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Article

Community Perceptions and Determinants of the Sustained Conservation of Historical Rubber Plantations in the Lomela and Lodja Territories, Sankuru Province, Democratic Republic of the Congo

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Abstract

The drastic and historic fall in natural rubber prices has prompted many smallholders around the world to abandon rubber plantations in favor of other survival alternatives. In the Lomela and Lodja territories of Sankuru Province (Democratic Republic of Congo), where a historical absence of a rubber market prevails, local communities have conserved rubber plantations inherited from the colonial era (dating back to 1955). Data collected from 401 households enabled us to identify the perceptions and determinants of rubber plantation conservation. The results show that households are highly dependent on forest ecosystem services. Agriculture is the main activity for 81.3% of respondents, in the context of extreme poverty where daily incomes amount to 0.33 USD/person. The patriarchal system favored men, who inherited 97% of the plantations. Men perceived the conservation of the plantations as beneficial, while women perceived it as serving external project interests. Perceptions were significantly influenced by gender, age, social and legal organization, geographical origin, mode of acquisition, main activity, diversification of income sources, membership in a tribal mutuality, access to the informal mutual aid networks,

membership in an association and contact with extension services. Conservation was positively and significantly correlated with geographical origin, membership in an association, contact with extension service, consideration of plantations as natural heritage and the ecosystem services provided. These results underline that rubber plantations cannot be understood only in terms of rubber production, but also in terms of their socio-ecological and heritage dimensions.

Keywords: sustained conservation; community perception; rubber plantations; conservation determinant; ecosystem services; Sankuru Province; Democratic Republic of the Congo

1. Introduction

Natural rubber is mainly obtained from the latex of the rubber tree, *Hevea brasiliensis* [Willd. ex A. Juss.] Mull. Arg., a perennial species that is native to the Amazon basin [1]. Worldwide, rubber plantations occupy around 10,315,732 hectares, most of which are managed by smallholders in Southeast Asian countries, where the majority own less than four hectares [2]. Sub-Saharan African countries occupy just 7% of this area [3]. Moreover, sub-Saharan Africa has a significant comparative advantage in terms of available acreage, labor costs and latex quality [4]. Natural rubber production in 2018 was recorded at 14.33 million tons, and over 60% of this was used in the automotive industry [5].

Generally grown as a monoculture [6], the rubber tree was first domesticated in 1876, when Sir Henry Alexander Wickham transported 70,000 seeds from Brazil to the Royal Botanic Gardens, Kew, England, which were then shipped to Asian countries after demonstrating a low germination rate [7]. The authors agree that nearly 2500 plant species produce latex containing natural rubber, which is still not exploitable [8,9]. However, only the latex of *Hevea brasiliensis* [Willd. ex A. Juss.] Mull. Arg. is the main source of commercially viable natural rubber [10,11]. Natural rubber is used as a raw material in the manufacture of over 50,000 industrial and non-industrial products [12,13]. Rubber trees also offer wood production opportunities [14]. Its branches are used in charcoal production [1,15], the main source of cooking energy in developing countries [16,17]. Other conversion technologies, such as pyrolysis and gasification, are also used in the energy production of rubber residues [1,18]. And let us not forget rubber seed hull extracts, which offer a promising green antioxidant alternative for increasing the oxidative stability of biodiesel [3,19].

Moreover, the growing global demand for natural rubber from 1890 to 1913 led to an economic boom in 1910 [20,21]. After the discovery of vulcanization, the high demand for natural rubber led to the search for a synthetic substitute with properties similar to those of natural rubber to meet global demand [22]. In this respect, synthetic polyisoprene rubber has emerged as an attractive alternative and, to date, is responsible for the drastic fall in natural rubber prices, adversely affecting the profitability of rubber plantations [23,24]. As a result, many smallholders have abandoned their rubber plantations and developed other survival alternatives [24,25], such as the production of more profitable crops [20,26], commercial activities [25], and others had no choice but to sell or lend their land [20].

According to history, *Hevea* was first planted in Congo Belge, now the Democratic Republic of the Congo (DRC), around 1809 [27]. Over the years, particularly around 1925, the expansion of the industry was supported by the establishment of vast industrial plantations in Equateur and Oriental Provinces, which were often managed by colonial and parastatal companies [28]. These rubber plantations structured a cash economy based on the export of latex [27]. For example, in 1960, the year of the country's independence, annual

natural rubber production was 60,000 tons, from 90,000 hectares of rubber plantations, 1/3 of which were planted by smallholders [29]. Unfortunately, between 1970 and 1990, following Zaireanization and the drastic fall in world prices for natural rubber, more than half the country's rubber plantations disappeared (Nair, 2021), quoted by [29]. A drop in production also justified by the general collapse of the agricultural sector [30], which is experiencing a veritable institutional, organizational and infrastructural vacuum [31].

In the Lomela and Lodja territories (Sankuru Province), located in the area of influence of Salonga National Park, which is rich in endemic species such as the Bonobo (*Pan paniscus*), Okapi (*Okapia johnstoni*) and forest elephant (*Loxodonta cyclotis*) [32–35], the historical rubber plantations established during the colonial period (in 1955) have gradually lost their initial economic function due to the collapse of the local natural rubber market and the absence of recovery policies [29]. In the absence of a structured and sustainable outlet, these rubber plantations are no longer exploited for latex, yet production continues to be conserved and appropriated by local communities. This situation raises significant questions about the socio-economic, cultural and institutional mechanisms underpinning this non-market conservation in a context of high socio-ecological vulnerability [36]. In these landlocked territories, communities face chronic poverty, limited access to modern productive resources and increased pressure on surrounding forest ecosystems, particularly the Salonga National Park [37]. In this context, rubber plantations constitute hybrid spaces, as they entail colonial heritage, land heritage, a wood-energy reserve and buffer zones between agricultural practices and protected areas.

Several recent studies have highlighted the challenges associated with sustaining rubber plantations in regions where the global rubber market has become uncertain, forcing small producers to reconfigure their livelihood strategies. This is the case in the study by [36,38]. In this context, the sustainable conservation of historic plantations is a critical issue for both biodiversity preservation and local productive heritage. However, research addressing this issue from the perspective of community perceptions remains scarce, particularly in Central Africa. Our study therefore aims to fill this gap by highlighting the social, economic, and cultural factors that determine the conservation of these plantations. Furthermore, unlike synthetic rubber based on polyisoprene, natural rubber from rubber tree plantations has a unique combination of mechanical properties, such as superior elasticity, better tear resistance, and increased biodegradability [13,39]. Moreover, natural rubber production relies on less-energy-intensive processes and emits fewer chemical compounds, making it a more environmentally friendly alternative. The cost of producing synthetic rubber, particularly in energy-constrained contexts such as those in the DRC, may also be higher in the long term. These factors reinforce the relevance of a sustainable conservation approach for historic rubber plantations, which represent both a strategic resource, rural heritage, and a lever for local ecological adaptation.

Specifically, this study aims to analyze community perceptions and identify the factors determining the sustained conservation of these historic rubber plantations by rural households. Understanding the underlying logics of conservation within this context of post-colonial crisis and the disintegration of the natural rubber market could provide innovative pathways for the participatory management of natural resources. This would enable public policies to be directed towards sustainable development and local resilience solutions that combine economic development, environmental conservation and social justice.

This article presents findings from empirical research aimed at analyzing the perceptions and key factors influencing rural communities' decisions regarding the conservation of historical rubber plantations. Moving beyond the plantations' potential as economic assets for natural rubber production, the study highlights their broader eco-systemic and cultural significance. These plantations not only offer productive value but also serve as

socio-cultural landmarks, intergenerational heritage sites, and vital reservoirs of ecosystem services for local populations. Our analysis suggests that the sustained conservation of these landscapes can only be understood through a holistic lens, recognizing the intersection of economic, ecological, identity-based, and social dynamics. By doing so, the study offers new insights into participatory natural resource management in post-colonial contexts.

2. Materials and Methods

2.1. Study Area

Sankuru Province is located at 3°21′27″ S, 23°35′48″ E and covers an area of 104,331 km^2 [40]. Like Kasaï Oriental and Lomami, Sankuru Province is one of the 26 Provinces of the DRC, resulting from the dismemberment of the former Province of Kasaï Oriental [37]. Seven other DRC Provinces surround this Province. Its northern border is marked by the Ndjale and Salonga rivers, which form the boundaries of the Salonga National Park [36]. It is subdivided into six territories: Lusambo, Lubefu, Katako-Kombe, Kole, Lodja and Lomela. Lusambo is the provincial capital, while Lodja is the largest center of economic activity [40]. This study concerns only the territories of Lomela and Lodja, where the historic rubber plantations are located (Figure 1) [36]. Sankuru is a predominantly forested Province, with equatorial forest covering the northern and eastern parts, and savannah dominating the southern and central-western parts [29]. It includes part of the Salonga National Park and the Sankuru Nature Reserve, known for their species that are endemic to the DRC, namely the *Pan paniscus* and *Okapia johnstoni*, as well as *Loxodonta cyclotis* [41]. These species are currently threatened with extinction by anthropogenic pressure [32,33,35].

Figure 1. Historical rubber plantation in Vango village (Lomela territory), Sankuru Province, DRC.

It is characterized by an equatorial climate in the northern part, gradually shifting to a humid tropical climate in the central and southern part [42]. The dry season, marked by a drop in rainfall, extends from May to August, while the rainy season, characterized by an increase in precipitation, occurs between September and April. In the northern part of the Province, the heaviest rainfall occurs in December and from mid-April to mid-May [29]. The Province's average annual temperature is 25 °C, with rainfall ranging

from 1500 mm to 2000 mm yearly. Its relief comprises low plateaus, terraces and "high" plateaus, with altitudes ranging from 300 m in the west to 700 m in the east [36]. With an estimated population of 4 million, this Province is essentially forest-dependent, placing heavy pressure on the Salonga National Park and the Sankuru Reserve, hence the need to generate alternative sources of income in order to reduce anthropogenic pressure on these ecosystems [41]. Figure 1 shows a historical rubber plantation in the village of Vango.

To identify the villages studied, documents published in the study area, mainly from the archives of the Belgian Development Agency (ENABEL), were consulted. In addition, interviews with sector officials and field visits were conducted. A total of 55 villages with rubber plantations were located and mapped in the territories of Lomela and Lodja (Figure 2). The following criteria were used to select the 14 villages for the survey. The village had to (i) be located in one of the two territories (Lomela and Lodja) selected for the study, and (ii) be recognized by the local communities, notably the sector and group leaders, as one of the major rubber plantation villages. To take part in the survey, the respondent had to (i) be one of the residents of the 14 villages selected for the study (Figure 2), and (ii) voluntarily agree to take part in the survey, without financial motivation. Interviews were then held with local people to explain the study method and obtain their free, prior and informed consent (FPIC) for active participation in the study. Figure 2 shows the location of the rubber plantation villages.

