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Research Article

Do Locals' Perception of Bushfire Impact on Rubber Trees Match or Mismatch with Empirical Data? Evidence from Edo State, Nigeria

Paul Orobosa OROBATOR*, Peter Akpodiogaga-a ODJUGO

University of Benin, Faculty of Social Sciences, Geography and Regional Planning, Benin City, Edo State, NIGERIA
*Corresponding Author: orobosa.orobator@uniben.edu

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Abstract

Aim of study: This study determined whether locals' perception of bushfire impact on rubber trees matched or mismatched with empirical data.

Area of study: This investigation was conducted in Rubber Research Institute of Nigeria (RRIN) and six neighboring communities (Uhie, Iyanomo, Obaretin, Obayantor I, Ogbekpen and Obagie) in Edo State, Nigeria.

Material and methods: Quantitative data on tree height, canopy, diameter at breast height (DBH) and bark were obtained by direct measurements and field observation in burnt and unburnt rubber plantations. Locals' perceptive data were obtained through the administration of questionnaire. Descriptive statistics were used to examine data on perception of locals' while Student-t test was adopted to determine significant differences of tree parameters in burnt and unburnt rubber plantations.

Main results: There were significant differences in height, canopy and DBH of rubber trees. Besides incidences of fissured tree bark; reduction in height, canopy and DBH of trees were detected in burnt rubber plantation. Majority of the local's agreed that bushfire negatively impacted rubber tree parameters and natives' perception aligned with the experiential results.

Highlights: Locals' perception of bushfire effect on rubber trees accessed through the Likert-type format of questionnaire matched with empirical data.

Keywords: Bushfire Effect, Empirical Data, Ethnoecology, Natives' Perception, Rubber Plantations

Yerel Halkın Kauçuk Ağaçları Üzerindeki Orman Yangını Etkisi Algısı Ampirik Verilerle Eşleşiyor mu veya Uyuşmuyor mu? Edo Eyaleti, Nijerya'dan kanıtlar

Öz

Çalışmanın amacı: Bu çalışmada, yerel halkın kauçuk ağaçları üzerindeki orman yangını etkisi algısının ampirik verilerle eşleşip eşleşmediğinin belirlenmesi amaçlanmıştır.

Çalışma alanı: Bu araştırma, Nijerya Kauçuk Araştırma Enstitüsü'nde (RRIN) ve Nijerya'nın Edo Eyaleti'ndeki altı komşu toplulukta (Uhie, Iyanomo, Obaretin, Obayantor I, Ogbekpen ve Obagie) yürütülmüştür.

Materyal ve yöntem: Yanmış ve yanmamış kauçuk plantasyonlarında ağaç boyu, kapalılık, göğüs çapı (DBH) ve kabuk ile ilgili nicel veriler doğrudan ölçümler ve saha gözlemi ile elde edilmiştir. Yerel halkın algısal verileri anket uygulaması yardımıyla toplanmıştır. Yerel halkın algısına ilişkin verileri incelemek amacıyla tanımlayıcı istatistikler kullanılırken, her iki kauçuk plantasyonunda ağaç parametrelerinin anlamlı farklılıkları Student-t testi kullanılarak belirlenmiştir.

Temel sonuçlar: Kauçuk ağaçlarının boy, kapalılık ve DBH değerlerinde anlamlı farklılıklar gözlemlenmiştir. Çatlamış ağaç kabuğu etkilerinin yanısıra, yanmış kauçuk plantasyonunda ağaçların boyunda, kapalılık ve DBH değerlerinde azalma tespit edilmiştir. Yerel halkın çoğunluğu, orman yangınının kauçuk ağacı parametrelerini olumsuz yönde etkilediği ve yerlilerin algısının deneyimsel sonuçlarla uyumlu olduğunu belirtmektedir.

Araştırma vurguları: Yerel halkın kauçuk ağaçları üzerindeki orman yangını etkisi algısı ampirik verilerle eşleşmektedir.

