NATIVES' PERCEPTION ON CAUSES AND MITIGATION OF BUSHFIRE IN RUBBER PLANTATIONS IN NIGERIA: A SOCIAL-ECOLOGICAL SYSTEM APPROACH

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Abstract: The study examined natives' perception on causes and mitigation of bushfire in rubber plantations from a social-ecological system (SES) perspective. Research data mainly from questionnaire and visual method was adopted for the investigation. Descriptive statistics (proportions and percentages) was adopted to analyze the perceptive data. Results showed that the natives' perceived uncontrolled bush burning as the leading cause of bushfire in rubber plantations whereas arson, lightning, fireworks, charcoal production and warding off snakes are not principal causative agents of bushfire in rubber plantations. The outcomes of the study also revealed that the natives perceived that enlightenment and education, fire fuels reduction, fire guards establishment, enforcement of laws against indiscriminate bush burning, issuing of burning permits, traditional rulers involvement and building of fire towers are vital mitigatory tactics against bushfire in rubber plantations. However, they perceived that enactment of laws against indiscriminate hunting and livestock grazing are not potential mitigative approaches. Based on the natives' perceptive information, the research recommended that an indigenous participatory approach should be adopted as a mitigating strategy against bushfire incidences in tropical rubber plantations.

Keywords: bushfire, indigenous, perception, rubber plantations, social-ecological system

1   INTRODUCTION

Bushfires are wild, unstructured fires that burn in grasslands, shrub lands, plantations or forests (Behera et al., 2020). Bushfires are social–ecological disturbances embraced from the standpoint of its disruption of vulnerable biomes in different communities (Prior and Eriksen, 2013). Unlike earthquakes or volcanic eruptions, bushfire is as a preventable hazard (Doerr and Santín, 2016). In contemporary years, there has been a dramatic upsurge of large bushfire incidents (Lindenmayer et al., 2023). Globally, about 350 million hectares of flora are burnt annually with practi-

cally one half found in sub-Saharan Africa (Kouassi et al., 2020). Tropical rainforests which were once believed to be resilient to bushfires are now facing extensive fires (Secretariat of the Convention on Biological Diversity, 2001). In Nigeria, bushfire has been a major land use problem for years and also challenging in reducing the frequency of its occurrences (Orobator and Ugwa, 2023). It is one of the foremost anthropogenic catastrophes in rubber plantations in the tropics (Orobator and Odjugo, 2023) and a dire agent of change facilitated by interactions of human and ecological systems (Steelman, 2016).

Natives are considered fundamental agents of environmental processes in their communities (Oldekop et al., 2016) and have incorporated fire as a tool to offer a variety of ecosystem services (Dunn et al., 2020). However, locals' usage of fire can be observed as a significant anthropogenic agent that has affected most biomes at varied scales (Santín and Doerr, 2016). The emerging challenge of confronting bushfire menace has necessitated forest managers, land administrators, plantation owners and researchers at progressively looking to natives' perceptions as a principal basis of evidence for indigenous participatory approach in bushfire management (Copes-Gerbitz et al., 2021). Indigenous perception of bushfire is vital to address its detrimental impacts with definite orientation to forestry, arable farming, rangelands, plantations, wildlife and soil quality (Yahaya and Amoah, 2013). The perception of locals' in the communities is central because of their ability to mitigate bushfire risks. This aligned with Community-Based Fire Management (CBFiM) which has emerged as advanced adaptive machinery for utilizing and managing bushfire (Kosoe et al., 2015).

In spite of the recurring incidences of bushfire in tropical tree ecosystems, up till now, locals' perception on causes and mitigation of bushfire remains under explored, especially in rubber plantations which are one of the dominant ecological tree biomes in Nigeria. Limited prior investigations on bushfire in *H. brasiliensis* plantations focused only on locals' perception of bushfire impact on rubber trees (Orobator and Odjugo, 2023); indigenous communities' knowledge of bushfire impacts on specific soil quality indicators in rubber plantations (Orobator and Ugwa, 2023), and effect of bushfire on soil bacteria and fungi in rubber plantations (Orobator, 2022). The dearth of scholarly understanding showed that substantial gaps need to be filled. Therefore, the goal of the study is to examine natives' perception on causes and mitigation of bushfire in rubber plantations. Specifically, the findings of the research will provide significant contemporary data for the formulation and implementation of indigenous bushfire policy targeted at conserving tropical *H. brasiliensis* plantations.

Theoretical background: Social-ecological system (SES)

Social–ecological systems (SES) also recognized as a "composite human–earth system" denotes a connecting system with intricacy and multilayer nesting geographies shaped by the interaction between humans and the environment (Gain et al., 2020). SES is a coherent system of biophysical (climate, biochemical cues, topography, soil quality, etc,) and social factors (individuals, communities, institutions,

etc.) interacting in the ecosystem (Holling, 2001). Social–ecological interactions reflect individuals; livelihood activities and ecological processes in the ecosystem and its exchanges capture the actions and responses between the social and ecological systems (Soga and Gaston, 2020). SES offers a compelling theoretical background to examine environmental problems and conceptualizes the ecosystem as an open system comprising of ecological and social components such as biomes, humans, wildlife etc. (Virapongse et al., 2016). It focuses on sustainability issues such as climate change, biodiversity loss, livelihoods, bushfire, poverty, policy, land use change, water, social and environmental justice etc. (De Vos et al., 2019).

Research literature in SES encompasses geography, resource science, environmental sciences, economics, social sciences and ecology (Liu et al., 2023). SES has been adopted by investigators to provide background in examining ecological issues rising from composite interactions between people and the environment (Folke et al., 2016). Copes-Gerbitz et al. (2021) stated that bushfire is inseparably related to underlying social context and reveals that bushfire interacts with and is reliant on community beliefs and decision making. Dunn et al. (2020) noted that large and severe bushfires are a noticeable result of a gradually more arid American West and that there is growing consent that social communities, land managers, and fire administrators need to acclimatize and learn to co-habitat with bushfires. Lake et al. (2018) reported that the Western science community is starting to admit the influence of indigenous peoples to fire-dependent landscapes and incorporate indigenous fire knowledge. Sheridan et al. (2015) adopted social and ecological indicative tools to develop a fire management plan for a communal forest encompassing a pervasive piñón pine species, Pinus cembroides subs. orizabensis, in the state of Tlaxcala, Mexico.

Understanding the causes and mitigation of bushfire incidences in rubber plantations through a SES background, requires examining the perceptions of the locals' who are strategic actors in the community. Theories are significant because they aid us know causes of problems and guide us to establish enhanced prevention policies (Beatson and McLennan, 2010). This established the utility of SES as a theoretical background to the research. Consequently, we considered the examined communities made up of locals as a social system characterized by structure. The structure of the communities refers to a construct of collective livelihood practices, perceptions, innate values, traditions etc. (Adger, 2006). The examined rubber plantations are considered as the ecological units with inherent degree of vulnerability to bushfire attacks while the individuals' perception depicts its social dimension.