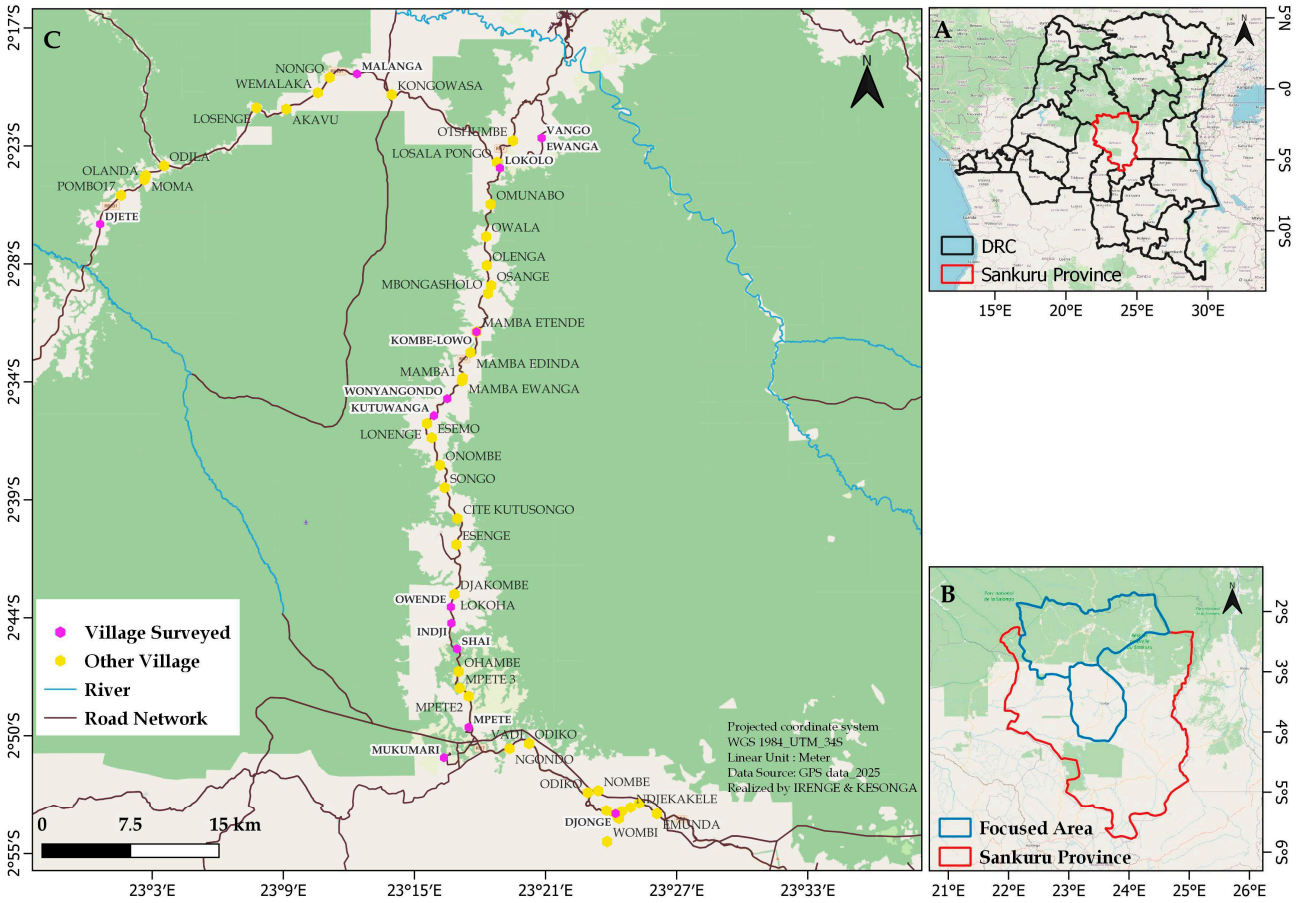

Figure 2. Location of rubber plantation villages in the Lomela and Lodja territories, Sankuru Province, DRC. The letter (**A**) in Figure 2 represents the country, the DRC; (**B**) the province of Sankuru; and (**C**) the area of interest.

2.2. Data Collection

Given the lack of reliable statistical data in the study area, the probabilistic approach was used through a broader survey to ensure that the sample was representative. The survey was conducted between December 2024 and February 2025, targeting a total of 401 households across 14 villages selected for the study. To our knowledge, this constitutes the most extensive data collection effort to date concerning historical rubber plantations in the Lomela and Lodja territories, including within the selected villages. Given the size of the sample relative to the local population, it can reasonably be considered representative for the purposes of this analysis. The 401 households surveyed were randomly selected from the 14 villages chosen for the study. Interviews were conducted in the local language (Tétela) and lasted between 35 and 45 min, depending on respondents' availability.

During the survey, respondents were asked to answer the following main questions: (i) Do you own a rubber plantation inherited from colonial times? And (ii) what is your perception of the conservation of these rubber plantations? Respondents who said they owned a rubber plantation were interviewed about how the plantations were acquired, how they were managed and the ecosystem services they provided. In addition, visits were organized to historical rubber plantations, generally located close to villages, to bring respondents' statements closer to the realities on the ground. All respondents were asked to provide information on their socio-demographic, economic, organizational or institutional, cultural and ecological characteristics, and on their perceptions of the ecosystem services provided by historical rubber plantations.

In addition, a series of unstructured qualitative interviews were conducted during the same survey period. The aim of these interviews was to gather respondents' views on why some of them are motivated to maintain rubber plantations and others are not. The qualitative interviews brought together 25 heads of households with or without rubber plantations, including 10 women, 15 men, 6 traditional chiefs and 5 representatives of rubber plantation owners' associations. Data from these qualitative interviews are included in the Results Section in the form of testimonials to support the quantitative data. Table 1 shows the distribution of interviewees according to the villages selected for the study.

Table 1. Distribution of respondents by selected villages in Lodja and Lomela territories, Sankuru Province, DRC.

Villages Surveyed	Number of Respondents Interviewed
Djete	36
Djonge	21
Ewanga	31
Indji	35
Kombe-lowo	37
Kutuwanga	30
Lokolo	20
Malanga	32
Mpete	23
Mukumari	32
Owende	31
Shai	30
Vango	12
Wonyangondo	31
Total	401

2.3. Data Analysis and Processing

The quantitative data collected in this study were recorded in an Excel file, and then analyzed using IBM SPSS Statistics 21.0 software. Descriptive analyses were used

to present qualitative variables in terms of numbers and percentages, and quantitative variables in terms of mean plus or minus standard deviation. Given the larger sample size, the chi-square test (X^2) was used to identify socio-demographic, economic and organizational/institutional characteristics that might influence respondents' perceptions of historical rubber plantations.

In addition, the decision to conserve rubber plantations was formalized as a binary variable representing the respondent's choice between two possible outcomes: actually conserving or owning a rubber plantation at the time of the survey (value 1) or not conserving one (value 0). This binary analysis framework enables the determinants of this decision to be estimated using the appropriate econometric model, such as the logit model, to capture the likely influences of socio-economic, cultural and environmental variables on the behavior of surveyed households.

The model is presented as follows:

$$Y = f\ (x, e) \tag{1}$$

Y is the dependent variable (whether or not to keep a rubber plantation); x is the matrix of variables explaining the variation in Y; and e is the logistic error of the distribution. The logit model is estimated by the maximum likelihood method, where Pi is the probability associated with the survey unit.

$$Pi = f\ (Ii) = \frac{1}{1 + e^{-Ii}} \tag{2}$$

$$I = \beta 0 + \beta 1Xi1 + \beta 2Xi2 + \beta 3Xi3 + \beta 4Xi4 + \ldots + \beta nXin \tag{3}$$

I is the vector corresponding to the characteristics of the survey unit and its choice decision; the βi indicate the coefficients of the explanatory variables; and the Xin indicate the explanatory variables [43]. Thus, the choice of the logit model was motivated by its approximation to the cumulative normal function, on the one hand, and by its mathematical simplicity and relevant interpretation, on the other. The model has also been used in several other studies that have identified the factors determining the conservation of forest ecosystems by local communities in developing countries [44–46]. Like several empirical studies that have developed econometric models by combining variables related to household characteristics in order to explain their decision to preserve or not preserve forest ecosystems, such as forests, mangroves, protected areas, and many others [47–50], this study uses a combination of variables considered by various authors mentioned above to identify those that may or may not explain local communities' decisions to conserve historic rubber plantations. These variables include those related to sociodemographic, economic [48], institutional, cultural, and ecological characteristics [51]. This study is based on the assumption that the variables selected in the model will explain households' decisions regarding the conservation of rubber plantations. As shown in Table 2, the independent variables used in this model were incorporated into the survey questionnaire in the form of open-ended and closed-ended questions. This study considers the statistical significance threshold to be $\alpha < 0.05$. Table 2 shows the independent variables used in the logit model.

Table 2 above shows the variables (X) we used in the logit model of factors influencing respondents' decisions regarding the conservation of historical rubber plantations. These influencing variables were incorporated as survey questions and considered as research hypotheses.

Table 2. Presentation of independent variables used in the logit model.

Independent Variables	Symbols	Description
Gender	X1	1 = Female; 0 = Male
Age	X2	1 = Young: ≤45 years old; 0 = Older: >45 years old
Study level	X3	1 = Educated; 0 = Uneducated
Social and organization	X4	1 = Matriarchy; 0 = Patriarchy
Civil status	X5	1 = Married; 0 = Not married
Respondent status	X6	1 = head of household; 0 = Single member
Respondent's origin	X7	1 = Native; 0 = Allochthonous
How plantations are acquired	X8	1 = Inheritance; 0 = Other modes
Main household survival activity	X9	1 = Agriculture; 0 = Other activities
Diversification of revenue sources	X10	1 = Yes; 0 = No
Membership in a mutual society	X11	1 = Yes; 0 = No
Access to informal self-help networks	X12	1 = Yes; 0 = No
Membership in a growers' association	X13	1 = Yes; 0 = No
Contact with extension services	X14	1 = Yes; 0 = No
Access to credit	X15	1 = Yes; 0 = No
Consideration of rubber plantations as natural heritage	X16	1 = Yes; 0 = No
Consideration of rubber plantations as a means of combating the consequences of climate change	X17	1 = Yes; 0 = No
Consideration of rubber plantations as a means of preserving the health of the local community	X18	1 = Yes; 0 = No
The social value of rubber plantations	X19	1 = Yes; 0 = No
Consideration of rubber plantations as a means of preserving other plant and animal species	X20	1 = Yes; 0 = No
Existence of beliefs or rituals associated with rubber plantations	X21	1 = Yes; 0 = No
Hopes of recovering natural rubber markets	X22	1 = Yes; 0 = No
Beneficiaries of ecosystem services provided by rubber plantations	X23	1 = Yes; 0 = No
Ban on rubber cutting	X24	1 = Yes; 0 = No
Ban on bush fires near rubber plantations	X25	1 = Yes; 0 = No
Imposition of access rights to rubber plantations	X26	1 = Yes; 0 = No
Existence of penalties for users who violate conservation rules	X27	1 = Yes; 0 = No

3. Results

The results below provide an overview of the diversity of the sample and, consequently, of the current situation in the villages of the historical rubber plantations located in the Lomela and Lodja territories.

