

Fire in Ghana's Dry Forest: Causes, Frequency, Effects and Management Interventions

Sandra Opoku Agyemang and Michael Müller, Faculty of Environmental Science, Department of Silviculture and Forest Protection, Technische Universität Dresden; **Victor Rex Barnes**, Faculty of Renewable Natural Resources, Department of Agroforestry, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

Abstract—This paper describes the number of fires, area burned, causes and seasonality of fires over a ten year period from 2002–2012 and investigates different fire management strategies and their effectiveness in the Afram headwaters forest reserve in Ghana. Data were collected from interviews of stakeholders in two communities adjacent to the reserve, and from 2002–2012 fire reports of the Ghana National Fire Service and Forest Service Division. For the period studied, nearly all fires were human-caused, and most arose through land use activities such as farming (19 percent) or hunting (15 percent) or from other activities such as charcoal production (10 percent) carried out in the forest. We also found out that, at least six fire incidences affected an area averaging approximately 31 hectares annually between 2002 and 2012. Nearly all fires occurred during the dry season (November–April) with the highest number of fires as well as largest area burnt occurring in January and February. Fire management efforts were more directed towards fire prevention than pre-suppression and suppression. However, other factors limited the effectiveness of fire management, including a lack of incentives for people to help put out fires and an absence of protective and suppression equipment. We recommend that there should be continuous education and capacity building, alternative farming methods, enforcement of wildfire laws, intensive patrols and inspection, maintenance of fire breaks, provision of lookout towers and other detection systems, provision of suppression equipment and collaboration between stakeholders.

Key words: forest fire, causes, fire frequency, management, prevention, pre-suppression, suppression

Introduction

Each year fires destroy considerable forest resources in Ghana. Most fires are anthropogenic in origin and are directly linked to livelihood activities (FORIG 2003). Burning is embedded in the cultural values and traditional farming systems of the people in Ghana (Nsiah-Gyabaah 1996) so changes in these practices can be difficult to achieve. Anthropogenic fires are the dominant threat to forests in Ghana (Kalame and others 2009) as well as agriculture and can lead to changes in vegetation, invasion of certain species and weeds, soil degradation and low agricultural crop yields (Amissah and others 2011). Within the Afram headwaters forest reserve, anthropogenic fires may thus threaten the long term capacity of the reserve to achieve its intended purposes. Forest fires in Ghana can significantly affect the economy, accounting for an annual loss of 210 million US Dollars, or roughly 3 percent of the Gross Domestic Product (GDP) (FORIG 2003; MLFM 2006). In 1994, about 98 million US Dollars were lost to forest fires representing 2 percent of the GDP of Ghana (Barnes and others 2004). Forest fires contributed to a decrease in total forest area in Ghana from 1990 to 2010 as reported in the global resources assessment

(FAO 2010). Concerns regarding forest fires have stimulated Ghana to adopt a comprehensive fire management strategy emphasizing a community-based approach (MLFM 2006), permitting stakeholders to participate in the use and management of fire. Effective fire management can include several different approaches, such as prevention, pre-suppression and suppression (Wingard and Moody 2000). Essential to the success of fire management is an understanding of the causes, seasonality, frequency and extent of fires, as well as of what management practices are being used, and how effective they are. At present, little such information is available in Ghana. This study was carried out to examine the causes, the frequency of fire, seasonality and area burnt and finally reveal the management strategies implemented.

Methodology

Brief Description of the Study Area

The study was carried out in the Afram headwaters forest reserve (Figure 1) involving two communities (Asempanaye and Asuboi). This particular forest reserve and two communities were selected due to prevalent fires over the years and the experience of the local people on forest fire and management. This forest reserve was designated and mapped in 1950 in the Offinso forest district with an area of 201 km². The forest reserve is characterized as