2   METHOD AND MATERIALS

Description of study area

The study was done in six communities namely Iyanomo, Uhie, Ogbekpen, Obaretin, Obayantor 1 and Obagie chosen purposively based on their close proximity to the Rubber Research Institute of Nigeria (RRIN), Edo State, Nigeria (Fig-

ure 1). The communities are located in Ikpoba Okha Local Government Area, Edo State, Southern Nigeria and they lie within Latitudes 6° 10' 52.32" – 6° 12' 48.96" N and Longitudes 5° 33' 17.28" – 5° 35' 0.96" E. The soils are majorly the Ferralitic soil type and they are characterized by the humid tropical climate.
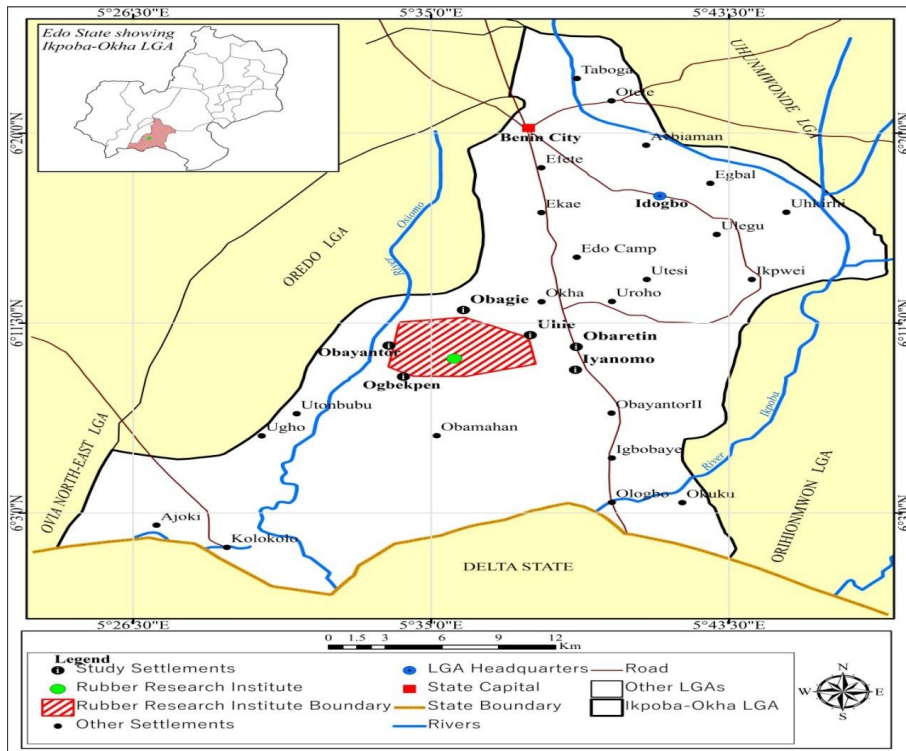

Figure 1 Ikpoba Okha Local Government Area showing Rubber Research Institute of Nigeria (RRIN) with the surrounding communities

Data Collection

Primary data were obtained from interviews, field observations, informal inter-active discussion and visual methods. Qualitative and quantitative methods were used into giving attention the data demands. Qualitative methodology permitted examining locals' experiences, perceptions, thoughts, feelings and ideas (Miles and Huberman, 2002). The target group was household heads and selection was based on systematic sampling technique. The major instrument for data collection was the questionnaire. Questionnaire is considered suitable when the object of the investiga-tion is to explore perceptions of a group or community in relation to some generally experienced aspects of their environment (Kosoe et al., 2015). The questionnaire

was administered to 200 household heads in the six communities. The household survey questionnaire was designed and pretested in the study areas to recognize possible undistinguishable questions. The questionnaire was reviewed based on response from the pilot survey. We defined a household head as the head of people living in the same compound or sharing the same agricultural fields. A household is defined as a farm family unit comprising of a group of interconnected persons living together, sharing the similar residence, working on the family farm, making farm-level choices and combining their labor to accomplish their farm under the chief headship of the household head (Kouassi et al., 2020). Review of Literature was undertaken and dependable sources of data such as scientific papers, policies and reports were obtained from libraries and internet. The secondary data offered a helpful or balancing support to the primary data set (Creswell et al., 2003). On-site observations made were done to have actual familiarity on burnt sites and some livelihood activities of the locals. Pictures improved the richness of data by adding depth and capturing more details (Glaw et al., 2017).

Data Analysis

Data obtained were analyzed using Statistical Package for the Social Sciences (SPSS) version 21. The statistical tools comprised of percentages and frequencies and the analyses were done both comparatively and descriptively. They offered insights into locals' perceptions of bushfire causes and mitigation. The use of tables allowed connecting evidence in ways that ascribe meaning to opinions (Cloutier and Ravasi, 2021). Tables also supported not only increase in clearness about data collection, examination, and outcomes, but also and no less significantly, organize and analyze data effectively (Cloutier and Ravasi, 2021). The indigenous perception of household heads was further validated by field observations, discussions and pictures.

3   RESULTS AND DISCUSSION

Indigenous perception of bushfire causes

Uncontrolled bush burning

Bush burning denotes to the act of setting weeds, timberland and grasses afire (Emetere and Aghogho, 2019). Household heads' perception of uncontrolled bush burning is shown in Table 1. At least 68.3 per cent of the household heads in the communities perceived that uncontrolled bush burning is liable to bushfire occurrences in rubber plantations. This inferred that majority of the household heads in the various communities demonstrated a good information base and understanding of uncontrolled bush burning as a key causal factor of bushfire in rubber plantations. Field observation also confirmed that majority of the rubber plantations were surrounded with farms (Figure 2). Personal discussions with the household heads affirmed that the natives carry out bush burning as a traditional pre-planting farming practice (Figure 3). They stated that it becomes problematic when the fire becomes unrestricted and spread to the adjoining rubber plantations. Ofuoku and Isife (2009)

reported that this type of bush burning is uncontrolled and could influence severely in biodiversity of both forest and plantation. Yahaya and Amoah (2013) stated that 25% of the respondents opined that scrublands are burnt in order to shield ruminants from reptiles such as scorpions and snakes. Ekinci (2006) reported that uncontrolled bush burning is one of the fundamental causes of bushfire.

Table 1 Perception of uncontrolled bush burning

Level of extent	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Very large extent	70(83.3)	17(77.3)	15(68.3)	8(80)	31(77.5)	15(68.2)
Large extent	7(8.3)	2(9.1)	3(13.6)	1(10)	6(15)	7(31.8)
Moderate extent	3(3.6)	2(9.1)	3(13.6)	1(10)	2(5)	1(4.5)
Little extent	2(2.4)	1(4.5)	1(4.5)	0	1(2.5)	1(4.5)
Very little extent	2(2.4)	0	0	0	0	0
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Figure 2 Rubber plantations in RRIN surrounded by cassava farms

Figure 3 Researcher with a native in a recently burnt farm

Indiscriminate livestock grazing/herdsmen activities

Household heads' perception of indiscriminate livestock grazing/herdsmen activities as accountable for bushfire incidences in rubber plantations are summarized in Table 2.

Table 2 Perception of indiscriminate livestock grazing/herdsmen activities

Level of extent	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Very large extent	67(79.7)	1(4.5)	13(59.2)	8 (80)	0	5(22.9)
Large extent	14(16.7)	0	6(27.3)	1(10)	3(7.5)	2(9.1)
Moderate extent	1(1.2)	1(4.5)	2(9.1)	1(10)	2(5)	2(9.1)
Little extent	1(1.2)	6(27.3)	1(4.5)	0	17(42.5)	13(59.1)
Very little extent	1(1.2)	14(63.7)	0	0	18(45)	0
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

The results revealed that only in Iyanomo, Obaretin and Uhie communities are indiscriminate livestock grazing/herdsmen activities vital contributory agent of bushfire occurrences in rubber plantations (Figure 4).

Bush burning by nomads is done to destroy the browning vegetation cover in the dry season and pave way for regeneration of green vegetation. During burning, fire blows-out into neighboring plantations (Ofuoku and Isife, 2009). Herders annu-

ally burn vegetation indiscriminately in order to stimulate early sprouting for their livestock (Ambe et al., 2015). Kusimi and Appati (2012) reported that occasionally locals are remunerated some token fees by nomadic herdsmen to set the dry flora aflame during the dry months of November to March while they migrate southwards to find fresh vegetation for the cattle; the herdsmen later come back with their cows around April and May by which time the vegetation may have regenerated by the initial rains of April and May. The findings of Adda (2015) showed that the major cause of the bushfire was Fulani herdsmen who used fire as a means of pasture management for grazing. Kusimi and Appati (2012) observed that 30% of bushfire are attributed to pastoralists. However, Katani et al., (2014) reported that 9.3% of local communities noted that livestock keepers' activities accounted of bushfire occurrences. In Obayantor 1, Ogbekpen and Obagie communities, indiscriminate livestock grazing/herdsmen activities contributes less to bushfire incidents. Discussion with household heads revealed that they prohibit livestock grazing/herdsmen activities in their domain.