Anahtar Kelimeler: Orman Yangını Etkisi, Ampirik Veriler, Etnoekoloji, Yerlilerin Algısı, Kauçuk Tarlaları

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Introduction

Bushfires are prevalent in most parts of Nigeria because during the dry season each year, locals' set fire on grasslands to open them and expedite the growth of new pastures for livestock. Farmers also adopt fire to prepare farmlands, break thick vegetation, control pests, weeds and parasites. At recurrent times, fire becomes wild and blows out to adjacent farms, savannas, woodlands or mixed/monoculture tree plantations. In the tropics, an increasing area of forest lands is deforested and forest land use is converted to perennial tree plantations (Ekanade & Orimoogunje, 2012). In tropical biomes, perennial tree crops are cultivated under a system of long-term or permanent farming and are vulnerable to bushfire incidents (Trollope et al., 2002). In Nigeria, bushfire is one of the major anthropogenic disasters in rubber plantations and the increasing all-encompassing need for latex has stimulated rubber plantation evolution since the last century (Singh et al., 2021). Bushfire as an ecological disturbance affects the morphology of rubber trees by influencing its different parameters of growth and development.

Height, canopy, diameter at breast height (DBH) and bark are defining features of the health and growth of rubber trees. Tree height plays a key role in the estimation of individual and total stand volumes; it is also significant in evaluating the total productive capability of the flora site and is essential to the social standing of specific tree capacity to access resources (Krause et al., 2019). Additionally, tree height is vital in assessing forest biomass and carbon stocks, which are elements of collective ecological significance for the mitigation of climate change through forest activities (Thenkabail, 2015). A study undertaken by Stovall et al. (2019), revealed that tree height was the strongest predictor of tree mortality compared with slope, maximum vapor pressure shortfall, available water storage, precipitation and maximum temperature. DBH contributes enormously to ecosystem functions and is a relevant predictor variable for the development of tree dimensions (Lutz et al., 2021). DBH is used also to describe stand structure, estimate tree volume and select an inventory sample of trees (Corral-Rivas et al., 2007). Tree canopy is a vital factor for tree growth and it governs the amount of solar radiation intercepted by a tree (Tanka, 2006). Tree bark plays an important role in transporting photosynthetic products in plant tissues relevant to the mechanics of the stem, aids in defense of the tree against herbivores, shields against the severe impacts of bushfire and offers insulation to trees in cold situations (Ducatez-Boyer & Majourau, 2017). The bark of rubber trees contain a network of interconnected vessels through which latex flows when opened and rubber is the major industrial product derived from latex (Verheye, 2010).

Fire is essential to anthropoid growth (Nikolakis & Roberts, 2020) and locals' inhabit across the world manage their lands with fire guided by their practices, experiences, customs and perceptions (Moura et al., 2019). Local perception on bushfire effect on tree ecosystems is still unbroken amongst indigenous populations in various parts of Africa but this understanding is not documented (UNEP, 2008). Majority of existing researches on rubber tree biomes (Ichikogu, 2011; Orimoloye et al., 2012; Meti et al., 2014; Ugwa et al., 2016; Orobator et al., 2020) have focused largely on quality of soils in rubber plantations. Prior investigations on vegetative biomes (Odhiambo, 2015; Denham et al., 2016; Verma et al., 2017; Hood et al., 2018; Barker et al., 2019; Bar et al., 2019; Stevens-Rumann & Morgan, 2019) have majored more on assessing fire impacts on other diverse tree species. Furthermore, previous studies of fire impacts on forest structure (Holden et al., 2007; Schafer et al., 2015; Lydersen et al., 2016; Forrestel et al., 2017; Stoddard et al., 2018; Bontrager et al., 2019) have mostly been undertaken in the temperate regions of the world. Notwithstanding the ecological and physiological implications of the height, canopy, DBH and bark of rubber trees as well as the socio-economic worth of rubber plantations in the Nigeria's economy, there has been no previous study conducted on the effect of bushfire on height, canopy, DBH and bark of rubber trees until now.