3.1. Characteristics of Respondents

The results in Table 3 show a wide disparity in the distribution of respondents by gender. The results showed that almost the entire sample was made up of men (91.52%). Our qualitative interviews and field observations showed that it was more difficult for a married woman to involve the household or divulge information without her husband's agreement. Most women would prefer that the man, who is considered culturally and legally to be the head of the household, respond to any eventuality that might involve the household. This undoubtedly explains the predominance of male heads of household in our sample. Respondents ranged in age from 18 to 81 years, with an average age of 45.53 ± 13.1 years. Most of these respondents (53.62%) belonged to the over-45 age group, and had a primary school education (47.13%). The overwhelming majority of respondents

(98.75%) reported living under a patriarchal system of social and legal organization, with 92.02% being married at the time of the survey. A substantial proportion (95.51%) identified themselves as heads of households, which had an average size of 9 ± 4 members. Subsistence farming and hunting emerged as the principal livelihood activities, cited by 81.30% and 10.72% of respondents, respectively. The mean monthly income reported was CDF 242,695.61 ± 171,218.52 (Congolese francs), equivalent to approximately USD 86.68 (US dollars). When adjusted per capita, this translates to an average daily income of USD 0.33 per household member, placing the surveyed population significantly below the regional poverty threshold of USD 2.15 per day [52], by a factor of 6.5. Similarly, most respondents (72.82%) had diversified sources of income. The same results showed that 76.06% of respondents owned rubber plantations and 23.94% did not. During our qualitative interviews, interviewees mentioned that most rubber plantations were owned by men, who had acquired them through inheritance. Women do not generally own rubber plantations. However, over time, some men lost their plantations to inter-community conflict, and others replaced them with survival crops such as rice and cassava. Inheritance was cited by almost all respondents (98.36%) as the main method of acquiring rubber plantations, with an average length of ownership of 19.27 ± 12.55 years.

Table 3. Socio-economic characteristics.

Variables	Terms and Conditions	Number of Employees (Percentage)
Gender	Female	34 (8.48)
	Male	367 (91.52)
Age	Young: ≤45 years old	186 (46.38)
	Older: >45 years	215 (53.62)
Study	Illiterate	77 (19.20)
	Primary	189 (47.13)
	Secondary	130 (32.42)
	University	5 (1.25)
Social and organization	Matriarchy	5 (1.25)
	Patriarchate	396 (98.75)
Civil status	Divorced	9 (2.24)
	Single	11(2.75)
	Widower	12 (2.99)
	Married	369 (92.02)
Respondent status	Head of household	383 (95.51)
	Single member	18 (4.49)
Respondent's origin	Native	360 (89.78)
	Allochtonous	41 (10.22)
Main household survival activity	Agriculture	326 (81.30)
	Hunting	43 (10.72)
	Breeding	16 (3.99)
	Fishing	14 (0.50)
	Civil servant	2 (3.49)
Diversification of revenue sources	Yes	292 (72.82)
	No	109 (27.18)
Owner of a rubber plantation	Yes	305 (76.06)
	No	96 (23.94)
Methods of acquiring rubber plantations	Purchase	4 (1.31)
	Donation	1 (0.33)
	Heritage	300 (98.36)

3.2. Respondents' Perceptions of the Conservation of Historical Rubber Plantations

Figure 3 below shows the distribution of respondents according to their perception of the conservation of historical rubber plantations. The results show that 45.89% of respondents affirmed that it is good that rubber plantations are preserved, as they enable households to benefit from them in the event of a revitalization of its value chain, which would still remain foreseeable, 42.14% of respondents said that it is important to preserve rubber plantations to remember ancestors and guarantee children's future, 9.73% of respondents said that it would be preferable if there were no more rubber plantations near villages, and 2.24% of respondents said that rubber plantations are mainly of interest to external projects.

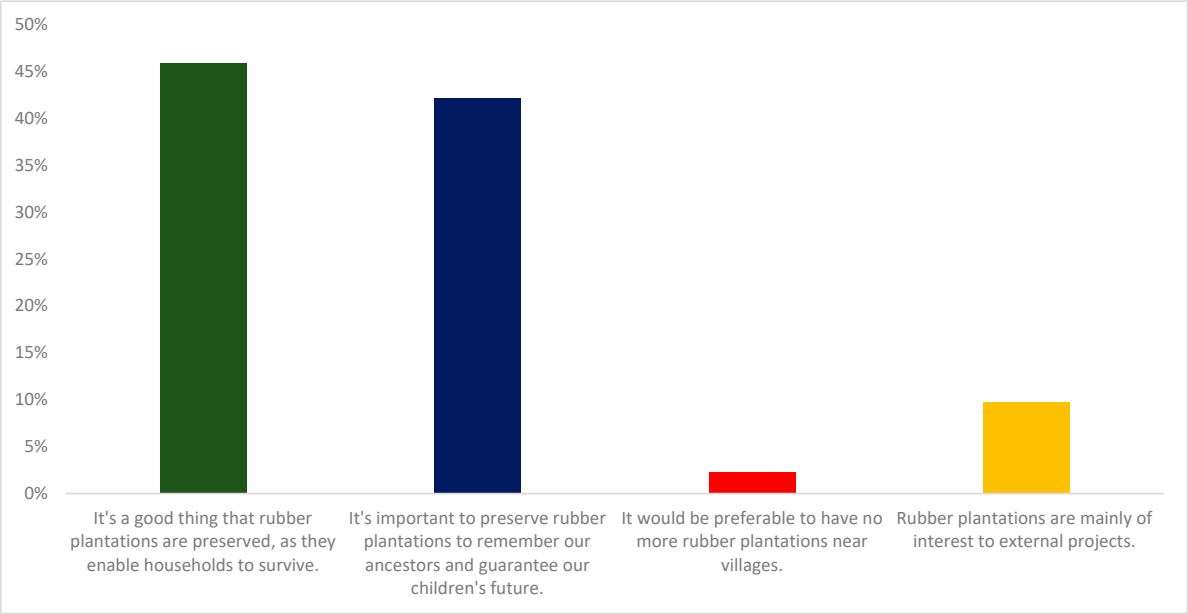

Figure 3. Distribution of respondents according to their perceptions of rubber plantation conservation.

This contrast suggests that women may perceive rubber plantation conservation as a means of attracting outside investment, or as being exploited for the benefit of outside stakeholders, rather than as a sustainable local resource. The chi-square test ($X^2 = 50.840$, $p = 0.000$ ***) confirms the statistical robustness of this discrepancy, and indicates a highly significant relationship between gender and perception of rubber plantations (Table 4). This high significance underlines the existence of a perception inequality between men and women, which can be attributed to socio-cultural and economic factors, such as the division of domestic responsibilities, natural resource management and women's limited participation in local decision-making processes. During our qualitative interviews, one woman stated that rubber plantations are often subject to projects involving men. Women's involvement is rarely taken into account. Moreover, rubber plantations occupy land that is close to villages, forcing women to travel long distances in search of arable land, and this is in a cultural context where men rarely accompany women to the fields. The men are content to hunt and fish, sometimes in forbidden areas. This often leads to arrests by the eco-guards and makes household survival more complex. One woman advocates reviving the rubber industry to provide employment for the men, or replacing rubber plantations with the main household survival crops, such as rice and manioc, which are the main food crops in the area.

Table 4. Socio-demographic characteristics of respondents in relation to their perception of the conservation of historical rubber plantations.

Independent Variables		Perceptions						
		It's a Good Thing That Rubber Plantations Are Preserved, as They Enable Households to Survive.	**It's Important to Preserve Rubber Plantations to Remember Our Ancestors and Guarantee Our Children's Future.**	**It Would Be Preferable to Have No More Rubber Plantations Near Villages.**	**Rubber Plantations Are Mainly of Interest to External Projects.**	**Total**	**X^2-Test (Pearson)**	***p*-Value**
Gender	Woman	11 (6)	7 (4.1)	1 (11.1)	15 (38.5)	34 (8.5)	50.840	0.000 ***
	Men	173 (94)	162 (95.9)	8 (88.9)	24 (61.5)	365 (91.5)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Age	Young	89 (48.4)	67 (39.6)	3 (33.3)	27 (69.2)	186 (46.4)	12.180	0.007 **
	Old	95 (51.6)	102 (60.4)	6 (66.7)	12 (30.8)	215 (53.6)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Study level	Illiterate	42 (22.8)	30 (17.8)	0 (100)	5 (12.8)	77 (19.2)	5.553	0.475
	Primary	79 (42.9)	82 (48.5)	5 (55.6)	21 (53.8)	187 (46.6)		
	Secondary	63 (34.2)	57 (33.7)	4 (44.4)	13 (33.3)	137 (34.2)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Civil status	Single	6 (3.3)	2 (1.2)	1 (11.1)	2 (5.1)	11 (2.7)	10.638	0.301
	Married	167 (90.8)	161 (95.3)	7 (77.8)	34 (87.2)	369 (92)		
	Divorced	5 (2.7)	2 (1.2)	1 (11.1)	1 (2.6)	9 (2.2)		
	Widower	6 (3.3)	4 (2.4)	0 (0)	2 (5.1)	12 (3)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Household status	Chief	180 (97.8)	165 (97.6)	9 (100)	29 (74.4)	383 (95.5)	45.198	0.000 ***
	Not chief	4 (2.2)	4 (2.4)	0 (0)	10 (25.6)	18 (4.5)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Social and legal organization	Matriarchy	1 (0.5)	0 (0)	0 (0)	4 (10.3)	5 (1.2)	28.696	0.000 ***
	Patriarchy	183 (99.5)	9 (100)	9 (100)	35 (89.7)	396 (98.8)		
	Total	184 (100)	9 (100)	9 (100)	39 (100)	401 (100)		
Respondent's origin	Aboriginal	169 (91.8)	163 (96.4)	4 (44.4)	24 (61.5)	360 (89.8)	49.338	0.000 ***
	Allochtone	15 (8.2)	6 (3.6)	5 (55.6)	15 (38.5)	41 (10.2)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		

Number of observations = 401; X^2, chi-square test; percentage in brackets; ** indicates a highly significant test at 5%; *** indicates a very highly significant test at 5%.

