase in sites 1 and 2, with 255 trees (38.8%) and 125 (32.9%) respectively of all trees recorded within these sites. Site 1, holds 8 different patches (61.54%) of *G. arborea* plantations while site 2 recorded 5 patches (38.46%) *G. arborea* plantations, whilst sites 3 and 4 lacks *G. arborea* plantations (Table 3). Several small patches of *G. arborea* plantations exist in the sites, this is an introduced species that has previously been promoted as a multi-use tree (boards, firewood and animal forage). It is an invasive species especially where there are fires (and cattle).

Table 3. Presence of *Gmelina arborea* Plantations.

Sites	Frequency	Percentage (%)
S_1	8	61.54

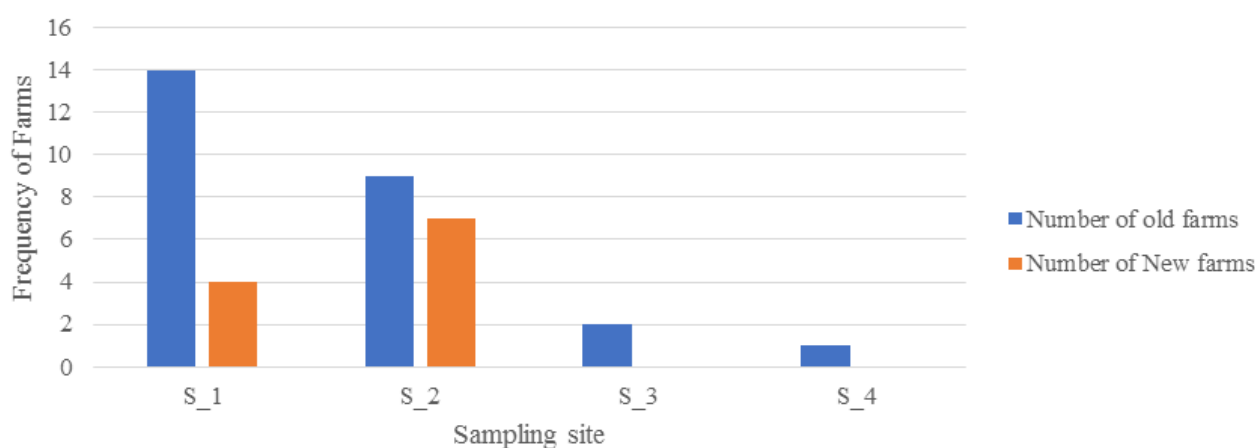


Figure 6. Number of New and Old Farms.

5. Discussions

Historical records, such as forest surveys, cultural practices, and traditions, are valuable for studying vegetation changes over time. However, their use in historical ecology is constrained by what was recorded, as it depends on the original purpose of data collection. Significant changes in forest use were observed in the study site and nearby areas of the forest reserve. The role of Traditional Ecological Knowledge (TEK) in promoting sustainable use and conservation of ecosystem services has gained attention due to increasing concerns over unsustainable forest resource use. TEK, through customs, rituals, myths, and taboos, has proven effective in conserving natural resources globally [5].

Both men and women are involved in harvesting forest

Presence of farm plots within the Forest reserve

Site 1 had the highest numbers (14) of old farms, with 4 new farms cultivated. Sites 2 has more old farms (9), but fewer new ones (Figure 6). Site 2 has the highest number of new farms cultivated during the period of this research. There is evidence of a few (2 and 1) very old farms on Sites 3 and 4, but fortunately not new ones and these sites still hold good secondary forest with good canopy cover.

resources, with women comprising about 75% of forest users globally due to their roles as caretakers and housekeepers [18]. Women possess extensive knowledge about forest species, including their abundance, location, and decline rates, and are often affected by negative forest management policies [18, 19]. In Nigeria, women identified a wide range of forest products, demonstrating greater versatility in forest resource use and management compared to men [20, 21]. Local people, including herbalists with specialized knowledge of medicinal plants and practices, are aware and willing to participate in forest management, which contributes to the success of community-based or participatory forestry [22, 23].

In sub-Saharan Africa, charcoal production for urban consumption is a major driver of forest degradation, often through clear-felling or selective cutting in forests and woodlands [24]. Clearcutting is typically linked to agricultural cultivation, with charcoal production as a secondary

activity [25]. Charcoal harvesting negatively impacts soil hydrological properties, with larger open areas being more damaging than smaller ones [26]. Selective logging targets wood species with high calorific value, but this practice can also lead to forest degradation and the potential extinction of preferred species [27, 28].

Studies on charcoal composition provide evidence of fire in various ecosystems. Daniau et al. [29] found that charcoal from paleo fires in the Luk profiles indicated rainforest fires. Neumann et al. [30] identified charred endocarps of *E. guineensis* mixed with charcoal from other taxa at specific intervals. The oldest charcoal assemblage was predominantly from a single species, likely *Guibourtia* [31]. Thomson et al. [32] observed macroscopic charcoal in 96.5% of sites, suggesting local burns across various land uses, except in two sloping fields in Karula National Park, Estonia. Harvey et al. [33] recorded 12,488 charcoal pieces from 47 samples during road construction in Western Hungary.