In carrying out investigations of bushfire impact on rubber trees, it is vital that the perception of natives should be integrated, especially as locals' activities (latex production, farming, hunting, charcoal production, livestock grazing, hunting etc.) are among the dominant anthropogenic activities within and around rubber plantations (Orobator, 2019). The global scientific community recognizes the significance of local perception in environmental inquiries; hence, they endorsed that scientific and indigenous perceptive data should be incorporated mostly in ecological research (UNEP, 2008). However, until now, no study has integrated empirical and indigenous perception data to investigate bushfire impacts on height, canopy, DBH and bark of rubber trees. Further gaps were established when a recent comprehensive global review on rubber plantation focused only on ecosystem functions (Singh et al., 2021).

Bushfire is in close association with most indigenous activities (deforestation, slash/burn and cattle ranching etc.) that are ancestral traditional practices (Jua´rez-Orozco et al., 2017) and this makes the current investigation appropriate. Despite the benefits of locals' perception in ecological studies, without scientific data, results from only indigenous perception can rarely be competent to deal with and relied on (Barriosa & Trejo, 2003). An integrated perceptive and scientific approach in biogeographical inquiries would disable the restriction of sentiments attached to site specificity and permit knowledge extrapolation through space (Cook et al., 1998). The objectives of this research were to: (i) examine the impact of bushfire on height, canopy, DBH and bark of rubber trees, (ii) analyze the perception of natives' on the effect of bushfire on height, canopy, DBH and bark of rubber trees and (iii) determine if locals' perception of bushfire impact on height, canopy, DBH and bark of rubber trees align or not with empirical data.

Material and methods

Study Area

The study sites are situated in Ikpoba Okha Local Government Area of Edo State, Nigeria (Figure 1) and their locations are presented in Table 1 below.

Table 1. Study sites and their coordinates

S/N	Study sites	Coordinates
1	Rubber Research Institute of Nigeria (RRIN)	6° 08' 54.99" - 6° 10' 0.48" N and 5° 34' 9.12" - 5° 36' 44.64" E
2	Obagie Community	6° 10' 52.32" - 6° 12' 48.96" N and 5° 34' 9.12" - 5° 36' 44.64" E
3	Uhie Community	6° 08' 42.72" - 6° 10' 39.36" N and 5° 36' 18.72" - 5° 38' 15.86" E
4	Iyanomo Community	6° 08' 16.8" - 6° 09' 34.56" N and 5° 38' 2.4" - 5° 40' 12" E
5	Obaretin Community	6° 09' 18'' - 6° 11' 06'' N and 5° 37' 11.35" - 5° 40' 11.94" E
6	Obayantor I Community	6° 09' 34.56" - 6° 10' 26.4" N and 5° 33' 04.13" - 50° 34' 21.66" E
7	Ogbekpen Community	6° 08' 04.54" - 6° 09' 21.39" N and 5° 33' 17.28" - 5° 35' 0.96" E

Their relief reflects a topography that is largely flat to gentle slope with an elevation ranging from 26m at the northern part to 36m and higher than the mean sea level in the southern region of Ikpoba Okha Local Government Area and are drained by River Ikpoba and River Ossiomo (Ugwa et al., 2005). The soils of the study areas are Ferrallitic soil type (Areola, 1991) which is deep, porous, non-mottled and non-concretionary red soils (Izevbigie et al., 2011). Their rainfall pattern is bimodal and it is characterized by an extended rainy season which begins in early March with a short rainy period stretching from September to late October (Eifediyi et al., 2012). The mean total annual rainfall is 2.255 mm with an average of 110 rainy days per annum and can reach up to 140 rainy days in some years. The mean minimum annual temperature is 25^0C while the maximum temperature is 29^0C. (Ugwa et al., 2016). The relative humidity is 72% and characterized by moderate wind speed and sunshine hours between 2 to 7 hours per day (Esekhade et al., 2003). Rubber Research Institute of Nigeria (RRIN) is endowed majorly with rubber trees (*Hevea brasiliensis*). However, annual crops such as yams (*Dioscorea)*, cassava (*Manihot esculenta*) and plantain (*Musa paradisiaca*) are prevalent in Iyanomo, Uhie, Obaretin, Obayantor 1, Obagie and Ogbekpen communities.