Furthermore, analysis by age group shows a clear demarcation between young and older people regarding their perception of rubber plantations. Young people (under 45) account for 48.4% of those surveyed with a positive perception of the need to conserve these plantations, while those who are over 45 represent 51.6% of those with the same opinion. This distribution suggests a significant difference in attitude according to age, with a more marked tendency among young people to perceive the conservation of rubber plantations as an asset to be protected for future generations. Young people are indeed more inclined to see the conservation of rubber plantations as essential to securing future generations' futures, which could reflect a heightened awareness of environmental and sustainability issues. This positive perception could be linked to a greater openness to sustainable development ideas and a desire to bequeath a favorable environment to future generations. On the other hand, although also they share a positive perception of conservation, older people seem to have a more nuanced view of the situation, probably due to their direct experience and adaptation to past changes, notably socio-economic and environmental evolutions linked to rubber plantations.

The chi-square test ($X^2 = 12.180$, $p = 0.007$ **) supports this hypothesis, revealing a moderate and statistically significant association between age and perception of rubber plantation conservation. These results suggest that age has a substantial influence on how individuals perceive the conservation of these plantations. It would be pertinent to examine in more detail the factors underlying these divergences, exploring how different

generations approach natural resource management issues and how their past experiences shape their vision of the future. Such analyses could offer avenues for the development of intergenerational conservation strategies that are better adapted to the specific perceptions and needs of the young and old alike.

With regard to the status of the head of household, the results reveal a marked distinction between individuals who occupy this role and those who do not. Household heads, who accounted for 95.5% of respondents, had a significantly more favorable and pronounced perception of the importance of rubber plantations. This trend could be explained by the fact that heads of household are often responsible for managing domestic and economic resources, and therefore have a vested interest in maintaining plantations to guarantee their family's long-term food and financial security. Their perception could also be influenced by a heightened sense of intergenerational responsibility, as they are responsible for preserving resources for future generations of their children or relatives. On the other hand, those who do not exercise responsibility tend to adopt a more distant stance with regard to the conservation of rubber plantations. A significant proportion of these individuals (25.6%) feel that plantations are mainly of interest to external projects. This could be due to their less direct involvement in the management of family or community resources, reducing their perception of the importance of these plantations in their daily lives or their future. In addition, non-household heads may perceive plantations as resources linked more to external issues, such as economic projects, than to immediate domestic or community concerns.

The difference observed between these two groups is highly significant, as indicated by the chi-square test value ($X^2 = 45.198$, $p = 0.000$ ***), suggesting that household head status is a determining factor in the perception of rubber plantation conservation. This result highlights the importance of social position and responsibilities within the family structure, which appears to play a crucial role in how individuals value natural resources and make decisions regarding their conservation. Future studies should explore in greater depth the impact of power dynamics within households and communities on natural resource management, particularly in rural contexts where family structures are often influential in decision-making.

Analysis of the respondents' social and legal organization reveals an almost absolute prevalence of the patriarchal system, with 98.8% of respondents adhering to this model. This social and legal structure has a significant influence on the perception of rubber plantations, particularly how these plantations are perceived as being primarily associated with development projects. Indeed, a consistent majority of participants who evolve within a patriarchal framework seem to consider rubber plantations not only as an economic resource but also as a lever for development initiatives or external interests, such as research projects and community support programs. The dominance of the patriarchal system in the region may explain this orientation, where power and decision-making structures are concentrated within men, who are generally perceived as the main holders of family and community authority. This dynamic may influence the perception of rubber plantations, which are then interpreted as assets for development or investment projects, rather than as conservation elements linked to environmental or intergenerational issues. It is likely that in such a context, individuals, particularly those who do not exercise significant decision-making power (such as women or young people), may have a more instrumentalized vision of these plantations, linking them more to external projects or immediate profit objectives than to a sustainable conservation perspective.

The statistical significance of this relationship is indicated by the chi-square test, whose value (X^2 = 28.696, p = 0.000 ***) shows that belonging to a patriarchal social organization is strongly linked to the perception that rubber plantations are mainly associated with development projects. This statistical association highlights the structural impact that social hierarchy can have on perceptions of natural resources.

In terms of management and conservation policy, it is therefore essential to consider the influence of the patriarchal model in rubber plantation management strategies. An approach that fails to take this reality into account risks failing to respond adequately to the concerns and needs of different categories of the local population, particularly women and young people, who may be under-represented in decision-making processes linked to plantation management. A more in-depth analysis of power relations within communities would therefore be beneficial in developing conservation policies that are more inclusive and better adapted to existing social structures.

Analysis of perceptions of rubber plantations by geographical origin reveals a marked distinction between natives and non-natives. Indeed, most indigenous respondents (89.8%) expressed a positive perception of the conservation of rubber plantations, suggesting a stronger attachment to the sustainable management of this natural resource. Conversely, a significantly lower proportion of non-natives (10.2%) see these plantations as relevant to development projects, rather than as a heritage to be preserved for future generations. This difference in perception between indigenous and non-indigenous groups is statistically significant, as confirmed by the chi-square test (X^2 = 7.823, p = 0.000 ***), indicating a direct relationship between respondents' geographical origin and their view of the conservation of rubber plantations. This result highlights the importance of geographical origin in shaping perceptions, suggesting that natives, who are probably more rooted in the territory and local resource management, develop a more favorable perception of plantation conservation as a common and sustainable good. On the other hand, non-natives, who may be less involved in the day-to-day management of plantations or less familiar with local dynamics, tend to perceive these plantations from a more utilitarian angle, focused on external projects.

This distinction also reveals cultural and socio-economic aspects that influence how different communities perceive rubber plantations. Indigenous people, likely to have a historical and ongoing relationship with these plantations, might perceive their conservation as necessary to maintain their traditional way of life. In contrast, non-indigenous people, often associated with external dynamics, might see them more as resources to be exploited as part of development projects or for economic purposes. The results underline that an approach to the management and conservation of these plantations cannot be practical without a thorough understanding of cultural differences and the varied perceptions that arise from them.

The analysis of respondents' economic characteristics in relation to their perception of rubber plantation conservation, as presented in Table 5, reveals several significant trends, both in terms of plantation acquisition, main activities, and the diversification of income sources. These economic variables are strongly associated with how individuals perceive the conservation of rubber plantations, and the statistical results corroborate this association with very marked significances.

Table 5. Economic characteristics of respondents in relation to their perception of the conservation of historical rubber plantations.

Independent Variables		Perceptions					X^2-Test (Pearson)	*p*-Value
		It's a Good Thing That Rubber Plantations Are Preserved, as They Enable Households to Survive.	It's Important to Preserve Rubber Plantations to Remember Our Ancestors and Guarantee Our Children's Future.	It Would Be Preferable to Have No More Rubber Plantations Near Villages.	Rubber Plantations Are Mainly of Interest to External Projects	Total		
Plantation acquisition method	Purchase	4 (2.2)	1 (0.6)	4 (44.4)	1 (2.6)	10 (2.5)	98.758	0.000 ***
	Donation	0 (0)	1 (0.6)	0 (0)	0 (0)	1 (0.2)		
	Inheritance	171 (92.9)	160 (94.7)	1 (11.1)	35 (89.7)	367 (91.5)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Main activity	Agriculture	166 (90.2)	131 (77.5)	5 (55.6)	26 (66.7)	328 (81.8)	35.799	0.007 **
	Breeding	3 (1.6)	8 (4.7)	1 (1.1)	5 (12.8)	17 (4.2)		
	Hunting	7 (3.8)	16 (9.5)	2 (2.22)	4 (10.3)	29 (7.2)		
	Fishing	2 (1.1)	0 (0)	0 (0)	0 (0)	2 (0.5)		
	Salaries	2 (1.1)	9 (5.3)	1 (1.1)	4 (10.3)	16 (4.0)		
	Trade	1 (0.5)	2 (1.2)	0 (0)	0 (0)	3 (0.7)		
	Other	3 (1.6)	3 (1.8)	0 (0)	0 (0)	6 (1.5)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Diversification of revenue sources	Yes	115 (62.5)	135 (79.9)	7 (77.8)	35 (89.7)	292 (72.8)	19.913	0.000 ***
	No	69 (37.5)	34 (20.1)	2 (22.2)	4 (10.3)	109 (27.2)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		

Number of observations in in-depth survey = 88; X^2, chi-square test; percentage in brackets; ** indicates a highly significant test at 5%; *** indicates a very highly significant test at 5%.

The method of plantation acquisition was found to be a determining factor in respondents' perceptions. Indeed, the chi-square test results (X^2 = 98.758, p = 0.000 ***) reveal a highly significant association between this mode of acquisition and perceptions of rubber plantation conservation. Those who acquired their plantations by inheritance feel it is important to conserve them to ensure their daily lives (92.9%) and those of future generations (94.7%), thanks to the ecosystem services these plantations provide. A few respondents consider plantations to only concern external projects (35.7%). On the other hand, plantation buyers seem less likely to think that these plantations should be conserved or protected, and more likely to perceive these plantations as interesting mainly for external projects. This suggests that an acquisition by inheritance is potentially perceived as an ancestral and lasting link with the land. In contrast, a purchase could imply a more utilitarian or commercial vision of the plantation, more focused on immediate profitability. Results relating to respondents' main activity also significantly affect their perception of rubber plantations. The chi-square test reveals moderate significance (X^2 = 35.799, p = 0.007 **), indicating that the main sector of activity influences how individuals perceive the conservation of these plantations. Those whose main occupation is farming have a significantly more positive perception of the need to conserve and protect rubber plantations, particularly with regard to conservation for future generations. In contrast, individuals whose main activity is livestock rearing, hunting or fishing seem to be more distant from the issues of rubber plantation conservation, suggesting that their relationship with the plantations is less direct or less involved in the process of sustainable natural resource management.

This trend is particularly marked in the group of herders, who have a weaker perception of the importance of plantations, possibly due to their orientation towards other forms of production or resource exploitation.