Figure 4 Indiscriminate livestock grazing/herdsmen activities in Iyanomo community

Unselective hunting

Hunting is another key livelihood activity in the most communities particularly in the dry season; most people go on hunting voyages and set fires to drive out game to kill for meat (Kusimi and Appati, 2012). Household heads' perception of indiscriminate hunting as a factor responsible for bushfire incidences in rubber plantations is revealed in Table 3. At least, on a cumulative basis, 80 per cent of household heads in Iyanomo and Obaretin communities perceived that indiscriminate hunting is not responsible for bushfire occurrences in rubber plantations. The deduced that indiscriminate hunting accounted minimally to bushfire incidences in both communities. This may be due to the prevalence of deforestation (Figure 5) in Iyanomo and Obaretin communities. The results is aligned with the findings of Meddour-

Sahar et al. (2013) which observed that only 1.25% of the respondents stated that hunting is a causal factor of bushfire. Similarly, Yahaya and Amoah (2013) reported that 17.5% of the respondents acknowledged hunting as anthropoid activity which also instigates bushfires. However, in Obayantor 1, Uhie, Ogbekpen and Obagie communities, indiscriminate hunting does boost bushfire incidences in rubber plantations.

Table 3 Perception on indiscriminate hunting

Level of extent	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Very large extent	3(3.6)	5(22.7)	1(4.5)	8 (80)	8(20)	5(22.7)
Large extent	1(1.2)	15(68.2)	1(4.5)	1(10)	28(70)	13(59.2)
Moderate extent	0	2(9.1)	1(4.5)	1(10)	3(7.5)	3(13.6)
Little extent	29(34.5)	0	7(32)	0	1(2.5)	1(4.5)
Very little extent	42(50)	0	12(54.5)	0	0	0
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Figure 5 Deforestation in Iyanomo community

This is consistent with reports by Kouassi et al. (2020) which stated that the outcomes of Bruzon (1994) and Fournier et al. (2014) revealed that hunting is a key cause of bushfires in Burkina Faso and Côte d'Ivoire respectively. During the dry season, locals deliberately kindle fire on dry vegetation and trap down the animals. This kind of burning often goes harsh touching non targeted forest (Izah et al., 2017). Fire is used to smoke out animals such as rabbits, ground squirrels from holes during hunting. Adedayo (2015) affirmed that people use fire as a hunting aid. Local

hunters and Fulani herdsmen set fire on the bush to hunt wild animals and get fresh forage for animals.

Arson

Majority of household heads perceived that arson contributed either in a little or very little extent to bushfire incidents in rubber plantations (Table 4). Among all the surveyed household heads, only 1.2% from Iyanomo community perceived that arson accounted to a very large extent to bushfire. The result implied that arson is not a major causal agent of bushfire in rubber plantations. The results aligned with Yahaya and Amoah (2013), who reported that only 7.5% of the respondents opined that some individuals' burn bushes out of jealousy. However, Karki (2002) reported that natives use fire to ruin natural forests or plantations in retaliation and for political motives. Hirschberger (2016) stated that 72% of forest fires in Russia are caused by arson, one third in Portugal, more than half in Spain, 85% in Italy and 37% in Australia. Applegate et al. (2001) reported that in Indonesia, arson was predominantly obvious in areas of natural forest on productive soils, and extents where large landholders had acquired land for large-scale plantations.

Table 4 Perception on arson

Level of extent	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Very large extent	1(1.2)	0	0	0	0	0
Large extent	0	0	1(4.5)	1(10)	1(2.5)	1(4.5)
Moderate extent	3(3.6)	1(4.5)	1(4.5)	1(10)	1(2.5)	1(4.5)
Little extent	29(34.5)	1(4.5)	6(27.3)	1(10)	6(15)	6(27.4)
Very little extent	51(60.7)	20(91)	14(63.7)	7(70)	32(80)	14(63.6)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Cigarettes

Table 5 revealed locals' perception of cigarettes as a cause of bushfire in rubber plantations. Cumulatively, majority of the household heads in Iyanomo (97.7%), Obaretin (95.4%), Ogbekpen (97.5%), Uhie (60%) and Obagie (77.3%) recognized that cigarettes can instigate bushfire in rubber plantations. The findings of the study agreed with Kusimi and Appati (2012) which reported that unplanned causes of bushfires involved cigarette smoking significantly. Secretariat of the Convention on Biological Diversity (2001) reported that in the period 1907 – 1957, bushfires that happened due to carelessness (smoking, camp fires, honey collecting) accounted for as much as 52%. Ambe et al. (2015) opined that some bushfires have been linked to

reckless cigarettes smokers. Discussions with the technical staff of RRIN revealed that rubber tappers of the plantations smoke cigarettes and that in carrying out the act, they have the tendency of throwing the stubs of the cigarettes or part of the un-finished cigarettes on the vegetation mat of the rubber plantations. Kouassi et al. (2020) reported that researches of Butry et al. (2014), FRNSW, (2020) and Marcano (1997) indicated that most bushfires are caused by unextinguished cigarette butts thrown by cigarette smokers.

Table 5 Perception on cigarettes

Level of extent	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Very large extent	12(14.3)	0	1(4.5)	0	3(7.5)	7(31.8)
Large extent	66(78.6)	0	17(77.3)	2(20)	28(70)	0
Moderate extent	4(4.8)	1(4.5)	3(13.6)	4(40)	8(20)	10(45.5)
Little extent	0	5(22.7)	1(4.5)	4(40)	0	3 (13.6)
Very little extent	2(2.4)	16(72.7)	0	0	1(2.5)	2(9.1)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Lightning

Household heads perceptions of lightning as a factor accountable for bushfire incidents in rubber plantations are shown in Table 6. It revealed that ≥ 80 of the sampled household heads in the communities perceived that lightning is minimally accountable to bushfire. This inferred that lightning is not a major cause of bushfire in the rubber plantations. In the tropics, the contribution of lightning to bushfire in-cidences is insignificant (Convention on Biological Diversity, 2001). The findings of the study aligned with Yahaya and Amoah (2013) which reported that only 22.5% of the respondents perceived that bushfires are triggered by lightning. However, in the temperate and boreal forests, lightning can be a major ignition source of bushfire (Secretariat of the Convention on Biological Diversity, 2001). Majority of fires in 2014 and 2015 were kindled by lightning storms in contrast to anthropogenic actions (Joshi, 2017). Bradford (2018) stated that in 2017, National Inter-agency Fire Center (NIFC) reported that in the United States, lightning resulted to closely 8,000 bush-fires and that 2.1 million hectares (5.2 million acres) were burnt. Hirschberger (2016) reported that in northern Russia, the percentage of bushfires triggered by lightning lies around 50 – 70%. Lightning strike can be responsible for causing up to one fourth of the bushfires in unpopulated areas of Australia (Hirschberger, 2016). In Canada, records obtained from 1981 to 1995 show that lightning triggered some 42% of bushfires (Secretariat of the Convention on Biological Diversity, 2001).

Table 6 Perception on lightning

Level of extent	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Very large extent	0	0	0	0	0	0
Large extent	1(1.2)	1(4.5)	1(4.5)	0	2(5)	1(4.5)
Moderate extent	1(1.2)	1(4.5)	1(4.5)	1(10)	2(5)	1(4.5)
Little extent	4(4.7)	1(4.5)	2(9.1)	1(10)	3(7.5)	2(9.1)
Very little extent	78(92.9)	19(86.5)	18(81.8)	8(80)	33(82.5)	18(81.9)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Fireworks

Household heads perception of fireworks is depicted in Table 7. The result revealed that most of the households perceived that fireworks are not major contributive causes of bushfire in rubber plantations. Household heads that fall into the category of very large extent, large extent and moderate, though a small percentage perceived fireworks as an agent responsible for bushfire in rubber plantations. Discussions with then indicated that at times, their children take along with them fireworks as they accompany them to the rubber plantations. This according to them can cause bushfire in the rubber plantations. Bushfire initiated by igniting off fireworks links to weather conditions and it occurs more during constitutional holidays, traditional and ethnic fiestas etc. (Ye, 2016).