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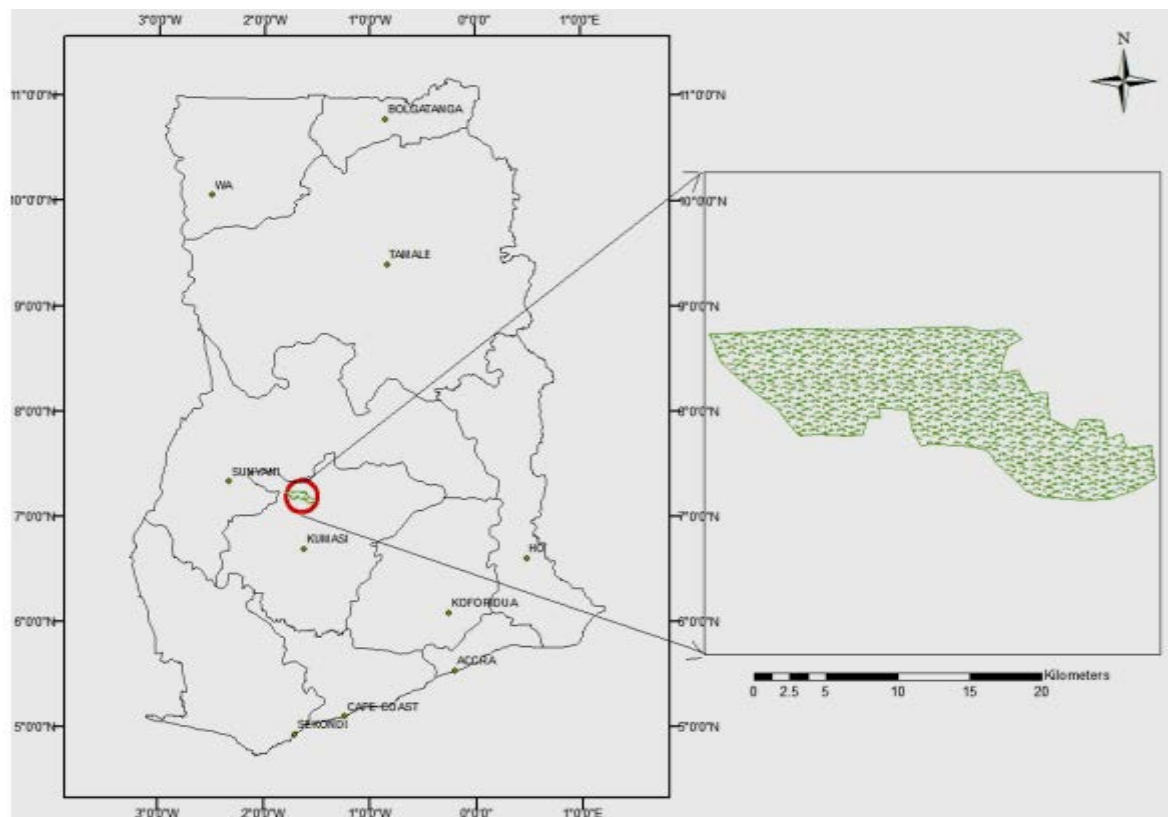


Figure 1—International Institute for Geo-information Science and Earth Observation Enshchede, The Netherlands and Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. Map of Ghana with the location of Afram headwaters forest reserve (Dwomoh 2009).

Dry Semi-Deciduous Forest Fire Zone Subtype (DSFZ). It has 773.5 ha of *Tectonia grandis*, *Triplochiton scleroxylon* and *Mansonia altissima* plantation (Hawthorne and Abu-Juam 1995). It lies between longitude 1° 32" and 1° 48" W and latitude 7° 0" and 7° 15" N. The forest reserve rests inside the Tropical Humid Climatic zone characterized by bimodal rainfall period in June and October. The daily mean temperatures are 30 °C maximum and 22 °C minimum with mean humidity of 80 percent. The mean annual rainfall ranges between 1,250-1,500 mm (Hall and Swaine 1976; Forest Services Division 1999). The floristic compositions of the forest are mainly *Broussonetia papyrifera*, *Milicia excelsa*, *Triplochiton scleroxylon*, and other indigenous species with dense understorey of *Chromolaena odorata*, and *Griffonia simplicifolia* (Hawthorne and Abu-Juam 1995; Hall and Swaine 1976). Most (70 percent) of the people are involved in agriculture. They cultivate food crops such as plantain, maize, cassava, and cash crops like coffee, cocoa and cashew (Ghana Districts 2006). Asempanaye, Asuboi, Akrofua and Kwapanin are some of the surrounding communities around the forest reserve. Annual forest fires, over exploitation and illegal logging are the major threats to the forest reserve.

Data Collection, Sampling and Analysis

To characterize patterns of fire cause, frequency and area burned, and associated management practices, a

series of interviews were conducted between March and June 2012. Interviews were conducted with stakeholders through the use of semi-structured questionnaires. Secondary data was obtained from monthly reports and collated data on forest fires from Forest Services Division (FSD) and Ghana National Fire Service (GNFS) between 2002 and 2012 and existing literatures. The primary data was collected through rapid rural appraisal with a combination of tools such as field observation, key informant interviews and meetings. In all, a total of 109 respondents were interviewed in the selected communities together with the representative of the Forest Services Division and Ghana National Fire Service in the Offinso forest district. A total of 53 people were interviewed in Asempanaye and 54 people were interviewed in Asuboi. Random sampling was used to select respondents in both selected communities. Emphasis was placed on being a farmer, hunter or fire volunteer since they are knowledgeable on forest fires or have their livelihood activities near and within the forest. Respondents were asked about fire causes, existing management strategies in prevention, pre-suppression and suppression while data on fire frequency and area burned from reports. Data was summarized, and where appropriate, analyzed using Microsoft Excel and Statistical Package for Social Sciences (SPSS version 17). T-test was used to test the differences between the fire occurrences and area burnt.