Diversification of income sources is another relevant economic factor in the analysis of perceptions. The chi-square test ($X^2 = 19.913$, $p = 0.000$ ***) shows a highly significant relationship between this variable and perceptions of rubber plantation conservation. However, individuals who have diversified their sources of income (notably through agriculture and other economic activities) have a more marked perception of the importance of plantation conservation. They are also more likely to stress the need to protect these plantations for future generations, suggesting that those with multiple sources of income are more likely to adopt a long-term, sustainable approach to natural resources, as opposed to those whose income is more dependent on a specific economic activity, who may adopt a more short-term outlook. On the other hand, those who do not diversify their sources of income tend to have a less favorable perception of the conservation and protection of rubber plantations, which could be linked to a more immediate focus on short-term economic gains, to the detriment of long-term environmental issues.

The results in Table 6 are interpreted based on an analysis of respondents' perceptions of rubber plantations in relation to certain organizational and institutional characteristics. This analysis was structured by examining each independent variable, the results of the chi-square test, and the implications of the results within a rigorous framework.

Table 6. Organizational or institutional characteristics of respondents in relation to their perception of historical rubber plantations.

Independent Variables		Perceptions					X^2-Test (Pearson)	*p*-Value
		It's a Good Thing That Rubber Plantations Are Preserved, as They Enable Households to Survive.	**It's Important to Preserve Rubber Plantations to Remember Our Ancestors and Guarantee Our Children's Future.**	**It Would Be Preferable to Have No More Rubber Plantations Near Villages.**	**Rubber Plantations Are Mainly Interest to External Projects**	**Total**		
Membership in a tribal mutual society	Yes	88 (47.8)	87 (51.5)	2 (22.2)	10 (25.6)	187 (46.6)	10.761	0.013 *
	No	96 (52.2)	82 (48.5)	7 (77.8)	29 (74.4)	214 (53.4)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Access to an informal support network	Yes	18 (9.8)	33 (19.5)	0 (0)	4 (10.3)	55 (13.7)	9.052	0.029 *
	No	166 (90.2)	136 (80.5)	9 (100)	35 (89.7)	346 (86.3)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Member of a growers' association	Yes	120 (65.2)	130 (76.9)	1 (11.1)	13 (33.3)	264 (65.8)	39.568	0.000 ***
	No	64 (34.8)	39 (23.1)	8 (88.9)	26 (66.7)	137 (34.2)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Contact with extension services	Yes	30 (16.3)	109 (64.5)	2 (22.2)	15 (38.5)	156 (38.9)	87.168	0.000 ***
	No	154 (83.7)	60 (35.5)	7 (77.8)	24 (61.5)	245 (61.1)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		
Access to credit or other forms of support	Yes	7 (3.8)	12 (7.1)	2 (22.2)	4 (10.3)	25 (6.2)	7.090	0.069
	No	177 (96.2)	157 (92.9)	7 (77.8)	35 (89.7)	376 (93.8)		
	Total	184 (100)	169 (100)	9 (100)	39 (100)	401 (100)		

Number of observations in in-depth survey = 88; X^2, chi-square test; percentage in brackets; * indicates thesignificanttestat 5%; *** indicates a very highly significant test at 5%.

The chi-square test revealed a significant association between membership in a social organization and the perception of rubber plantations (p = 0.013 *). Indeed, 47.8% of members of a social organization consider it good to conserve rubber plantations, and 51.5% think that it is important to protect them for future generations. On the other hand, among non-members, these perceptions are less pronounced (52.2% and 48.5%, respectively). The non-member group presents a higher proportion of individuals who prefer the cessation of rubber plantations (77.8%). These results suggest that involvement in a social organization could positively influence perceptions linked to plantation conservation, making them more sensitive to issues of sustainability and intergenerational transmission.

Statistical analysis also shows a significant association between access to an informal self-help network and perception of rubber plantations (p = 0.029 *). Among those who benefit from such networks, a higher proportion consider plantations something that should be protected for future generations (19.5% versus 9.8% among those without access to such networks). Conversely, non-beneficiaries of such networks are more likely to think that plantations should be abandoned (77.8% versus 22.2% among those benefiting from such networks). These results show that informal networks can play an important role in the perception of the benefits of rubber plantations, notably by creating bonds of solidarity and support within local communities.

Membership in a planters' association is strongly associated with the perception of rubber plantations (p = 0.000 ***). Indeed, a majority of members (65.2%) consider conserving plantations to be beneficial to their economic survival, and 76.9% think that it is crucial to protect these plantations for future generations. On the other hand, a majority of non-members believe that it would be preferable to abandon the plantations (88.9% versus 11.1% of members). This result highlights the importance of planters' associations in the management and sustainability of rubber plantations, suggesting that collective organization around this activity can positively influence the perception of its long-term benefits.

There is a very strong association between contact with extension services and perception of rubber plantations (p = 0.000 ***). Among those who had been in contact with these services, 64.5% felt that plantation conservation was essential, and 83.7% thought that protecting them for future generations was crucial. In contrast, these perceptions are much less pronounced among those who have not had contact (35.5% and 22.2%, respectively). These results imply that access to extension services, which can provide technical information and practical advice on sustainable plantation management, is crucial to improving farmers' perceptions of the long-term value of rubber plantations.

3.3. Modeling Conservation Factors in Historical Rubber Plantations

The results (Table 7) show the factors that are positively and negatively correlated with the sustainable conservation of historical rubber plantations. The positively correlated factors concern age, level of education, marital status, respondent's status in the household (being head of household), respondent's origin (being indigenous), mode of plantation acquisition (inheritance), consideration of agriculture as the household's main activity, diversification of income sources, membership in a tribal mutual-benefit society, access to informal mutual, membership in an association, contact with an extension service, access to credit, consideration of rubber plantations as a natural heritage, consideration of rubber plantations as a means of combating the consequences of climate change, consideration of rubber plantations as a means of preserving the health of the local community, consideration of rubber plantations as a social value, consideration of rubber plantations as a means of keeping other plant and animal species, the hope of regaining a market for natural rubber, being a beneficiary of the ecosystem services rendered by rubber plantations, and knowledge of the ban on bush fires near rubber plantations. On the other hand, gender

(being a woman), social and legal organization (matriarchy), the existence of beliefs or rituals associated with rubber plantations, the ban on cutting rubber trees, the imposition of plantation access rights and the existence of penalties for cutting down a rubber tree had a negative influence on the conservation of rubber plantations. During our qualitative interviews, some respondents stated that belonging to a tribal mutuality associated with colonial history reinforced their attachment to cultural values. Nevertheless, the existence of sanctions that can go as far as expulsion from the village in the event of rubber cutting, as well as rituals associated with rubber plantations, are increasingly frowned upon, albeit by a minority of inhabitants, notably because of their Christian affiliation. For example, some people mentioned that in the event of social problems such as the death of customary chiefs, epidemics or climatic disturbances such as prolonged rains, instead of invoking God, some community members went to the rubber plantations to invoke the spirits of the ancestors in order to obtain help. These practices were frowned upon by the villages' Christian communities.

Table 7. Estimation of the logit model in rubber plantation conservation. The signs of the coefficients and the odds ratios denoted by Exp(B) indicate the direction of the relationship between the variables in the equation. The Wald statistic plays the same role as the *t*-test, revealing the contribution of each predictor to model improvement.

Independent Model Variables	B	E.S	Wald	Sig.	Exp(B)	95% Confidence Interval for EXP(B)	
						Lower	Superior
Type	−0.976	0.997	0.960	0.327	0.377	0.053	2.656
Age	0.024	0.431	0.003	0.956	1.024	0.440	2.384
Study level	0.114	0.506	0.051	0.822	0.892	0.331	2.408
Social and legal organization	−17.895	16,511.969	0.000	0.999	0.000	0.000	.
Civil status	0.201	0.914	0.048	0.826	0.818	0.136	4.908
Respondent's status in the household	0.177	1.169	0.023	0.880	1.193	0.121	11.797
Respondent's origin	1.602	0.760	4.449	0.035 *	0.201	0.045	0.893
How rubber plantations are acquired	0.966	1.338	0.521	0.470	2.626	0.191	36.129
Agriculture as main activity	1.010	1.060	0.907	0.341	2.746	0.344	21.943
Diversification of revenue sources	0.315	0.525	0.359	0.549	0.730	0.261	2.044
Membership in a tribal mutual society	0.008	0.464	0.000	0.986	0.992	0.399	2.464
Access to informal self-help networks	0.850	0.625	1.852	0.174	2.340	0.688	7.965
Association membership	1.148	0.594	3.735	0.050 *	0.317	0.099	1.016
Contact with an extension service	1.830	0.612	8.940	0.003 **	6.231	1.878	20.674
Access to credit	1.386	0.818	2.873	0.090	3.998	0.805	19.848
Consideration of plantations as natural heritage	2.570	1.061	5.874	0.015 *	0.077	0.010	0.612
Consideration of rubber plantations as a means of combating the consequences of climate change	0.082	0.523	0.025	0.875	0.921	0.330	2.568
Consideration of rubber plantations as a means of preserving the health of the community	0.628	0.725	0.751	0.386	0.534	0.129	2.208
The social value of rubber plantations	1.203	1.062	1.283	0.257	0.300	0.037	2.408
Consideration of rubber plantations as a means of preserving other plant and animal species	0.122	0.559	0.048	0.827	1.130	0.378	3.381
Existence of beliefs or rituals associated with Hevea plantations	−0.108	0.436	0.061	0.804	0.898	0.382	2.110
Hope for a return to the rubber market	0.606	1.295	0.219	0.640	0.546	0.043	6.901
Beneficiaries of ecosystem services provided by plantations	4.206	0.534	61.935	0.000 ***	0.015	0.005	0.042
Ban on cutting rubber trees	−0.396	0.623	0.403	0.525	0.673	0.199	2.282
Ban on bush fires near plantations	0.006	1.022	0.000	0.995	1.006	0.136	7.451
Imposing access rights to plantations	−0.623	0.547	1.299	0.254	0.536	0.184	1.566
Existence of penalties	−0.803	0.596	1.816	0.178	0.448	0.139	1.440
Constant	1.426	1.224	1.358	0.244	4.162		

Legend: Number of observations: 401; 2 log likelihood = 187.580; R^2 (Nagelkerke) = 0.703; *p*-value = 0.000 ***; * = statistical test significant at 5%; ** = statistical test highly significant at 5%; *** = statistical test highly significant at 5%.