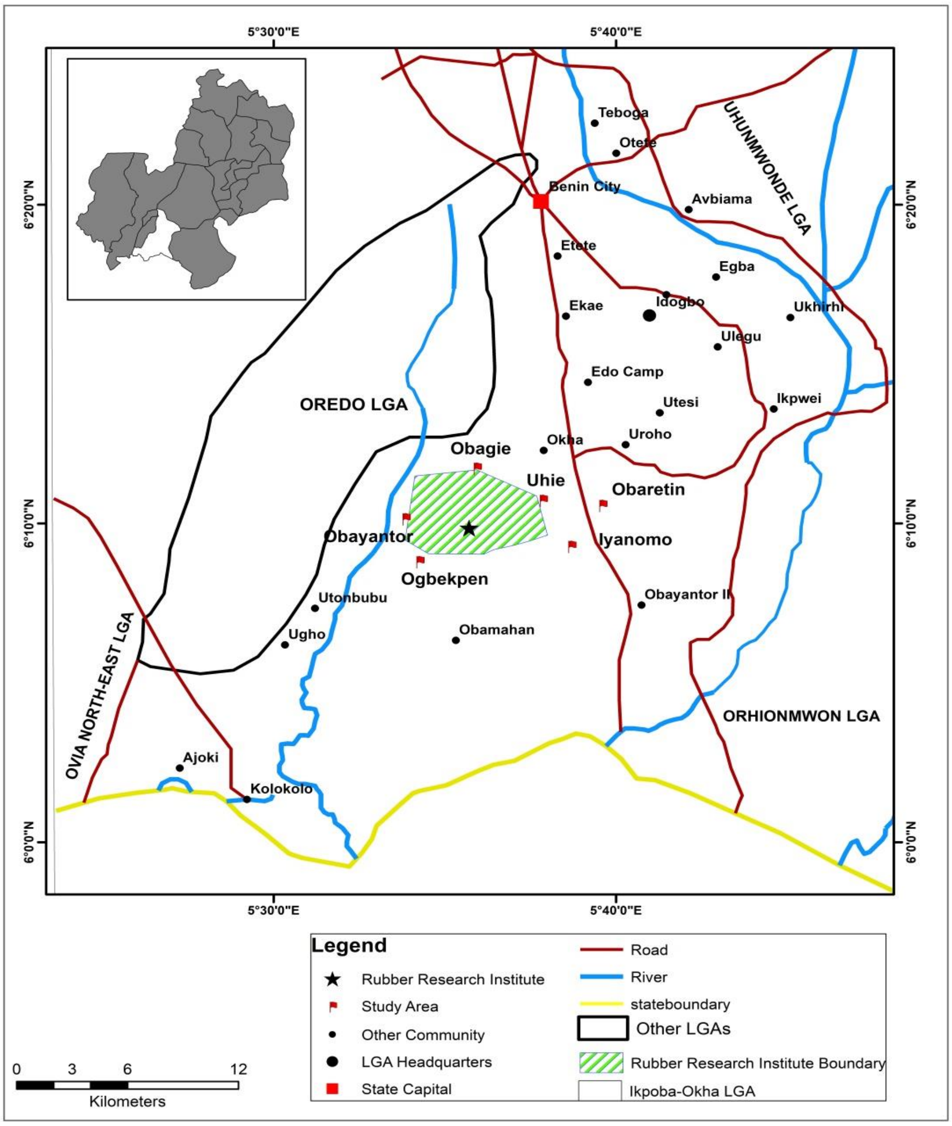

Figure 1. Rubber Research Institute of Nigeria (RRIN) with other study areas

Study Design and Tree Sampling Procedures

The grid sampling design and the non-destructive vegetation sampling methods were adopted for this research. The non-destructive vegetation sampling method is an indirect method which involves the measurement of specific tree parameters (height, DBH, canopy etc.) that have significant relationships with tree growth and development (Ogidiolu, 1997). However, due to the homogeneity of tree species in rubber plantations, the research adopted a sample area of 100 m^2 and plot size of 20 m × 20 m (Enaruvbe, 2017). Each of the sampled areas in the unburnt and burnt rubber plantations was further divided into 25 plots of 20 m × 20 m each. Ten 20 m × 20 m plots from each of the sampled areas in the burnt and unburnt rubber plantations were randomly selected making a total of twenty 20 m × 20 m plots for this study. Four rubber trees were randomly sampled from each of the ten plots of 20 m × 20 m while forty rubber trees from the burnt and unburnt rubber plantations were sampled, making an overall of eighty rubber trees. The choice of the number of rubber trees was based on the need to ensure accuracy and differences in the rubber tree properties between the unburnt and burnt rubber plantations, especially as the goal of the study is to ensure that each plot is adequately representative (Otypkova & Chytry, 2006). Due to the unavailability of lasers, the height of the rubber trees was estimated with the aid of a 10 m pole (Oliveira-Filho et al., 1994). In measuring the height of each rubber tree, the

10m pole was placed on the base of the selected rubber tree very close to its trunk. To aid proper estimation of the measurement of the rubber tree height, the 10m pole was marked at intervals of 1m each. DBH was measured using a measuring tape at approximately 1.5 m height from the ground surface (Enaruvbe, 2017). The unburnt and burnt rubber plantations were both 10 years old. The widths of canopies of the rubber trees were determined by projecting the edge of the tree canopy to the ground and measuring the length along one axis from edge to edge through the center of the tree canopy with a measuring tape. However, a field observation tactic was adopted to identify the incidence of fissured bark on the trees of the burnt rubber plantation.

Research Population and Questionnaire Administration

The research population comprises natives of Uhie, Ogbekpen, Obaretin, Iyanomo, Obayantor 1 and Obagie communities respectively. In this study, the six communities were chosen principally because of their vulnerability to bushfire occurrence owing to their livelihood activities. In addition, these communities have close proximity to the Rubber Research Institute of Nigeria (RRIN) where the rubber plantations are located. The respondents for the questionnaire were heads of households which are predominantly local farmers from the neighboring communities and