Table 7 Perception on fireworks

Level of extent	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Very large extent	1(1.2)	0	0	0	0	0
Large extent	1(1.2)	1(4.5)	1(4.5)	0	1(2.5)	1(4.5)
Moderate extent	2(2.4)	1(4.5)	1(4.5)	1(10)	1(2.5)	1(4.5)
Little extent	15(17.8)	1(4.5)	3(13.6)	2(20)	2(5)	6(27.3)
Very little extent	65(77.4)	19(86.5)	17(77.4)	7(70)	36(90)	14(63.6)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Charcoal production

The household heads' perception of charcoal production as a cause of bushfire in rubber plantations is shown in Table 8. The survey revealed that only Obayantor 1 community had the highest number of household heads (63.6%) who perceived that charcoal production is moderately responsible for bushfire in rubber plantations. This finding aligned with Kusimi and Appati (2012) who observed that unintentional causes of bushfires involved charcoal burning. Adda (2015) reported that fires from charcoal burners are also responsible for bushfire.

Table 8 Perception on charcoal production

Level of extent	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Very large extent	0	1(4.5)	0	0	0	0
Large extent	3(3.6)	2(9.1)	1(4.5)	1(10)	1(2.5)	1(4.5)
Moderate extent	4(4.8)	14(63.6)	1(4.5)	1(10)	10(25)	4(18.2)
Little extent	38(45.2)	5(22.7)	7(31.9)	1(10)	18(45)	10(45.5)
Very little extent	39(46.4)	0	13(59.1)	7(70)	11(27.5)	7(31.8)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

In contrast, majority of household heads in Iyanomo, Obaretin, Uhie, Ogbekpen and Obagie communities affirmed that charcoal production is not a major causal agent of bushfire in rubber plantations. Discussion with the household heads in the communities showed that charcoal production is undertaken far away in the forest and not close to the rubber plantations. The findings of the research agreed with Agyemang and Müller (2015), they reported that only 10 per cent of the respondents perceived that charcoal production is accountable to bushfire. Similarly, Katani et al., (2014) reported that only 0.7% of locals' opined that charcoal production can be ascribed to instigating bushfire.

Warding off snakes

Snakes are mostly predominant in communities where there is dense vegetation. Table 9 showed household heads' perception of warding off snakes. Majority of household heads perceived that warding off snakes contribute in a little way to bushfire in rubber plantations. Among all the surveyed household heads, only 1.2% and 4.5% from Iyanomo and Obayantor 1 communities perceived that warding off snakes results to bushfire in rubber plantations in a very large extent. About 70 per cent perceived that warding off snakes is not a major cause of bushfire in the rubber

plantations. This is consistent with observations by Kusimi and Appati, (2012) which reported that only 6% of bushfires are caused by warding off snakes.

Table 9 Perception on warding off snakes

Level of extent	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Very large extent	1(1.2)	1(4.5)	0	0	0	1(4.5)
Large extent	1(1.2)	1(4.5)	1(4.5)	0	2(5)	1(4.5)
Moderate extent	8(9.5)	2(9.1)	2(9.1)	1(10)	2(5)	3(13.6)
Little extent	36(45.3)	8(36.4)	9(40.9)	1(10)	1(2.5)	10(45.5)
Very little extent	38(45.3)	10(45.5)	13(59.1)	8(80)	35 (87.5)	7(31.8)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Locals' Perception of bushfire mitigative strategies

Enlightenment and education

The perception of household heads of the use enlightenment and education of the locals on the dangers of uncontrolled bush burning to reduce bushfire in rubber plantations is revealed in Table 10. 80.9 per cent of household heads in Iyanomo community and 63.7 per cent of household heads in Obaretin and Obagie strongly agreed to this mitigation strategy. However, only 12.5 per cent of household heads in Ogbekpen community strongly disagreed. Adedayo (2015) recommended that the state government and NGOs' should make efforts to enlighten the people on the dangers of bushfire. This is consistent with observations by Amissah et al. (2010) that farmers perceived that education should be undertaking to caution farmers of high-risk eras and also encourage them to follow to proscription of burning these high-risk times. The findings of the study agreed with Emetere and Aghogho (2019) which reported that the public should be enlightened of the necessity to protect the forests and put an end to the ruin of the bushes by bushfires. Similarly, Hirschberger (2016) stated that public awareness of bushfire risk and suitable behavior should be reinforced by sensitization and enlightening undertakings.

Reduction of fire fuels

Fire fuels are possible causes of bushfire especially during the dry season in the tropics. Table 11 indicates household heads' perception of the reduction of fire fuels. 45.5 per cent of household heads in Obaretin community strongly agreed that reduc-tion of fire fuels in farms before dry season should be recommended while 83.2 per cent of household heads in Iyanomo community also strongly agreed. Most house-

hold heads in the communities perceived that reduction of fire fuels in farms is a mitigating strategy against bushfire in rubber plantations. This aligned with Amissah et al. (2010) which reported that farmers perceived that reducing fuel load will aid to reduce the intensity and spread of fire in case of fire outbreak. Reducing fire fuels is one plan of action tree plantation owners can use to make their plantations more resilient to bushfire (Bennett et al. 2010).

Table 10 Perception on enlightenment and education

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	68 (80.9)	18 (81.8)	14 (63.7)	7 (70)	28 (70)	14(63.7)
Agree	9 (10.7)	3 (13.6)	4 (18.2)	0	6 (15)	5 (22.7)
Undecided	0	2 (9.1)	1 (4.5)	0	0	0
Disagree	4(4.8)	3 (13.6)	1 (4.5)	1 (10)	1 (2.5)	2 (9.1
Strongly disagree	3 (3.6)	1 (4.5)	2 (9.1)	2 (20)	5 (12.5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Table 11 Perception on reduction of fire fuels

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	70 (83.2)	12 (54.5)	10 (45.5)	6 (60)	26 (65)	14(63.8)
Agree	5 (6)	6 (31.9)	6 (27.3)	2 (20)	7 (17.5)	5 (22.7)
Undecided	4 (4.8)	1 (4.5)	3 (13.6)	0	1 (2.5)	1 (4.5)
Disagree	2 (2.4)	2 (9.1)	2 (9.1)	1 (10)	3 (7.5)	1 (4.5)
Strongly disagree	3 (3.6)	1 (4.5)	1 (4.5)	1 (10)	3 (7.5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Establishment of fire guards in farms

Establishment of fire guards is significant approach to mitigate bushfire incidences particularly in the dry season. Table 12 shows household heads' perception of fire guards' establishment in farms. 85.7 per cent in Iyanomo community percep-

tion supported the establishing of fire guards in farms before the start of the dry season, whereas 59.1 per cent in Obaretin community endorsed this measure. However, while 68.2 per cent proposed this approach in Obagie community, 70 per cent in Uhie community agreed to it. This suggested that most of the heads of household in the communities favor the establishing of fire guards. This aligned with the study of Katani et al. (2014) which reported that in Miombo woodlands of Eastern Tanzania, creating fire breaks was acknowledged and highlighted by communities living next to to the forest reserves. However, Dyke and George (2017) reported that in Crofton village, Makoni District, Zimbabwe, farmers were unwilling to construct fireguards due to dearth of capacity and lack of implementation and following-up by Environmental Management Agency (EMA). Nyamadzawo et al. (2013) reported that at farm level, farmers established fire guards before the start of planting season.