Figure 4 below shows a village located in a rubber plantation area in Sankuru Province, illustrating the socio-economic dynamics that govern these rural areas. The architecture of the dwellings, built in cobs with vegetable leaf roofs, bears witness to a strong dependence on local natural resources and resilience in the face of climatic and economic constraints. The forest backdrop underscores the interaction between human activities and the surrounding ecosystem. This proximity highlights the ecosystem services provided by rubber plantations, as well as the challenges involved in conserving them.

Figure 4. Village near rubber plantations in Sankuru Province.

4. Discussion

4.1. Characteristics of Respondents in Relation to Their Perception of the Conservation of Historical Rubber Plantations

Our results showed that most of our respondents perceived the conservation of rubber plantations as beneficial, while a minority felt that these plantations served the interests of external projects. Our results are corroborated by those of a recent study which identified 21 ecosystem services provided by these same plantations and indicated the local community's dependence on these services. These services are classified into four categories: eleven provisioning services, four regulating services, four cultural services and two supporting services [36].

Additionally, the literature consistently supports the notion that, similar to other conserved forest ecosystems [53,54], rubber plantations are likely to deliver significant ecosystem services to local communities [36]. This finding aligns with our own results (Table 7), which demonstrate a strong, statistically significant correlation between the provision of ecosystem services and the conservation of rubber plantations. Furthermore, existing research suggests that rubber plantations contribute to carbon sequestration, capturing substantial amounts of carbon dioxide from the atmosphere [38].

Furthermore, our survey results revealed a high representation of men (91.52%) aged over 45 (53.62%) in the conservation of rubber plantations in the Lomela and Lodja territories. These same results showed that being male, elderly, head of household, having patriarchy as a social and legal organization, owning rubber plantations by inheritance, practicing agriculture as a main activity, having diversified sources of income, being a

member of a tribal mutual-benefit society, having access to an informal self-help network, being a member of a rubber planters' association and having been in contact with extension services all have a significant influence on perceptions linked to the conservation of rubber plantations.

Qualitative analysis of the interviews conducted, particularly that with a woman living in the village of Lokolo, highlights the persistence of highly patriarchal customary norms governing women's access to land resources. According to this interviewee, women are structurally excluded from inheriting land capital, particularly rubber plantations, as long as a man remains in the family line. This testimonial, representative of several cases recorded, reveals that the rare female owners of rubber plantations can only gain access to them under exceptional circumstances, such as the absence of male heirs (only daughter) or belonging to a royal lineage where inheritance rules are more flexible.

The structuring of customary land law, as observed in the study area, enshrines a logic of transmission, to the benefit of men considered to be the legitimate heirs of plantations. This structural inequality is reinforced by the predominantly patriarchal social and legal organization, which almost 99% of respondents declared to be the dominant mode of regulation. As a result, the conservation and management of historical rubber plantations are overwhelmingly in the hands of men. At the same time, women are relegated to subsistence farming functions, marginalized in the dynamics of patrimonial capitalization.

These findings align with the critical analyses by [55] and by [56], according to which customary systems in sub-Saharan Africa maintain unequal gender regimes that restrict women's economic autonomy, particularly in regard to land tenure. Refs. [57,58] also confirm that rubber plantations in village contexts are generally transferred from father to son, perpetuating women's almost systematic inaccessibility to this strategic resource. This situation raises major issues regarding land justice, socio-economic inclusion and the sustainability of agroforestry systems, particularly in a context where old rubber plantations are invested with economic, memorial and ecological functions.

Many authors agree that the characteristics of local communities, such as the diversification of income sources, are likely to improve living conditions and reduce pressure on forest ecosystems [59] as well as on protected areas [60,61]. The results of our interviews revealed that the lack of male employment, due in particular to the absence of perennial crops, which are often the preserves of men, leads to strong pressure on natural resources and puts too much pressure on women to grow food crops, which would be their preserves. These men said they hoped to find secure sources of income, such as the production of natural rubber, as was the case in colonial times, for hunting remains an activity with a high risk of arrest and uncertainty linked to the increasing scarcity of wildlife products. Local communities' pressures on Salonga National Park have already been reported in research [62].

4.2. Factors Influencing the Decision to Conserve Rubber Plantations

When the world faces the serious environmental consequences of deforestation and dramatic forest degradation [63,64], it is essential to gain a better understanding of the decisions that local communities make to conserve forest ecosystems, particularly rubber plantations. Authors agree that local communities' decisions to conserve forest ecosystems may vary according to the socio-demographic, economic [65], institutional [51], cultural and ecological context in which they evolve [66].

Furthermore, the characteristics of each community member are likely to influence the decision whether or not to participate in the conservation of forest ecosystems. In this study, the respondents' origin (being indigenous), membership in an association, contact with an extension service, consideration of rubber plantations as a natural heritage, and benefiting

from the ecosystem services provided by these plantations positively and significantly influenced the conservation of rubber plantations. On the other hand, gender (being a woman), social and legal organization (matriarchy), the existence of rituals associated with rubber plantations, the prohibition of cutting rubber trees, the imposition of access rights to plantations and the existence of sanctions linked to the cutting of a rubber tree had a negative influence on the conservation of rubber plantations.

Furthermore, the highly significant influence of the ecosystem services provided by rubber plantations on conservation can be attributed to the strong dependence of local communities on these plantations. Several authors have also observed that the ecosystem services provided by forest ecosystems increase the dependance of communities and strengthen their decision to participate in their conservation [67,68]. Ref. [65] adds that ecosystem services are tools for forest ecosystem conservation projects.

Conversely, the negative influence of gender on the conservation of rubber plantations can be explained by the fact that patriarchy, a widespread form of social and legal organization in the villages studied, discriminated against women in the inheritance of land and rubber plantations, to the benefit of men. This could have had a negative impact on women's motivation to maintain rubber plantations. Furthermore, in the villages surveyed, farming was cited as the main household survival activity, and it was mainly practiced by women, without the support of their husbands (heirs to the land and rubber plantations). Despite this, these women were forced to travel long distances searching for farmland, even though the rubber plantations were close to the villages. This could also negatively affect the women's motivation to maintain the rubber plantations. One study argues that, as forest ecosystem conservation challenges intensify, local communities' involvement, particularly that of women, is becoming increasingly crucial (Ota et al., 2024). Unfortunately, gender-related barriers, such as limited access to education, resources and leadership roles, limit their potential contribution [66].

Furthermore, although this study did not directly incorporate biophysical variables such as biodiversity, carbon storage, or ecosystem resilience indicators, it offers a detailed analysis of the social representations and community dynamics that shape the conservation of historic rubber plantations. These plantations, inherited from the colonial period, constitute not only declining productive capital, but also an agroforestry heritage that could play a strategic role in addressing contemporary climatic and socio-economic challenges [69]. Similarly, ref. [70] emphasize, through a case study in the Amazon, that the conservation of traditional forest systems relies heavily on the perceived coherence between economic utility, cultural recognition, and the social memory of the landscape. In this sense, our results are part of an emerging field of research that advocates for the revaluation of old plantations through an integrated reading of social and territorial determinants. They help to demonstrate that any sustainable conservation strategy would benefit from being co-constructed with local communities, not only for reasons of efficiency, but also in the interests of environmental justice and respect for identity-based attachments to the land.

Our diagnosis led us to consider historical rubber plantations not only as potential vectors for natural rubber production, but also as having a socio-cultural and environmental dimension for local communities. This analysis argues for a thoughtful revival of the rubber industry in Sankuru Province, in order to create jobs for men and reduce pressure on the Salonga National Park. Our results can be considered in policy research aimed at improving the management of conserved forest ecosystems and protected areas threatened by anthropogenic pressure from local communities.

5. Conclusions

The study deciphered the factors that are likely to influence local communities' perceptions and decisions regarding the conservation of historic rubber plantations, inherited from colonial period (in 1955). The data collected from the 401 interviewers showed a wide disparity between men (91.52%) and women (8.48%). The right to own rubber plantations was dictated by patriarchy, which favored men, who hold 97% of rubber plantations by inheritance, and discriminated against women. In terms of conservation policy, it is therefore essential to consider the influence of the patriarchal model in conservation strategies for historical rubber plantations. An approach that fails to consider this reality risks failing to respond adequately to the concerns and needs of different categories within a rural community, particularly women and young people, who may be under-represented in decision-making processes.

The same results showed that households survived thanks to agriculture practiced mainly by women and hunting by men. Each household member lived in extreme poverty, with a daily income of USD 0.33, 6.5 times below the regional poverty line. This exacerbates the pressure on natural resources. The study calls for a well-considered and inclusive revival of the rubber industry, likely to guarantee jobs for men and reduce pressure on protected areas such as the Salonga National Park.

In addition, perceptions of rubber plantations were significantly influenced by gender, age, social and legal organization, geographical origin, mode of acquisition, main activity, the diversification of income sources, membership in a tribal mutuality, access to an informal self-help network, membership in an association and contact with extension services. Men perceived the conservation of rubber plantations as beneficial, while women thought these plantations served the interests of external projects. Conservation of rubber plantations was positively and significantly correlated with geographical origin, membership in an association, contact with an extension service, the consideration of plantations as natural heritage and the ecosystem services provided

The dependence of local communities on these ecosystems, particularly because of the cultural value and services they provide, plays a decisive role in their desire to conserve them. However, this dynamic is strongly influenced by economic constraints, extreme poverty, land pressure and the absence of clear public policies for the sustainable development of these former plantations. It is therefore crucial to strengthen institutional support, encourage local incentive mechanisms and integrate these plantations into rural development and sustainable landscape management policies. Ultimately, a participatory, inclusive and integrated approach is needed to ensure these historic plantations' sustainability while improving local communities' living conditions. Taking these local dynamics into account is essential for the development of policies aimed at strengthening the governance of tropical forest ecosystems and envisaging an inclusive and sustainable revival of old rubber plantations in developing countries. These findings also highlight that rubber plantations preserved since colonial times cannot be understood solely in terms of rubber production, but must also be considered from a socio-ecological and heritage perspective. The results of this study suggest that national natural resource management policies and development agencies will need to take local contexts into account, particularly with regard to community perceptions and motivations, in strategies aimed at establishing sustainable models for forest ecosystem conservation. In terms of research limitations, this study did not address issues related to ecology, biodiversity, and ecosystem services such as carbon sequestration in rubber plantations. Although our findings revealed that the heritage dimension is linked to local communities' consideration of rubber plantations, in order to highlight the initial economic dimension linked to the existence of rubber plantations, we recommend an in-depth study of the factors influencing local communities' intentions to

revive natural rubber production in historic rubber plantations that have been conserved since the colonial era.