laborers employed by RRIN. The selection of head of household was based on the systematic sampling technique. To acquire data on the perception of bushfire effects on rubber tree height, canopy, DBH and bark, the Likert-type format type of questionnaire was administered to the household heads (Figure 2). Based on the sample size (two hundred), questionnaires allocated were as follows: Uhie (10), Ogbekpen (40), Obaretin (22), Iyanomo (84), Obayantor 1 (22) and Obagie (22). Personal discussions with the sampled locals' were also used to elicit information for this study.

Figure 2. Researcher with one of the locals' (household head) in Ogbekpen Community

Statistical Analyses

Descriptive statistics was the main statistical analysis adopted to examine the perception of the locals' in the examined communities. This statistical tool helped to show the frequencies and percentages of the perceptive data of the locals' on the impacts of bushfire on the height, canopy, DBH and bark of rubber trees. Descriptive statistics was also used to characterize and understand the nature and properties of their distribution (Gouwakinnou et al., 2019) by providing summaries about the samples and observations made (Kaushik & Mathur, 2014). To determine significant differences in height, tree canopy and DBH of rubber trees in the burnt and unburnt rubber plantations, inferential statistics (Student t-test statistical technique) was used. All statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 22.

Results

Demographic Characteristics of Household Heads

The summary of demographic characteristics of household heads is indicated in Table 2. Majority of the household heads were males (189) while only 5.5 percent were females. Out of the 200 household heads, 133 (66.6 percent) were 60 years and above. 104 out of the 200 household heads do not have any form of formal education. Cumulatively, the results agree with the situations observed in most classic Nigerian rural communities where minority of household heads are females while majority of the natives are not well-read.

Table 2. Demographic characteristics of respondents

Variables	Categories	Frequency	Percentage
Gender	Male	189	94.5
	Female	11	5.5
Age	< 30 years	-	
	31–39 years	2	1
	40 -49 years	15	7.5
	50 -59 years	50	25
	60 years and above	133	66.5
Educational status	No formal	104	52
	Primary six cert	71	35.5
	JSSCE/SSCE	9	4.5
	ND/HND/B.Sc.	14	7
	M.Sc./Ph.D.	2	1
Occupation	Civil servant	27	13.5
	Farming	138	69
	Trading	13	6.5
	Hunting	13	6.5
	Retiree	9	4.5

Empirical Data on Tree Height, Diameter-at-Breast Height (DBH) and Canopy

Data on tree height, DBH and tree canopy of burnt and unburnt rubber plantations are shown in Table 3. The range of values of tree heights in unburnt rubber plantation varies from 12.50 - 14.50 m with mean value of 14.09 m. In the burnt rubber plantation, the range of values of tree heights varies from 9.20 - 10.38 m with mean value of 9.72 m. The differences of tree heights in the unburnt and burnt plantations were significant (P < 0.05).