Table 12 Perception on establishment of fire guards in farms

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	72 (85.7)	14 (63.8)	13 (59.1)	7 (70)	25 (62.5)	15 (68.2)
Agree	8 (10.7)	5 (22.7)	5 (22.8)	2 (20)	9 (22.5)	4 (18.3)
Undecided	0	1 (4.5)	1 (4.5)	0	3 (7.5)	1 (4.5)
Disagree	1 (1.2)	1 (4.5)	1 (4.5)	1 (10)	2 (5)	1 (4.5)
Strongly disagree	2 (2.4)	1 (4.5)	2 (9.1)	0	1 (2.5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Enactment of laws against indiscriminate bush burning

Enactment of laws against indiscriminate bush burning is vital to mitigate bushfire incidences in most biomes. Table 13 indicates household heads' perception of enactment of laws against indiscriminate bush burning. Majority of household heads (85.7 per cent) in Iyanomo community strongly agree that laws should to be enacted to reduce locals' uncontrolled bush burning while 50.1 per cent of household head in Obaretin community also strongly agreed. On a cumulative basis, among all the communities, only 20 per cent of household heads in Uhie community did not agree. Discussion with the household heads revealed their perceived doubts in the enforcement of laws. They opined that people generally don't readily adhere to laws and that they hope that such laws are not compromised. This aligned with Hirschberger (2016) which reported that in South America, a number of such laws are not enforceable due to deficiency concerning their executions.

Table 13 Perception on enactment of laws against indiscriminate bush burning

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	72 (85.7)	17 (77.3)	11 (50.1)	6 (60)	24 (60)	14 (63.6)
Agree	8 (8.3)	2 (9.1)	9 (40.9)	2 (20)	10 (25)	6 (27.4)
Undecided	1 (1.2)	1 (4.5)	1 (4.5)	0	1 (2.5)	1 (4.5)
Disagree	1 (1.2)	1 (4.5)	1 (4.5)	1 (10)	2 (5)	0
Strongly disagree	2 (2.4)	1 (4.5)	0	1 (10)	3 (7.5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Despite a dissenting minority perception, most of the household heads perception supports this approach. This may infer their determination to make efforts targeted at realizing it. Dasmann (1975) confirmed that people's perception of bushfire influences their engagement in the implementation of laws. Usman and Adefalu (2010) proposed the enactment of political and legal charters for tree protection and control.

Allotting of burning permit

Allotting of burning permit to farmers will help to regulate bush burning activities among farmers. Table 14 summarized the perceptions of household heads. Some household heads in Uhie (10%) and Obagie (9.1%) communities were undecided on their perception of issuing selective burning permit to farmers to reduce bush burning in farms.

Table 14 Perception on selective burning permit

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	68 (81)	14 (63.6)	14 (63.6)	7 (70)	25 (62.5)	13 (59.2)
Agree	10 (11.3)	5 (22.9)	6 (27.4)	1 (10)	10 (25)	5 (22.7)
Undecided	4 (4.8)	1 (4.5)	1 (4.5)	1 (10)	1 (2.5)	2 (9.1)
Disagree	1 (1.2)	1 (4.5)	1 (4.5)	0	2 (5)	1 (4.5)
Strongly disagree	1 (1.2)	1 (4.5)	0	1 (10)	2 (5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Discussion with them revealed that this measure if adopted may disrupt their plans when they want to go to farms. However, majority of the household heads in the communities perceived that allotting burning permit to farmers should be recommended as a measure to mitigate bushfire in rubber plantations. The affirmative views of the majority may imply their resolution to make concerted efforts to achieving it. Agyemang and Müller (2015) affirmed that issuing of selective burning permits will help to reduce incidences of indiscriminate bush burning.

Traditional rulers' engagement

Traditional rulers are a major part of the socio-cultural infrastructure of any community because of their great influence over their subjects. Table 15 depicts household heads' perception of the involvement of traditional rulers. Majority of the household heads perceived that traditional rulers' involvement should be recommended as a measure to mitigate bushfire occurrences in rubber plantations. This aligned with the study of Mäkelä and Hermunen (2007) which reported that in Burkina Faso, the Fire Management Committees have effectively incorporated traditional leadership in their fire management effort and that involvement of traditional authorities in evolving and encouraging fire management is essential. Similarly, Kosoe et al. (2015) reported that household heads recognized the traditional ruling classes (Chief/Elders) as one of the stakeholders in the management of wildfires in the Tain II Forest Reserve of Ghana. The assenting view of most of the household heads deduces the high regard that the locals have for traditional heads. Lignule (2017) stated that guidelines for bushfire avoidance were made in a general meeting of the community which was summoned by the chief, and that bushfire prevention began with the chief holding the culprits and his sub chiefs responsible for such bushfires.

Table 15 Perception on Traditional rulers' involvement

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	66 (78.5)	13 (59.2)	14 (63.6)	6 (60)	31 (77.5)	11 (54.6)
Agree	13 (15.5)	6 (27.3)	5 (22.5)	2 (20)	6 (15)	7 (31.8)
Undecided	1 (1.2)	1 (4.5)	0	0	0	0
Disagree	2 (2.4)	1 (4.5)	2 (9.1)	1 (10)	2 (5)	2 (9.1)
Strongly disagree	2 (2.4)	1 (4.5)	1 (4.5)	1 (10)	1 (2.5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

The results of the study aligned with Adda (2015), who reported that 92 per cent of the respondents supported the involvement of traditional authority.

Building of fire towers

Building of fire towers is a possible mitigative method against bushfire occurrences. Table 16 revealed household heads' perception of building of fire towers. Majority (cumulatively 80 per cent and above) of the household heads in the communities perceived that building of fire towers at strategic locations within RRIN and surrounding communities should be adopted as a measure to mitigate bushfire in rubber plantations. Fire tower is fire detection and suppression apparatus employed to identify bushfire early and aid to reduce the extent of its spread (Alkhatib, 2014).

The approving perception of majority of the household heads may imply their resolve to support efforts aimed at attaining it. However, minority of the household heads (aggregately 13.6 and 4.5 per cent) did not agree to the building of fire towers. Discourse with them revealed that they perceived that building of fire towers at strategic locations within communities may expose their traditional practices.

Table 16 Perception on building of fire towers

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	66 (78.5)	15 (68.2)	14 (63.6)	6 (60)	26 (65)	11(54.6)
Agree	13 (15.5)	6 (27.3)	5 (22.5)	2 (20)	11 (27.5)	7 (31.8)
Undecided	1 (1.2)	0	0	0	0	0
Disagree	2 (2.4)	1 (4.5)	2 (9.1)	1 (10)	2 (5)	2 (9.1)
Strongly disagree	2 (2.4)	0	1 (4.5)	1 (10)	1 (2.5)	1 (4.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Enactment of laws against indiscriminate hunting

Household heads' perception of enactment of laws against indiscriminate hunting are indicated in Table 17. Majority of the household heads perception in Iyanomo (50 per cent disagree while 36.9 per cent strongly disagree), Obaretin (50 per cent disagree, whereas 27.3 per cent strongly disagree) and Uhie (60 per cent disagree while 20 per cent strongly disagree) communities do not support this approach. Discussions with them revealed that enacting such laws may lead to joblessness especially for natives who engage solely in hunting and depend on it as their major source of income. Nonetheless, most of the household heads in Obayantor 1 (50 per cent agreed whereas 45.5 per cent strongly agreed) and Obagie (54.6 per cent agreed whereas 36.4% strongly agreed) communities perception supported the enactment of laws. Enactment of laws according to the household heads will help to regulate hunting activities in the communities. However, Katani et al. (2014) reported that feeble enforcement of prevailing laws and bylaws was admitted by many respondents.

Table 17 Perception on enactment of laws against indiscriminate hunting

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	0	10 (45.5)	3 (13.6)	1 (10)	11 (27.5)	12 (54.6)
Agree	9 (10.7)	11 (50)	0	1 (10)	9 (22.5)	8 (36.4)
Undecided	0	0	2 (9.1)	0	0	0
Disagree	42 (50)	1 (4.5)	11 (50)	6 (60)	10 (25)	2 (9.1)
Strongly disagree	32 (36.9)	0	6 (27.3)	2 (20)	10 (25)	0
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

Enactment of laws against indiscriminate livestock grazing

Household heads' perception of enactment of laws against indiscriminate live-stock grazing are revealed in Table 18. At least 80 per cent of the heads of house-hold in Iyanomo, Obaretin and Uhie communities perceived that enactment of laws should be used as an approach to mitigate bushfire in rubber plantations. Adda (2015) recommended the registration of all Fulani herdsmen as a way to regulate their indiscriminate livestock grazing. In contrast, majority of the household heads in Obayantor 1, Ogbekpen and Obagie communities (cumulatively, 57.5 per cent and above) do not perceive that laws should be enacted. They stated that even among the locals' livestock grazing is already prohibited in their communities. Hirschberger (2016) reported that in Portugal, grazing on sheep pastures is sponsored, as these act as firebreaks that check the blowout of bushfires.