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References

1. Hytönen, J.; Nurmi, J.; Kaakkurivaara, N.; Kaakkurivaara, T. Rubber tree (*Hevea brasiliensis*) biomass, nutrient content, and heating values in Southern Thailand. *Forests* **2019**, *10*, 638. [CrossRef]
2. Malamba-Lez, D.; Tshala-Katumbay, D.; Bito, V.; Rigo, J.-M.; Kyandabike, R.K.; Yolola, E.N.; Katchunga, P.; Koba-Bora, B.; Ngoy-Nkulu, D. Concurrent heavy metal exposures and idiopathic dilated cardiomyopathy: A case-control study from the katanga mining area of the Democratic Republic of Congo. *Int. J. Environ. Res. Public Health* **2021**, *18*, 4956. [CrossRef]
3. Oyekunle, D.T.; Gendy, E.A.; Barasa, M.; Oyekunle, D.O.; Oni, B.; Tiong, S.K. Review on utilization of rubber seed oil for biodiesel production: Oil extraction, biodiesel conversion, merits, and challenges. *Clean. Eng. Technol.* **2024**, *21*, 100773. [CrossRef]
4. Diaby, M.; Ferrer, H.; Valognes, F. A social choice approach to primary resource management: The rubber tree case in Africa. *For. Policy Econ.* **2013**, *28*, 8–14. [CrossRef]
5. Ali, M.F.; Akber, M.A.; Smith, C.; Aziz, A.A. The dynamics of rubber production in Malaysia: Potential impacts, challenges and proposed interventions. *For. Policy Econ.* **2021**, *127*, 102449. [CrossRef]
6. He, L.; Yang, Y.; Ma, J.; Yuan, B.; Fang, F.; Wang, J.; Wang, M.; Li, A.; Chen, J.; Hui, S.; et al. Transcriptomic and Proteomic Integration Reveals Key Tapping-Responsive Factors for Natural Rubber Biosynthesis in the Rubber Tree *Hevea brasiliensis*. *Forests* **2024**, *15*, 1807. [CrossRef]

7. Roy, C.B.; Goonetilleke, S.N.; Joseph, L.; Krishnan, A.; Saha, T.; Kilian, A.; Mather, D.E. Analysis of Genetic Diversity and Resistance to Foliar Pathogens Based on Genotyping-by-Sequencing of a Para Rubber Diversity Panel and Progeny of an Interspecific Cross. *Plants* **2022**, *11*, 3418. [CrossRef]
8. Florez-Velasco, N.; Ramos, V.F.; Magnitskiy, S.; Balaguera-López, H. Ethylene and jasmonate as stimulants of latex yield in rubber trees (*Hevea brasiliensis*): Molecular and physiological mechanisms. A systematic approximation review. *Adv. Agrochem* **2024**, *3*, 279–288. [CrossRef]
9. Latour-Paczka, K.; Luciński, R. Artificial Biopolymers Derived from Transgenic Plants: Applications and Properties—A Review. *Int. J. Mol. Sci.* **2024**, *25*, 13628. [CrossRef]
10. Silva, M.J.; Claro, P.I.C.; da Silva, J.C.; Júnior, E.J.S.; Gonçalves, P.d.S.; Martins, M.A.; Mattoso, L.H.C. Evaluation of the physicochemical properties of natural rubber from *Hevea brasiliensis* clones. *Ind. Crops Prod.* **2021**, *171*, 113925. [CrossRef]
11. Venkatachalam, P.; Geetha, N.; Sangeetha, P.; Thulaseedharan, A. Natural rubber producing plants: An overview. *Afr. J. Biotechnol.* **2013**, *12*, 1297–1310. [CrossRef]
12. Azizan, F.A.; Kiloes, A.M.; Astuti, I.S.; Aziz, A.A. Application of optical remote sensing in rubber plantations: A systematic review. *Remote Sens.* **2021**, *13*, 429. [CrossRef]
13. Cornish, K. Alternative Natural Rubber Crops: Why Should We Care? *Technol. Innov.* **2017**, *18*, 244–255. [CrossRef]
14. Jawjit, S.; Jawjit, W.; Pibul, P.; Wongcharee, S.; Suwannahong, K. Enhancing the sustainability of the sawn rubberwood industry through resource-efficient and cleaner production approaches. *J. Clean. Prod.* **2024**, *479*, 143913. [CrossRef]
15. Petsri, S.; Chidthaisong, A.; Pumijumnong, N.; Wachrinrat, C. Greenhouse gas emissions and carbon stock changes in rubber tree plantations in Thailand from 1990 to 2004. *J. Clean. Prod.* **2013**, *52*, 61–70. [CrossRef]
16. Njenga, M.; Iiyama, M.; Terada, Y.; Kitenge, D.; Gitau, J.; Kinuthia, R.; Mendum, R. 'The Problem is a Lack of Firewood': Charcoal briquettes for cooking energy in refugee and host communities. *Soc. Sci. Humanit. Open* **2024**, *9*, 100852. [CrossRef]
17. Zulu, L.C.; Richardson, R.B. Charcoal, livelihoods, and poverty reduction: Evidence from sub-Saharan Africa. *Energy Sustain. Dev.* **2013**, *17*, 127–137. [CrossRef]
18. Krukanont, P.; Prasertsan, S. Geographical distribution of biomass and potential sites of rubber wood fired power plants in Southern Thailand. *Biomass Bioenergy* **2004**, *26*, 47–59. [CrossRef]
19. Oleinik, G.; Soares, L.C.; Benvegnú, D.M.; Lima, F.O.; Rodrigues, P.R.P.; Gallina, A.L. Rubber tree (*Hevea brasiliensis*) seed shell extracts as a promising green antioxidant alternative to increase biodiesel oxidation stability. *Process Saf. Environ. Prot.* **2024**, *190*, 429–437. [CrossRef]
20. Jayathilake, H.M.; Jamaludin, J.; De Alban, J.D.T.; Webb, E.L.; Carrasco, L.R. The conversion of rubber to oil palm and other landcover types in Southeast Asia. *Appl. Geogr.* **2023**, *150*, 102838. [CrossRef]
21. Singh, A.K.; Liu, W.; Zakari, S.; Wu, J.; Yang, B.; Jiang, X.J.; Zhu, X.; Zou, X.; Zhang, W.; Chen, C.; et al. A global review of rubber plantations: Impacts on ecosystem functions, mitigations, future directions, and policies for sustainable cultivation. *Sci. Total Environ.* **2021**, *796*, 148948. [CrossRef] [PubMed]
22. Cruz-Morales, J.A.; Gutiérrez-Flores, C.; Zárate-Saldaña, D.; Burelo, M.; García-Ortega, H.; Gutiérrez, S. Synthetic Polyisoprene Rubber as a Mimic of Natural Rubber: Recent Advances on Synthesis, Nanocomposites, and Applications. *Polymers* **2023**, *15*, 4074. [CrossRef] [PubMed]
23. Huang, I.Y.; James, K.; Thamthanakoon, N.; Pinitjitsamut, P.; Rattanamanee, N.; Pinitjitsamut, M.; Yamklin, S.; Lowenberg-DeBoer, J. Economic outcomes of rubber-based agroforestry systems: A systematic review and narrative synthesis. *Agrofor. Syst.* **2023**, *97*, 335–354. [CrossRef]
24. Wang, J.; Jiang, H.; He, Y. Determinants of Smallholder Farmers' Income-Generating Activities in Rubber Monoculture Dominated Region Based on Sustainable Livelihood Framework. *Land* **2023**, *12*, 281. [CrossRef]
25. Nicod, T.; Bathfield, B.; Bosc, P.; Promkhambut, A.; Duangta, K.; Chambon, B. Households ' livelihood strategies facing market uncertainties: How did Thai farmers adapt to a rubber price drop? *Agric. Syst.* **2020**, *182*, 102846. [CrossRef]
26. Makiling, M.; Marza, M.C.C.; Tolentino, T.B.P. Soil organic carbon in an abandoned rubber plantation in. *Ecosyst. Dev. J.* **2023**, *13*, 29–33.
27. Wie, T.K. *Colonial Extraction in the Indonesian Archipelago: A Long Historical View*; Routledge: London, UK, 2013. [CrossRef]
28. Clarence-Smith, W.G. Grands et petits planteurs de caoutchouc en Afrique (1934–1973). *Économie Rural.* **2012**, *330–331*, 88–102. [CrossRef]
29. De Roover, E.D.E. Analyse de la Chaîne de Valeur Hevea Selon la Methode Vca4D, Dans Les Territoires de Lodja et Lomela, Province du Sankuru, Rdc, en Vue de la Relance de la Filiere. Master's Thesis, Université de Liège-Gembloux Agro-Bio Tech, Gembloux, Belgium, 2022. Available online: http://www.nber.org/papers/w16019 (accessed on 13 May 2024).
30. Angélique, N.C.; Stany, V.; Lebailly, P.; Azadi, H. Agricultural Development in the Fight against Poverty: The Case of South Kivu, DR Congo. *Land* **2022**, *11*, 472. [CrossRef]
31. Nsele, M.K.; Dogot, T.; Maréchal, K. Unraveling the role of informal mutual aid networks in maintaining urban farms in Lubumbashi, Democratic Republic of Congo. *Front. Sustain. Food Syst.* **2023**, *7*, 1248937. [CrossRef]