Table 3. Summary of tree height, diameter-at-breast height and tree canopy measurements

Vegetation Parameter	Unburnt Rubber Plantation				Burnt Rubber Plantation				*p* -value
	Range	Mean	Std	CV	Range	Mean	Std	CV	
TH (m)	12.50 - 14.50	14.09	0.59	4.18	9.20 - 10.38	9.72	0.43	0.44	0.02*
DBH (cm)	70.00 - 79.00	74.70	2.75	3.68	39.00 - 46.00	42.60	2.36	5.53	0.02*
TC (m)	7.05 - 8.65	8.11	0.58	7.15	3.82 - 4.75	4.40	0.30	6.81	0.02*

TH: Tree height, DBH : Diameter- at- breast height and TC: Tree canopy

The values of DBH in unburnt rubber plantation vary from 70.00 to 79.00 cm with mean value of 74.70 cm. In burnt rubber plantation, the range of values of DBH varies from 39.00 to 46.00 cm with mean value of 42.60 cm. The differences of DBH in the unburnt and burnt plantations were significant (P < 0.05).The range of values of tree canopies in unburnt rubber plantation vary from 7.05 - 8.65 m with mean value of 8.11m. In burnt rubber plantation, the range of values of tree heights varies from 3.82 - 4.75 m with mean value of 4.40 m. The differences of tree canopies in the unburnt and burnt plantations were significant (P < 0.05).

Perceptive Data of The Locals' on The Effects of Bushfire on Tree Canopy

Results showed household heads' perception of the impacts of bushfire on the canopies of rubber trees in Table 4. The proportion of household heads who perceived that bushfire impacted the canopies of rubber trees negatively were more compared to those who perceived otherwise. However, regarding the distribution of the perception of locals in the investigated communities, the most unifying feature among their analyzed perceptions was observed in the examined communities, where a minimum of 50% of the natives' perceived that bushfire has a negative effect on the canopies of rubber trees.

Table 4. Locals' Perception of the negative effects of bushfire on the canopies of rubber trees

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	66 (78.6)	16 (72.7)	11 (50)	7 (70)	24 (60)	17 (77.4)
Agree	13 (15.4)	4 (18.3)	4 (27.3)	1 (10)	9 (22.5)	3 (13.7)
Undecided	0	0	1 (4.5)	0	1 (2.5)	0
Disagree	2 (2.4)	1 (4.5)	2 (9.1)	1 (10)	3 (7.5)	1 (4.5)
Strongly disagree	3 (3.6)	1 (4.5)	2 (9.1)	1 (10)	3 (7.5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Locals' Perception on The Effects of Bushfire on Tree Height

Locals' were asked to state their perception on the negative impacts of bushfire on the height of trees in rubber plantations. The results of their perception are shown in Table 5. The highest percentage of the perception of natives' was recorded in Obagie Community. Notwithstanding, at least 50 percent of locals' in all the studied communities perceived that bushfire impacts the height of rubber trees negatively.

Table 5. Locals' Perception of the negative impact of bushfire on the height of rubber trees

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	72 (85.7)	12 (54.5)	16 (72.7)	6 (60)	26 (65)	19 (86.5)
Agree	2 (2.4)	5 (22.8)	5 (22.7)	2 (20)	10 (25)	1 (4.5)
Undecided	0	1 (4.5)	0	0	1 (2.5)	0
Disagree	4 (4.8)	2 (9.1)	1 (4.5)	1 (10)	1 (2.5)	1 (4.5)
Strongly disagree	6 (7.1)	2 (9.1)	0	1 (10)	2 (5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Natives' Perception on The Effects of Bushfire on DBH

Data on locals' perception of the reduction of DBH of rubber trees due to bushfire are shown in Table 6. The highest proportion of sampled natives' who perceived that bushfire leads to reduction of DBH of rubber trees were from Iyanomo (89.3 percent); followed by Ogbekpen (70 percent), Obaretin (68 percent), Uhie (60 percent), Obagie (59.1 percent) and Obayantor 1 (59.1 percent) communities respectively.