Gmelina arborea is native to tropical moist forests in Asia, including India, Burma, Sri Lanka, and southern China, and is widely cultivated in tropical regions across Africa, Asia, Australia, the Americas, the Caribbean, and Pacific islands [34, 35]. It is a prominent plantation species in Nigeria [36] and thrives in the tropical climates of West Africa, including Nigeria, Ivory Coast, Sierra Leone, and Ghana [36]. *G. arborea* is an economically important tree, valued for its strong yet lightweight timber, and is used in construction, instrument making, and paper production [37, 34]. Additionally, it plays a significant role in agroforestry, with benefits such as carbon sequestration and use in home gardens [38].

Self and Parker [39] suggested that selective marking is most effective after the first or second thinning, as lower tree density reduces effort. Petersons [40] found that night thinning and marking trees with fluorescent dye increased productivity by 15%. However, Kuitto and Mäkelä [41] recommended operator selection as a better approach for crop-thinning operations. Sainoi et al., [42] highlighted the importance of choosing the right tapping system to optimize rubber plant physiology and yield, typically favoring high-frequency systems. Aun et al., [43] emphasized that sustainable rubber production relies on proper felling methods and selecting healthy trees with appropriate tapping marks. Poor tapping was identified as the main cause of low latex yields in the Philippines [44].

The growing demand for woody biomass for energy production in Europe has driven the search for innovative logging systems to thin young, dense forests. This includes exploring alternative strategies and switching to smaller tree diameters to boost production and resource mobilization for energy [45, 46]. Eliasson [47] and Bergström et al. [48] used simulation models to examine the impact of cutting levels on harvester productivity. Bergström et al. [45] also highlighted the benefits of surface harvesting systems in dense young stands, particularly for biomass acquisition. The debate on tree selection methods in thinning operations, including op-

erator-based selection versus prior tree marking, has been extensively discussed [39].

6. Conclusions

Collecting information from local communities is crucial for assessing the true value of species and making informed decisions on their sustainable use. Local knowledge of vegetation use is key to developing effective conservation strategies. Research highlights the importance of edge communities for the condition, health, and management of Sierra Leone's Kasewe Forest Reserve. Tradition, culture, and rituals play a significant role in the services and products of the reserve. A historical account of gum copal pricing and marketing remains a neglected aspect of Sierra Leone's history. The study also reveals that deforestation and charcoal production continue to negatively impact species diversity, vegetation cover, and soil hydrological properties, emphasizing the need to consider interactions with other land uses in forest management.

The repeated occurrence of *Gmelina arborea* plantations in the Kasewe Forest Reserve indicates that human activity has influenced the dynamics of plant communities. Using remnants of *G. copallifera* to estimate its historical abundance offers a quantitative approach to measure changes in its density, though limitations exist due to anthropogenic disturbances and unidentified remnants. This method also helps estimate historical species levels where early records are unavailable. The current state of *G. copallifera* trees with no harvesting marks in the non-degraded areas reflect the recovery of the vegetation cover in the reserve from past human disturbances.

In the Kasewe Forest Reserve, soil samples from degraded areas contained more charcoal than those from non-degraded areas, with charcoal present in over 49% of samples. The charcoal footprint in soil correlates with the duration and intensity of agricultural land use. Charcoal in non-degraded sites settles deeper than in degraded sites, though differences are not significant in sloping or agricultural areas. Cultivation, logging, and charcoal burning significantly weaken the forest's structure and composition, leading to lower floral diversity, species richness, and less developed communities in disturbed areas. Increased human activity in these areas was associated with higher charcoal production pressure, deforestation, and soil degradation, all linked to disturbance intensity.

There is an urgent need for sustainable management of local forests to mitigate deforestation and agricultural impacts. All stakeholders must recognize the connections between biodiversity, ecosystem services, and the destructive effects of human activities. Understanding the harm caused by our actions could drive change. Ultimately, establishing a sustainable relationship between humans and nature is essential for ensuring that future generations can enjoy these areas.

Degraded areas in the Kasewe Forest Reserve exhibit low

species richness due to intensive logging, charcoal burning, and agricultural activities, including annual ploughing. Key native species such as *Guibourtia copallifera*, *Hannoa klaineana*, *Harungana madagascariensis*, *Nesogordonia papaverifera*, and *Phyllocosmus africanus* are crucial for future research. Overharvesting of mature wood has hindered the recovery of these species, with one-third of identified stumps belonging to *G. copallifera* and *N. papaverifera*. More than 72% of the plant species used in the area were previously collected from the protected zone, with *G. copallifera* being a preferred target for charcoal production.

Guibourtia copallifera trees are more abundant in non-degraded areas compared to degraded ones, where charcoal pits are more prevalent. Charcoal production remains active in these areas. *G. copallifera* is a sensitive species, as the collection of its plant parts negatively impacts its habitat, population, and regeneration process. The species' regeneration depends on key factors like pollination, seed development, germination, and plant growth, which are disrupted by overharvesting.

The study found that *Guibourtia copallifera* is selectively targeted for harvest, which, if continued, could lead to local extinction and negative ecological consequences. The population structures of *G. copallifera* and other species in degraded areas have been severely disrupted, limiting their recovery unless anthropogenic disturbances are reduced or eliminated. The study recommends strict measures to combat illegal activities, enhanced forest fire control, and a comprehensive recovery plan to restore and maintain the degraded areas of the forest reserve.

Abbreviations

IC	Informed Consent
DBH	Diameter at Breast Height
TEK	Traditional Ecological Knowledge
IK	Indigenous Knowledge

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Conflicts of Interest

The authors declare no conflicts of interest.

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