Table 18 Perception on enactment of laws against indiscriminate livestock grazing

Level of agreement	Iyanomo Frequency (%)	Obayantor 1 Frequency (%)	Obaretin Frequency (%)	Uhie Frequency (%)	Ogbekpen Frequency (%)	Obagie Frequency (%)
Strongly agree	41 (48.8)	0	17 (77.3)	7 (70)	12 (30)	2 (9.1)
Agree	33 (39.3)	1 (4.5)	4 (18.2)	1 (10)	5 (12.5)	1 (4.5)
Undecided	0	0	0	0	0	0
Disagree	6 (7.1)	2 (9.1)	1 (4.5)	1 (10)	13 (32.5)	9 (40.9)
Strongly disagree	4 (4.8)	19 (86.4)	0	1 (10)	10 (25)	10 (45.5)
Total (200)	84 (100)	22 (100)	22 (100)	10 (100)	40 (100)	22 (100)

4   CONCLUSION

Bushfire is one of the principal disturbances in tree plantations that extensively impact the ecosystem, surroundings, and socio-economic infrastructure of countries across the world. The research examined natives' perception on causes and mitigation of bushfire in rubber plantations in Nigeria. The outcomes revealed that the locals perceived that uncontrolled bush burning is the major cause of bushfire in rubber plantations. However, they opined that arson, lightning, fireworks, charcoal production and warding off snakes are not vital contributory factors responsible for bushfire in rubber plantations. The findings of our study also indicated that the natives perceived that enlightenment and education, fire fuels reduction, establishment of fire guards, enactment of laws against indiscriminate bush burning, allotting burning permits, traditional rulers involvement and building of fire towers are key measures of mitigation against bushfire occurrences in rubber plantations. Nevertheless, they perceived that enactment of laws against indiscriminate hunting and livestock grazing are not potential mitigatory strategies.

On a global perspective, Kala (2023) recommended the provision of adequate financial resources, technologies and training as significant mitigating strategies against the bushfires. Katani et al. (2014) identified enlightenment creation, law implementation, creating fire breaks, introduction of other generating sources of income, and enhancing agriculture practices as possible tactics to moderate bushfires incidence in Miombo woodlands of Eastern Tanzania. Kusimi and Appati (2012) suggested the preferment and strengthening of anti-bushfire education through local chiefs to aid the reduction of the hazard in Krachi District, Ghana. In Central Côte d'Ivoire, West Africa, Kouassi et al. (2020) concluded that hunting is the main cause of bushfire. Clark (2020) stated that fuel load in forests is the major cause of big bushfires in Australia. Dyke and George (2017) noted that in Zimbabwe, land clearing, irregular dumping of ashes, brick molding and arson were the principal causes of bushfires. Yahaya and Amoah (2013) affirmed that in the Nandom District of the Upper West Region of Ghana, the key anthropogenic trigger of bushfire was bush burning for agricultural purposes, hunting, arson and burning to protect ruminants from reptiles. In the forest transition zone of Ghana, Amissah et al. (2010) concluded that early vegetable and yam cultivation whereby the burning of slash occurs between December and February are the significant specific cropping practices responsible for bushfire occurrences.

Due to real-world cultural constraints and scope of the research, this paper cannot provide information from livestock herdsmen who are one of the instigators of bushfire. Language as a barrier prevented having discussion with them unlike the case of the household heads. Notwithstanding, in practical terms, the obtained indigenous perceptive evidence of the study can be used as a foundation and standard for decision-making in local participatory approach for the ecological conservation and sustainability of rubber plantations in the tropics. Also, the perception of the locals can be integrated into scientific bushfire management practices in tree plantation biomes. The study recommended that similar investigation should be undertaken in

other major tropical perennial tree biomes such as cocoa (*Theobroma cacao*), kola (*Cola nitida*) and oil palm (*Elaeis guineesis*) plantations. This will further advance biogeographical and fire ecological investigations.

References

ADDA, G. B. 2015. *The Effects of Bushfires on Food Security in the Sissala East District*. (Master's thesis, Institute for Continuing Education and Inter–disciplinary Research, University for Development Studies). [online] [cit. 2023-10-18]. Available at: <http://udsspace.uds.edu.gh/jspui/handle/123456789/633>

ADEDAYO, A. G. 2015. Assessment of the impact of Bush Fire on availability of NTFPs to Rural Households in Oyo State, Nigeria. *Journal of Sustainable Technology*, 6, 2, 22-31.

ADGER, W. N. 2006. Vulnerability. *Global Environmental Change*, 16, 268-281. DOI: http://dx.doi.org/10.1016/j.gloenvcha.2006.02.006

AGYEMANG, S. O., MÜLLER, M. 2015. Fire in Ghana's Dry Forest: Causes, Frequency, Effects and Management Interventions. *Proceedings of the large wildland fires conference, Missoula. U. S.*345p. [online] [cit. 2023-09-10]. Available at: <https://www.fs.usda.gov/treesearch/pubs/49423>

ALKHATIB, A. A. 2014. A Review on Forest Fire Detection Techniques. *International Journal of Distributed Sensor Networks*, 2, 4, 23-40.

AMBE, B. A., EJA, I. E., AGBOR, C. E. 2015. Assessment of the impacts and people's perception of bush burning on the grasslands and montane ecosystems of the Obanliku Hills/Plateau, Cross River state, Nigeria. *Journal of Natural Sciences Research*, 5, 6, 12-20.

AMISSAH, B. K., AGYEMAN, V. K. 2010. Wildfire Incidence and Management in the Forest Transition Zone Of Ghana: Farmers' Perspectives. *Ghana J. Forestry*, 26, 61-73.

APPLEGATE, G. B. A., CHOKKALINGAM, U., SUYANTO, S. 2001. *The underlying causes and impacts of fires in South-east Asia*. Final Report. Bogor, Indonesia, Center for International Forestry Research, International Centre for Research in Agroforestry, USAID, US Forest Service: 58.

BEATSON, R., MCLENNAN, J. 2010. *Understanding community bushfire safety issues from social psychological perspectives – Discussion Paper: 1.* Community Bushfire Safety – Theories to Guide Research & Practice. Bushfire CRC Extension Bushfire Community Safety & Decision Making Project (C9), 1-32.

BEHERA, S. K., SAHU, S. K., PRADHAN, B. B. 2020. Bushfire Study: Causes, Effects and Risks to the Ecosystem Due to Changes in Climate. *International Journal of Modern Agriculture*, 9, 3, 5790 5890.

BENNETT, M., FITZGERALD, S., PARKER, B., MAIN, M., PERLEBERG, A., SCHNEPF, C., MAHONEY, R. 2010. Reducing Fire Risk on Your Forest Property. *Pacific Northwest Extension Publication 618*. [online] [cit. 2023-07-20]. Available at: <http://ext.wsu.edu/forestry/documents/pnw618complete.pdf>

BRADFORD, A. 2018. Wildfires: Causes, Costs and Containment. *Live Science*. [online] [cit. 2023-06-20]. Available at: <https://www.livescience.com/63458-wildfires.html>

CLARK, C. 2020. Causes of Big Bushfires in Australia: Higher Temperatures and Rainfall or More Fuel? *Journal of Geoscience and Environment Protection*, 8, 79-94.