Table 6. Locals' Perception on DBH

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	69 (89.3)	12 (54.6)	15 (68.3)	6 (60)	28 (70)	13 (59.1)
Agree	9 (10.7)	6 (27.3)	4 (18.2)	2 (20)	7 (17.5)	6 (27.3)
Undecided	1 (1.2)	1 (4.5)	1 (4.5)	0	1 (2.5)	0
Disagree	2 (2.4)	2 (9.1)	1 (4.5)	1 (10)	2 (5)	1 (4.5)
Strongly disagree	3 (3.6)	1 (4.5)	1 (4.5)	1 (10)	2 (5)	6 (27.3)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Locals' Perception of Bushfire Impacts on The Bark Rubber Trees

An important part of a rubber tree that is prone to bushfire attack is its bark. The results of a sample survey of the perceptions of locals' of fissured bark of rubber trees owing to bushfire occurrences in rubber plantations is summarized in Table 7. The outcome showed that majority of the natives' in all the communities (Iyanomo, Ogbekpen, Obaretin, Uhie, Obagie and Obayantor 1) perceived that bushfire was responsible for the presence of fissured bark on the trees in the burnt rubber plantation. Their perception was affirmed as correct, as we personally observed in the field that the bark of trees in the burnt rubber plantation were not only burnt but fissured. This observed consequence of bushfire on rubber tree bark in the burnt rubber plantation was absolutely absent on trees in the unburnt rubber plantation.

Table 7. Locals' Perception of bushfire impacts on rubber trees bark

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	70 (83.3)	18 (81.8)	13 (59.1)	7 (70)	25 (62.5)	15 (68.3)
Agree	11 (13.1)	3 (13.6)	7 (31.8)	1 (10)	9 (22.5)	4 (18.2)
Undecided	0	1 (4.5)	0	0	1 (2.5)	1 (4.5)
Disagree	1 (1.2)	2 (9.1)	1 (4.5)	1 (10)	3 (7.5)	1 (4.5)
Strongly disagree	2 (2.4)	2 (9.1)	1 (4.5)	1 (10)	2 (5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Discussion

Effect of Bushfire on Tree Height

The result of this investigation revealed that the mean value of tree height was higher in unburnt rubber plantation (14.09 m) than in burnt rubber plantation (9.72 m). The result revealed the negative impact of bushfire on the height of rubber trees. This may account for the observed significance difference of the height of trees in the unburnt and burnt rubber plantations (Table 3). The detected reduction in the height of the trees in the burnt plantation may be ascribed to the decrease in metabolic activity which controls the rapidity and length of the growth of trees (Ogidiolu, 1997). García-Jiménez et al., (2017) had earlier reported that the height of a tree is a factor that helps to reveal bushfire influences. Consequently, relating the empirical results obtained from the field with the data of the perception of the locals', we observed that the perception of the natives' on the impact of bushfire on tree height matched with empirical data. The results affirm that the natives' have a good understanding that bushfire will affect the height of rubber trees negatively.

Effect of Bushfire on DBH

The result of this study revealed that burnt rubber plantation had lower mean DBH value (42.60 cm) compared to unburnt rubber plantation with a mean DBH value of 74.70 cm. This implies that bushfire has negative effects on the DBH of rubber trees. The observed significant difference of DBH of rubber trees in the unburnt and burnt plantations may be due to improved cambial activities and greater presence of nutrient supply of the unburnt rubber trees (Ogidiolu, 1997). However, it may be expected that since the rubber trees in burnt rubber plantation have been affected by bushfire, the burnt rubber trees may have decreased cambial activity due to lower availability of nutrient supply in the burnt trees. Generally, only a few of the natives in all the communities do not believe that bushfire has a negative impact on the DBH of rubber trees.