32. Hart, J.A.; Grossmann, F.; Vosper, A.; Ilanga, J. Human Hunting and its Impact on Bonobos in the Salonga National Park, Democratic Republic of Congo. In *The Bonobos. Developments in Primatology: Progress and Prospects*; Springer: New York, NY, USA, 2008; pp. 245–271. [CrossRef]
33. Hohmann, G.; Fruth, B. New records on prey capture and meat eating by bonobos at Lui Kotale, Salonga National Park, Democratic Republic of Congo. *Folia Primatol.* **2008**, *79*, 103–110. [CrossRef]
34. Ibesoa, J.M. Use of forest products by the local people of the Salonga National Park in the Congo. *Acta Univ. Agric. Silvic. Mendelianae Brun.* **2009**, *57*, 51–59. [CrossRef]
35. Mbale, H.K.; Mukendi, M.; Bongo, G.N. The endemic mammals of the Democratic Republic of the Congo-Bonobo, Gorilla and Okapi–in ex situ situation in the Zoos of Europe: Inventory, Access and Benefit Sharing. *Indones. J. Conserv.* **2021**, *10*, 42–47. [CrossRef]
36. Mobunda Tiko, J.M.; Ndjadi, S.S.; Obandza-Ayessa, J.L.; Banga, D.B.; Balandi, J.B.; Musavandalo, C.M.; Mweru, J.P.M.; Michel, B.; Rakotondrasoa, O.L.; To Hulu, J.P.M. Farmers ' Perception of Ecosystem Services Provided by Historical Rubber Plantations in Sankuru Province, DR Congo. *Conservations* **2025**, *5*, 7. [CrossRef]
37. Rimoin, A.W.; Alfonso, V.H.; Hoff, N.A.; Doshi, R.H.; Mulembakani, P.; Kisalu, N.K.; Muyembe, J.-J.; Okitolonda, E.W.; Wright, L.L. Human Exposure to Wild Animals in the Sankuru Province of the Democratic Republic of the Congo. *Ecohealth* **2017**, *14*, 552–563. [CrossRef] [PubMed]
38. Tiko, J.M.; Ndjadi, S.S.; Obandza-Ayessa, J.L.; Mweru, J.P.M.; Michel, B.; Beeckman, H.; Rakotondrasoa, O.L.; Hulu, J.P.M.T. Carbon Sequestration Potential in Rubber Plantations: A Complementary Approach to Tropical Forest Conservation Strategies, a Review. *Earth* **2025**, *6*, 21. [CrossRef]
39. Omar, M.F.; Ali, F.; Jami, M.S.; Azmi, A.S.; Ahmad, F.; Marzuki, M.Z.; Muniyandi, S.K.; Zainudin, Z.; Kim, M.P. A Comprehensive Review of Natural Rubber Composites: Properties, Compounding Aspects, and Renewable Practices with Natural Fibre Reinforcement. *J. Renew. Mater.* **2025**, *13*, 497–538. [CrossRef]
40. Madeleine, M.; Oyakoy, A.; Valu, R.G.; Ndey, S.I.; Ndamba, A.K.; Musibono, D. Toxicity test of some plant extracts of plants used in catching fish in Sankuru. *Int. J. Latest Res. Humanit. Soc. Sci.* **2019**, *2*, 137–146.
41. Kabemba, F.N.; Mbaya, R.L.; Kapuadi, A.M.; Nyembwe, A.M.; Mamadou, C.; Kamutanda, K.; Koné, I. Couvert forestier et distribution de Pan paniscus dans la Réserve Naturelle de Sankuru, RD Congo. In Proceedings of the Conférence OSFACO: Des Images Satellites Pour la Gestion Durable des Territoires en Afrique, Cotonou, Bénin, 13–15 March 2019.
42. Albert, N.; Godart, P.M.; Ovungu, H. Départements Géosciences, Environnement et Société La Problématique de la Gestion des Déchets Liquides dans la Province du Sankuru en République Démocratique du CONGO. Ph.D. Thesis, Université Libre de Bruxelles, Brussels, Belgium, 2022.
43. Nsele, M.K.; Nkulu, J.; Fyama, M.; Maréchal, K.; Dogot, T. Factors Influencing the Sustained Adoption of Innovative Techniques by Urban Farmers in Lubumbashi, Democratic Republic of Congo. *Agriculture* **2022**, *12*, 1157. [CrossRef]
44. Garekae, H.; Thakadu, O.T.; Lepetu, J. Socio-economic factors influencing household forest dependency in Chobe enclave, Botswana. *Ecol. Process.* **2017**, *6*, 40. [CrossRef]
45. Stare, D.; Ščap, Š.; Malovrh, Š.P. Factors Influencing Private Forest Owners Decision-Making Rationalities to Implement Salvage Logging after Large-Scale Natural Disturbances in Slovenia. *Croat. J. For. Eng. J. Theory Appl. For. Eng.* **2025**, *46*, 165–177. [CrossRef]
46. Stockmann, J.; Franz, K.; Seintsch, B.; Neitzel, C. Factors Explaining the Willingness of Small-Scale Private Forest Owners to Engage in Forestry—A German Case Study. *Forests* **2024**, *15*, 319. [CrossRef]
47. Savari, M.; Khaleghi, B. Factors influencing the application of forest conservation behavior among rural communities in Iran. *Environ. Sustain. Indic.* **2024**, *21*, 100325. [CrossRef]
48. Savari, M.; Damaneh, H.E.; Damaneh, H.E. Conservation behaviors of local communities towards mangrove forests in Iran. *Glob. Ecol. Conserv.* **2024**, *56*, e03311. [CrossRef]
49. Munaw, H.Z. Factors Influencing the Attitudes of Local Community towards Protected Areas, Case Study on Ambatara Protected Area Forest Conservation, Northwest Ethiopia. *East Afr. J. For. Agrofor.* **2023**, *6*, 238–253. [CrossRef]
50. Mendako, R.K.; Tian, G.; Matata, P.M. Identifying Socioeconomic Determinants of Households' Forest Dependence in the Rubi-Tele Hunting Domain, DR Congo: A Logistic Regression Analysis. *Forests* **2022**, *13*, 1706. [CrossRef]
51. Wambugu, E.W.; Obwoyere, G.O.; Kirui, B.K. Socioeconomic Factors that determine community participation in forest management and conservation of adjacent ecosystems: A case of Aberdare forest, Kenya. *J. Ecol. Nat. Environ.* **2017**, *9*, 165–176. [CrossRef]
52. Arvidsson, R.; Brunke, J.; Nordelöf, A. Towards a method for poverty reduction potential in social life cycle assessment with application to the cobalt supply chain. *Int. J. Life Cycle Assess*, 2025; *in press*. [CrossRef]
53. Bhatt, H.; Jugran, H.P.; Pandey, R. Cultural ecosystem services nexus with Socio-Cultural attributes and traditional ecological knowledge for managing community forests of indian western Himalaya. *Ecol. Indic.* **2024**, *166*, 112379. [CrossRef]

54. Mori, A.S.; Lertzman, K.P.; Gustafsson, L. Biodiversity and ecosystem services in forest ecosystems: A research agenda for applied forest ecology. *J. Appl. Ecol.* **2017**, *54*, 12–27. [CrossRef]
55. Akurugu, C.A.; Dery, I.; Bata, P.D. Marriage, bridewealth and power: Critical reflections on women's autonomy across settings in Africa. *Evol. Hum. Sci.* **2022**, *4*, e30. [CrossRef]
56. Ezeilo, J.N. Rethinking women and customary inheritance in Nigeria. *Commonw. Law Bull.* **2021**, *47*, 706–718. [CrossRef]
57. Fenske, J. Trees, tenure and conflict: Rubber in colonial Benin. *J. Dev. Econ.* **2014**, *110*, 226–238. [CrossRef]
58. Peluso, N.L. Rubber erasures, rubber producing rights: Making racialized territories in West Kalimantan, Indonesia. *Dev. Change* **2009**, *40*, 47–80. [CrossRef]
59. Badola, R.; Barthwal, S.; Hussain, S.A. Attitudes of local communities towards conservation of mangrove forests: A case study from the east coast of India. *Estuar. Coast. Shelf Sci.* **2012**, *96*, 188–196. [CrossRef]
60. Bryce, K.; Hunter, K.L. Enhancing climate change planning and adaptive management in marine protected areas through targets, thresholds, and social-ecological objectives. *Front. Mar. Sci.* **2024**, *11*, 1339871. [CrossRef]
61. Jacob, D.E. Determinants of Income Diversification among Support Zone Communities of Nigeria National Parks. *Econ. Environ. Stud.* **2020**, *20*, 9–23. Available online: www.ees.uni.opole.pl (accessed on 20 April 2024).
62. Tingu, C.; Mathunabo, A.; Bondjembo, T.; Mabhungu, P. Impact des activités anthropiques sur la viabilité des ressources naturelles du Parc National de la Salonga (PNS), en RD Congo: Cas des activités des Yaelima dans le bloc sud Anthropogenic activities and natural resource viability in a protected area. *J. D'economie Manag. D'environnement Droit* **2019**, *2*, 86–101.
63. Mahapatra, S.; Kumar, B.; Shekhar, M.; Datta, D.; Pratap, A.; Rathnayake, U. Results in Engineering Understanding forest fragmentation dynamics and identifying drivers for forest cover loss using random forest models to develop effective forest management strategies in North-East India. *Results Eng.* **2025**, *26*, 104640. [CrossRef]
64. Parsch, C.; Wagner, B.; Engert, J.E.; Panjaitan, R.; Laurance, W.F.; Nitschke, C.R.; Kreft, H. Forecasting deforestation and carbon loss across New Guinea using machine learning and cellular automata. *Sci. Total Environ.* **2025**, *970*, 178864. [CrossRef]
65. Figueroa, F.; Caro-Borrero, Á.; Revollo-Fernández, D.; Merino, L.; Almeida-Leñero, L.; Paré, L.; Espinosa, D.; Mazari-Hiriart, M. 'I like to conserve the forest, but I also like the cash': Socioeconomic factors influencing the motivation to be engaged in the Mexican Payment for Environmental Services Programme. *J. For. Econ.* **2016**, *22*, 36–51. [CrossRef]
66. Ally, T.A.; Kumar, R.; Verma, R.K.; Verma, R.K.; Bhargava, R. Role and Empowerment of Women in Wildlife Conservation: The Intersection of Gender Equality and Biodiversity Protection. *Pak. J. Life Soc. Sci.* **2024**, *22*, 12918–12927. [CrossRef]
67. Duşcu, D.M.; Rîşnoveanu, G. Understanding visitor preferences: Perceived importance of anthropogenic and natural forest features in supplying cultural ecosystem services. *For. Ecosyst.* **2025**, *13*, 100306. [CrossRef]
68. Izquierdo-Tort, S.; Alatorre, A.; Arroyo-Gerala, P.; Shapiro-Garza, E.; Naime, J.; Dupras, J. Exploring local perceptions and drivers of engagement in biodiversity monitoring among participants in payments for ecosystem services schemes in southeastern Mexico. *Conserv. Biol.* **2024**, *38*, e14282. [CrossRef] [PubMed]
69. do Carmo Loch, V.; Celentano, D.; Saraiva, R.V.C.; Alvarado, S.T.; Berto, F.D.F.; Serra, R.T.; Barroso, J.C.; Guajá, T.A.; Rousseau, G.X. Forest species for biocultural restoration in eastern Amazon, Brazil. *Ethnobiol. Conserv.* **2023**, *12*, 1–15. [CrossRef]
70. Celentano, D.; Rousseau, G.X.; Engel, V.L.; Façanha, C.L.; De Oliveira, E.M.; De Moura, E.G. Perceptions of environmental change and use of traditional knowledge to plan riparian forest restoration with relocated communities in Alcântara, Eastern Amazon. *J. Ethnobiol. Ethnomed.* **2014**, *10*, 11. [CrossRef]

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