CLOUTIER, C., RAVASI, D. 2021. Using tables to enhance trustworthiness in qualitative research. *Strategic-organization*, 19, 1, 11313. DOI: https://doi.org/10.1177/1476127020979329

COPES-GERBITZ, K., HAGERMAN, S. M., DANIELS, L. D. 2021. Situating Indigenous knowledge for resilience in fire-dependent socialecological systems. *Ecology and Society*, 26, 4, 25. DOI: https://doi.org/10.5751/ES-12757-260425.1-14

CONVENTION ON BIOLOGICAL DIVERSITY, 2001. Impacts of human-caused fires on biodiversity and ecosystem functioning, and their causes in tropical, temperate and boreal forest biomes. *CBD Technical Series no. 5. Montreal, SCBD*, 42p. [online] [cit. 2023-06-10]. Available at: <https://www.cbd.int/doc/publications/cbd-ts-05.pdf>

CRESWELL, J. W., CLARK, V. L. P., GUTMANN, M. L., HANSON, W. E. 2003. Advanced mixed methods research design In: Tashkkori, A., Teddle, C. (eds.) *Handbook of mixed methods in social and behavioral research*. 2nd edition, 209-240. Thousand Oaks, CA: Sage Publications, Inc.

DASMAN, R. F. 1975. *The Conservation Alternative*. Switzerland: IUCN, Morges John Wiley.

DE VOS, A., BIGGS, R., PREISER,. R. 2019. Methods for Understanding Social-Ecological Systems: A Review of Place-based Studies. *Ecology and Society*, 24, 4, 16. DOI: 10.5751/es-11236–240416

DOERR, S. H., SANTÍN, C. 2016. Global trends in wildfire and its impacts: perceptions versus realities in a changing world. *Phil. Trans. R. Soc. B*, 371, 1-18.

DUNN., C, J., O'CONNOR, C, D., ABRAMS, J., THOMPSON, M. P., CALKIN, D, E., JOHNSTON, J. D., STRATTON, R., GILBERTSON-DAY, J. 2020. Wildfire risk science facilitates adaptation of fire-prone socialecological systems to the new fire reality. *Environ. Res. Lett.*, 15, 025001, 1-14.

DYKE, C., GEORGE, N. 2017. Causes of wildland fires and factors that influence knowledge of fire management at 8 Crofton villages, Makoni District, Zimbabwe. *SAJEST*, 2. DOI: http://dx.doi.org/10.4314/sajest.v4i1.39813.1-9.

EMETERE, M. E., AGHOGHO, E. 2019. Dynamics of pollution from bush burning: Analysis from first principles. *Journal of Physics: Conf. Series 1299*, 012031: 1-7. DOI: 10.1088/1742-6596/1299/1/012031

EKINCI, H. 2006. Effects of Forest fire on some properties of soil. *International Journal of Agriculture and Biology*, 8, 1, 102-106.

FOLKE, C., BIGGS, R., NORSTRÖM, A. V., REYERS, B., ROCKSTRÖM, J. 2016. Social-ecological resilience and biosphere-based sustainability science. *Ecol. Soc.*, 21, 3, 41.

GAIN, A. K., GIUPPONI, C., RENAUD, F. G., VAFEIDIS, A. T. 2020. Sustainability of complex social-ecological systems: Methods, tools, and approaches. *Reg. Environ. Chang*, 20, 102.

GLAW, X., INDER, K., KABLE, A., HAZELTON, M. 2017. Visual Methodologies in Qualitative Research: Autophotography and Photo Elicitation Applied to Mental Health Research. *International Journal of Qualitative Methods*, 16, 1-8.

HIRSCHBERGER, P. 2016. *Forests ablaze Causes and effects of global forest fires*. WWF Deutschland, Berlin, 1-108.

HOLLING, C. S. 2001. Understanding the Complexity of Economic, Ecological, and Social Systems. *Ecosystems*, 4, 5, 390-405.

IZAH, S. C., ANGAYE, T. C. N., AIGBERUA, A. O, NDUKA, J. O. 2017. Uncontrolled bush burning in the Niger Delta region of Nigeria: potential causes and impacts on biodiversity. *International Journal of Molecular Ecology and Conservation*, 7, 1, 1-15.

JOSHI, M. 2017. *Lightning a major cause of wildfires*. [online] [cit. 2023-09-28]. Available at: <https://www.geospatialworld.net>

KALA, C. P. 2023. Environmental and socioeconomic impacts of forest fires: A call for multilateral cooperation and management interventions. *Natural Hazards Research*, 3, 286-294.

KARKI, S. 2002. *Community Involvement in and Management of Forest Fires in South East Asia*. International World Conservation Union (IUCN) - World Headquarters Rue Mauverney 28 CH-1196 Gland, Switzerland. [online] [cit. 2023-09-10]. Available at: <https://gfmc.online/wp-content/uploads/PFFSEA-CBFiM-Review-SE-Asia.pdf>

KATANI, J. Z., MADOFFE, S. S., AMANZI, N. S., RIJA, A. A., MIDTGAARD, F., MBEYALE, G., ZAHABU, E., TARIMO, B. C. 2014. Assessment of fire prevalence and

reduction strategies in Miombo woodlands of Eastern Tanzania. *Tanzania Journal of Forestry and Nature Conservation*, 8, 1, 1-14.

KOSOE, E. A., OSUMANU, I. K., BARNES, V. R. 2015. Wildfire Management in the Tain II Forest Reserve of Ghana: An Evaluation of Community Participation. *Open Access Library Journal*, 2, 1-10. DOI: http://dx.doi.org/10.4236/oalib.1101964.

KOUASSI, J, WANDAN, N., MBOW, C. 2020. Exploring Wildfire Occurrence: Local Farmers' Perceptions and Adaptation Strategies in Central Côte d'Ivoire, West Africa. *Journal of Sustainable Forestry*, 41 (2), 173-192. DOI: 10.1080/10549811.2020.1845744.

KUSIMI, J. M., APPATI, J. W. 2012. Bushfires in the Krachi District: The Socio-Economic And Environmental Implications. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XXXIX-B8, 39–44. DOI: https://doi.org/10.5194/isprsarchives-XXXIX-B8-39-2012.

LAKE, F. K., PARROTTA, J., GIARDINA, C. P., DAVIDSON-HUNT I., UPRETY, Y. 2018. Integration of traditional and western knowledge in forest landscape restoration. In: Mansourian, S., Parrotta, J. (eds.) *Forest landscape restoration: integrated approaches to support effective implementation*. Routledge, New York, New York, USA, 198-226. DOI: https://doi.org/10.4324/9781315111872-12

LIGNULE, E. 2017. *Self-mobilization for wildfire prevention in the Goziri community, Upper West Region, Ghana*. United Nations University Land Restoration Training Programme (finalproject). [online] [cit. 2022-06-10]. Available at: <http://www.unulrt.is/static/fellows/document/lignule2017.pdf>

LINDENMAYER, D., TAYLOR, CH., BLANCHARD, W., ZYLSTRA, P., EVANS, M. J. 2023. What environmental and climatic factors influence multidecadal fire frequency? *Ecosphere*, 14 (8): e4610. DOI: https://doi.org/10.1002/ecs2.4610

LIU, F., DAI, F., YIN, J. 2023. A Review of Social–Ecological System Research and Geographical Applications. *Sustainability*, 15,8, 6930.

MÄKELÄ, M., HERMUNEN, T, 2007. *Fire Management on Rural Lands in Burkina Faso A community-based approach*. Development Policy Information Unit. Ministry for Foreign Affairs of Finland/1-56.

MEDDOUR-SAHAR, O., LOVREGLIO, R., MEDDOUR, R., LEONE, V. 2013. Fire and People in Three Rural Communities in Kabylia (Algeria): Results of a Survey. *Open Journal of Forestry*, 3, 1, 30-40.

MILES, M. B., HUBERMAN, A. M. 2002. *The Qualitative Researcher's Companion*. London, Sage.

NYAMADZAWO, G., GWENZI, W., KANDA, A., KUNDHLANDE, A., MASONA, C. 2013. Understanding the causes, socio-economic and environmental impacts, and management of veld fires in tropical Zimbabwe. *Fire Science Reviews*, 2, 2, 1-13.