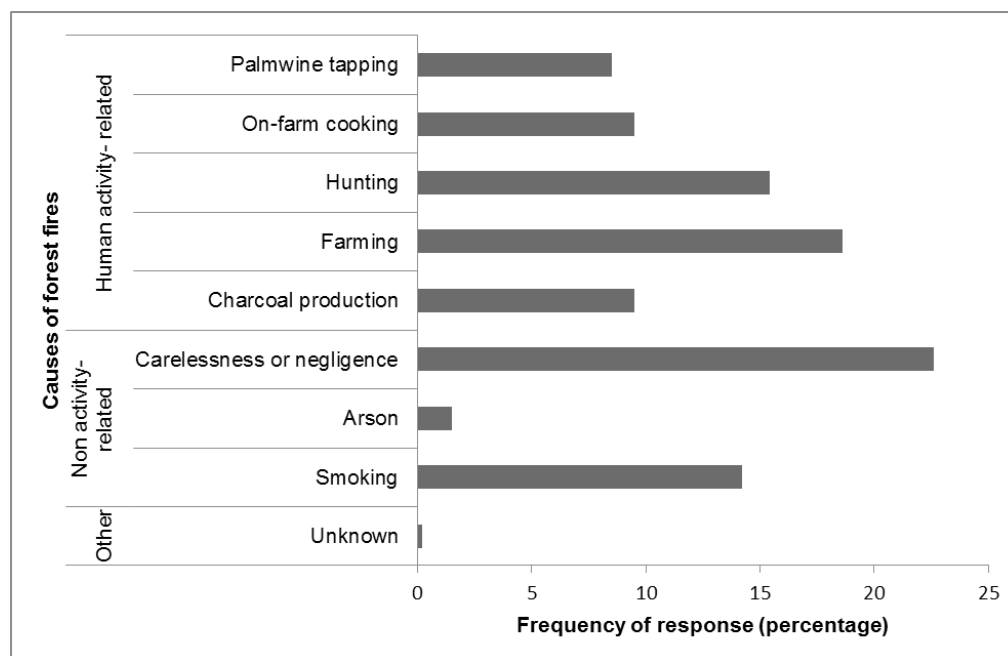


Figure 2—Cause of forest fires in Afram headwaters forest reserve.

Results and Discussion

Causes of Forest Fires

As expected, the overwhelming majority of fires were anthropogenic in origin. Natural fires were not mentioned as a cause. The human-caused fires were further categorized into human activity-related, such as farming, and non-activity related, such as carelessness. The human activity causes were related to livelihood activities carried out by people. The study revealed that human activities constituted 61 percent of the total causes of forest fires. Out of this total, 19 percent were originating from farming followed by hunting (15 percent) and charcoal production (10 percent) (Figure 2).

In Ghana, most farmers prepare land using fire which is considered as the fastest, easiest and most economic way for land preparation. This is very common in the taungya farms (in which crops are planted together with tree seedlings on the same land until tree canopy closure) within the forest and farms outside the forest. After clearing the land, the debris is allowed to dry for some weeks. Later, fire is set to the debris for easy planting of crops which can be annual, biennial and perennial. This type of farming practices and the flammability of a particular vegetation type make the environment susceptible to wildfires (Amissah and others 2010). During hunting, fire is used to smoke out animals from holes such as the ground squirrels. Sometimes, hunters perceive that animals are hiding in thickets and therefore set fire to trap them. Many fires are started by cigarette butts dropped by smokers. Generally all these findings correspond to some studies carried out in some parts of Ghana and other tropical countries (Appiah and others 2010; FORIG 2003; Kunwar and Khaling 2006). Carelessness and negligence caused 37 percent of the fires. Unknown was the least with less than 1 percent (Figure 2).

Carelessness or negligence is a common problem, where people carelessly forget to control fires that they start. Farmers and hunters are mostly blamed because they use the fire for their gains without controlling it. Some of the rural people do not want to take responsibility for fires that might extend into the forest. Appiah and others (2010) and Kunwar and Khaling (2006) have described these situations as common factors in other areas.

Forest Fire Frequency and Area Burnt

The forest fire occurrences and area burnt were presented according to yearly and monthly incidences from 2002 to 2012.