Discussions with these marginal numbers of locals' showed that they perceived that bushfire can enhance the growth of the DBH of rubber trees after bushfire fire occurrence in the rubber plantations. Notwithstanding, the views of the majority of the sampled natives' in all the communities inferred that the locals' perceived that bushfire leads to a decrease in DBH of rubber trees in rubber plantations. Aligning the perception of household heads on the negative impact of bushfire on DBH of rubber trees with empirical results, we observed that the perception of the locals' matched with empirical data, indicating that bushfire has a negative impact on DBH of the rubber trees. Therefore, the natives have a correct perception of the effects of bushfire on DBH of rubber trees. However, Holden et al. (2007) in examining effects of multiple wildland fires on ponderosa pine stand structure in two Southwestern Wilderness Areas, USA, observed that DBH of the trees was significantly higher in areas burnt twice and also in mid-20th century than in areas burnt twice but not burnt in mid-century. This infers that the DBH of varied tree species respond contrarily to bushfire effects. Ogidiolu (1997) had earlier reported that the size of DBH varies with the prevailing ecological disturbances.

Effect of Bushfire on Tree Canopy

The result of this study indicates a reduction in tree canopy from 8.11 m in unburnt rubber plantation to 4.40 m in burnt rubber plantation. This infers that bushfire has adverse effects on the canopies of rubber trees. The observed significant difference of tree canopies in the unburnt and burnt plantations may be credited to the size and vitality of rubber trees due to the absence of the effects of bushfire on the unburnt rubber trees (Ogidiolu, 1997). The result of this study is consistent with the findings of Faber-Langendoen & Davis (1995), they reported that tree canopy cover decreased overtime due to burn effects. Aligning the perception of household heads on the negative impact of bushfire on the canopies of rubber trees in rubber plantations with the empirical results, we detected that the perceptions of the locals' matched with empirical data, which showed that bushfire had a negative impact on the canopies of the rubber trees. This deduces that household heads have a good understanding of bushfire impacts on rubber tree canopies. It may be anticipated that since the burnt rubber plantation has been affected by bushfire, the affected rubber trees may not have the resilience or ability to develop enough spreading canopy compared to the rubber trees of the unburnt rubber plantation.

Effect of Bushfire on The Bark of Rubber Trees

The perception of majority of the natives showed that bushfire has a negative impact on the bark of rubber trees. Our personal observations in the field also affirmed that most trees in the burnt rubber plantation had fissured barks, indicating the damaging effects of bushfire on tree bark. Relating the perceptions of the natives with observed field findings, we discovered that the perceptions of the locals' matched also with our observations. This indicates that the natives have a correct perception that bushfire was responsible for the fissured bark of rubber trees in the burnt rubber plantation. The heat emanating from bushfire affects both the tree bark as well as the cambium resulting in fissures on the tree bark. Fire typically destroys trees in two ways; that is by damaging the cambium layer just underneath the bark of a tree and by destroying all of the buds and leaves (Kolb, 2002).

Conclusions

It is significant to gain a better understanding of how locals' perceived bushfire impact on rubber trees in Nigeria. The study focused on how locals' perception of bushfire impact on rubber trees match or mismatch with empirical data. The findings indicated that there were significant differences ($P < 0.05$) in height, canopy and DBH of rubber trees in both burnt and unburnt rubber plantations. Besides detected incidences of fissured tree bark in the burnt rubber plantation; decrease in the height, canopy and DBH of trees were also revealed. The results of this study also showed that the locals' perceived that bushfire negatively impacted the canopy, height, DBH and bark of rubber trees. The research concluded that natives' perception of bushfire effect on rubber trees matched with empirical data demonstrating that the locals' have a good understanding of bushfire impacts on height, canopy and DBH of rubber trees. Such right indigenous perception is important for initiating sustainable strategies for the prevention of bushfire in rubber plantations and enhancement of the social, economic and ecological values of rubber trees in the tropics. This contemporary study makes noteworthy contributions in progressing flora, fire ecology and ethnoecological investigations in Nigeria.

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Conflict of Interest

The authors have no conflicts of interest to declare.

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