OFUOKU, A. U., ISIFE, B. I. 2009. Causes, effects and resolution of farmers-nomadic cattle herders' conflict in Delta state, Nigeria. *International Journal of Sociology and Anthropology*, 1, 2, 47-54.

OLDEKOP, J. A., HOLMES, G., HARRIS, W. E., EVANS, K. L. 2016. A global assessment of the social and conservation outcomes of protected areas. *Conservation Biology*, 30,133-141.

OROBATOR, P. O. 2022. Effect of bushfire on soil bacteria and fungi in perennial tree plantation ecosystems. *Journal of Geographic Thought & Environmental Studies (JOGET)*, 17, 1, 1-11.

OROBATOR, P. O., ODJUGO, P. A. O. 2023. Do locals' perception of bushfire impact on rubber trees match or mismatch with empirical data? Evidence from Edo State, Nigeria. *Kastamonu University Journal of Forestry Faculty*, 23, 1, 52-63. DOI: 10.17475/kastorman.1269503

OROBATOR, P. O., UGWA, I. K. 2023. Indigenous communities' knowledge of bushfire impacts on specific soil quality indicators in rubber plantations of Southern Edo State, Nigeria. *Journal of Agriculture, Forestry and Fisheries*, 20 (1-2), 7-14.

OSTROM, E. 2009. A general framework for analyzing sustainability of social-ecological systems. *Science*, 24, 325 (5939), 419-422.

PRIOR, T., ERIKSEN, C. 2013. Wildfire preparedness, community cohesion and social-ecological systems. *Global Environmental Change*, 23, 6, 1575-1586.

SANTÍN, C., DOERR, S. H. 2016. Fire effects on soils: the human dimension. *Phil. Trans. R. Soc. B,* 371, 20150171. DOI: 10.1098/rstb.2015.0171.

SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY. 2001. *Impacts of human-caused fires on biodiversity and ecosystem functioning, and their causes in tropical, temperate and boreal forest biomes*. Montreal, SCBD, 42p. (CBD Technical Series no. 5).

SHERIDAN, R. A. S., FULÉ, P. Z. LEE, M. E., NIELSEN, E. A. 2015. Identifying Social ecological Linkages to Develop a Community Fire Plan in Mexico. *Conservation and Society*, 13 (4), 395-406.

STEELMAN, T. 2016. US wildfire governance as social-ecological problem. *Ecology and Society*, 21 (4):3. DOI: http://dx.doi.org/10.5751/ES-08681-210403

SOGA, M., GASTON, K. J. 2020. The ecology of human–nature interactions. P*roceedings of the Royal Society B*, 287, 20191882.

USMAN, B. A., ADEFALU, L. L. 2010. Nigerian forestry, wildlife and protected areas: Status report. *Biodiversity*, 11 (3-4), 44-52.

VIRAPONGSE, A., BROOKS, S., METCALF, E. C., ZEDALIS, M., GOSZ, J., KLISKEY, A., ALESS, L. 2016. A social-ecological systems approach for environmental management. *Journal of Environmental Management*, 178, 83-91.

YAHAYA, A., AMOAH, S. T. 2013. Bushfires in the Nandom District of the Upper West Region of Ghana. Perpetual Threat to Food Crop Production. *Journal of Environment and Earth Science*, 3, 7, 10-14.

YE, W. 2016. Investigation and identification of fire caused by setting off fireworks. *Procedia Engineering*, 135, 427-430.

Názory miestnych obyvateľov na príčiny a zmiernenie požiarov v kaučukových plantážach v Nigérii: sociálno-ekologický prístup

Súhrn

Požiare porastov prestavujú jeden z hlavných problémov na stromových plantážach, ktoré vo veľkej miere ovplyvňujú ekosystém, okolie a sociálno-ekonomickú infraštruktúru krajín na celom svete. Výskum skúmal vnímanie domorodcov v oblasti príčin a spôsobov zmiernenia požiarov v kaučukových plantážach v Nigérii. Výsledky ukázali, že miestni obyvatelia vnímali skutočnosť, že nekontrolované vypaľovanie kríkov je hlavnou príčinou požiarov na kaučukových plantážach. Zastávali však názor, že podpaľačstvo, blesky, ohňostroje, výroba dreveného uhlia a ochrana dobytka pred hadmi nie sú kľúčovými faktormi, ktoré by v zásadnej miere prispievali k požiarom na kaučukových plantážach. Zistenia našej štúdie ukazujú, že miestni obyvatelia považujú osvetu a vzdelanie, zníženie spotreby paliva, zriadenie protipožiarnych stráží, prijatie zákonov proti bezohľadnému vypaľovaniu kríkov, udeľovanie povolení na spaľovanie, zapojenie miestnych lídrov a budovanie požiarnych veží za kľúčové opatrenia na zmiernenie výskytu požiarov na kaučukových plantážach. Napriek tomu však deklarujú, že prijímanie zákonov proti nelegálnemu lovu a paseniu hospodárskych zvierat nepovažujú za potenciálne zmierňujúce nástroje v tejto oblasti.

Z globálneho hľadiska Kala (2023) odporučil zabezpečenie primeraných finančných zdrojov, technológií a školenia ako významné postupy na zmiernenie požiarov. Katani et al. (2014) identifikoval osvetu, náležitú implementáciu zákonov

a nariadení, vytváranie protipožiarnych zón, zavádzanie iných zdrojov príjmu a zlepšovanie poľnohospodárskych postupov ako možné taktiky na zmiernenie výskytu požiarov v lesoch Miombo vo východnej Tanzánii. Kusimi a Appati (2012) navrhli uprednostňovať a posilňovať vzdelávanie v oblasti protipožiarnej ochrany prostredníctvom miestnych osobností s cieľom pomôcť znížiť nebezpečenstvo v okrese Krachi v Ghane. Z výsledkov ďalších štúdií je zrejmé, že v centrálnej časti Pobrežia Slonoviny v západnej Afrike hlavnú príčinu požiarov predstavuje lov a s ním spojené aktivity (Kouassi a kol., 2020). Clark (2020) uviedol, že uskladnenie paliva v lesoch je hlavnou príčinou veľkých požiarov v Austrálii. Dyke a George (2017) poznamenali, že v Zimbabwe boli hlavnými príčinami lesných požiarov čistenie pozemkov, nesprávne uskladnenie popola, pálenie tehál a podpaľačstvo. Yahaya a Amoah (2013) potvrdili, že v okrese Nandom v regióne Upper West v Ghane bolo kľúčovým antropogénnym spúšťačom požiarov v buši vypaľovanie kríkov na poľnohospodárske účely, lov, podpaľačstvo a vypaľovanie na ochranu prežúvavcov pred plazmi. V lesnej prechodnej zóne Ghany Amissah et al. (2010) dospel k záveru, že skoré pestovanie zeleniny a jamu, pri ktorom dochádza k páleniu odrezkov medzi decembrom a februárom, sú významné špecifické pestovateľské postupy zodpovedné za výskyt požiarov.

Kvôli reálnym kultúrnym obmedzeniam a rozsahu výskumu tento článok neposkytuje informácie od pastierov dobytka, ktorí častokrát požiar neúmyselne spôsobia. Jazyk ako bariéra bránil diskusii s nimi na rozdiel od obyvateľov z bežných domácností. Bez ohľadu na to, z praktického hľadiska, výsledky tejto štúdie môžu byť použité ako základ a štandard pre rozhodovanie v rámci lokálneho participatívneho prístupu v oblasti ekologickej ochrany a udržateľnosti kaučukových plantáží v trópoch. Vnímanie miestnych obyvateľov možno tiež integrovať do vedeckých postupov riadenia požiarov v biomoch stromových plantáží. Štúdia odporúča, aby sa podobné výskumy uskutočnili na iných veľkých tropických trvalých stromových biomoch, ako sú plantáže kakaa (Theobroma cacao), koly (Cola nitida) a palmy olejnej (Elaeis guineesis). Tým sa podporí ďalší biogeografický a ekologický výskum v oblasti problematiky požiarov.