Annual frequency of forest fire frequency and area burnt

Over the period of 2002 to 2012, there were at least 6 fires per year, and a mean area burned of 31 ha within the forest reserve. However, there were distinct periods with very different characteristics during this ten year period. Between 2002 and 2003 fire occurrences and area burnt were very high (Figure 3), followed by rapid declines from 2004 to 2011, most likely related to the inception of wild-fire management project between the Forestry Commission of Ghana and the Netherlands Government (MLFM 2006). This project contributed funds to research, education and management of forest fires during this period. The decline during 2004 to 2011 was followed by a significant increase in fire frequency and area burnt from 2011 to 2012, corresponding to a lack of funds and logistical support after the end of the project. An additional potentially contributing factor is the restoring of degraded lands through forest plantation development, enrichment planting and community forestry by the Forestry Commission enshrined in the Ghana forest and wildlife policy (2012). It seems likely that this policy could provide an incentive for burning land

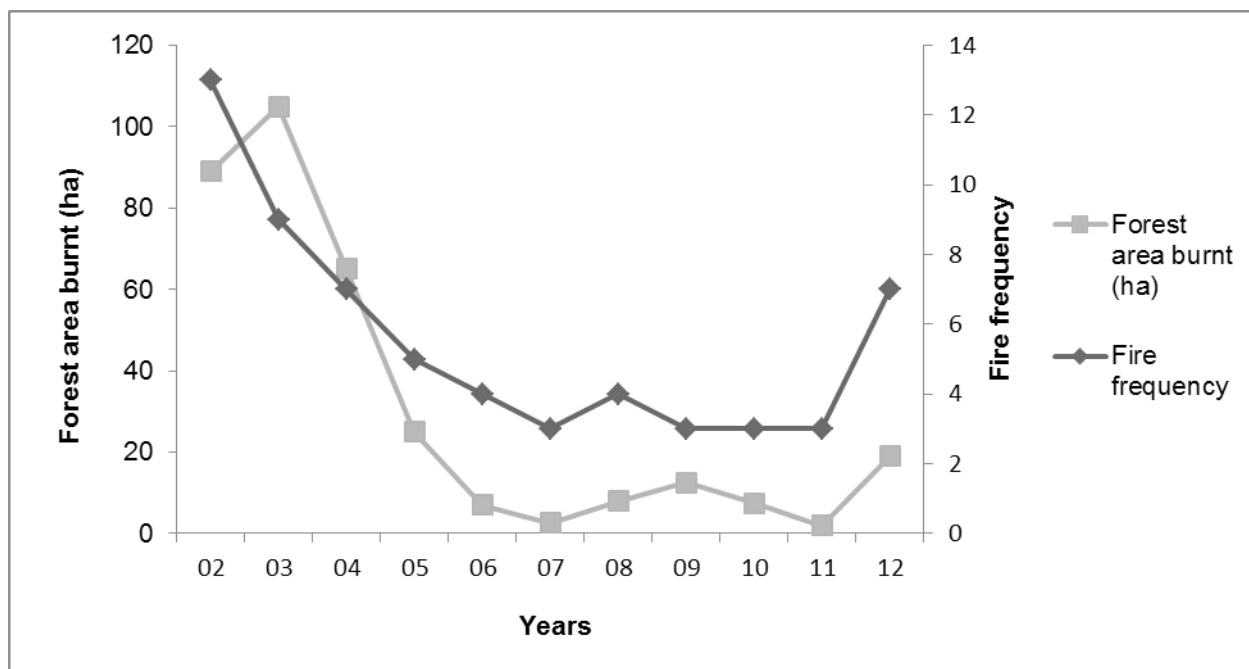


Figure 3—Annual forest fire frequency and area burnt over the period of 2000 to 2012 in Afram headwaters forest reserve.

to make it possible for such activities. For many farmers, burning land provides one of the few ways to prepare land for use; these fires can then get out of hand. It is also evident that the higher the number of fires the higher area burnt ($R^2 = 0.88^{**}$, $P = 0.001$). The increase in forest fire frequency to the increase area burnt is related to increased activity of humans in and around the forest (Xanthopoulos 2000).

Monthly frequency of forest fire and area burnt

Analysis of monthly occurrence of fires shows a strong seasonal trend, in which, forest fires usually started from November and ended in April. January and February were observed to be the peak forest fire season in the Afram

headwaters forest reserve. The fire season tends to disappear from May to October which was also attested by the local people (Figure 4). Generally, the dry season marks the occurrences of forest fire in the tropics (SCBD 2001). The dry season which starts from November to April is also the period of “harmattan” where the air is dry with high current and increased leaf litter on the forest floor that influences fire ignition. Amissah and others (2010) studied the high risk months for burning slash which coincided with the period mentioned. The peak of the fire season was in agreement with other studies (Adedoyin and Olanrewaju 2006; Yanek 2000). In relating this to the causes, the hunting season runs from January through July where some hunters illegally use

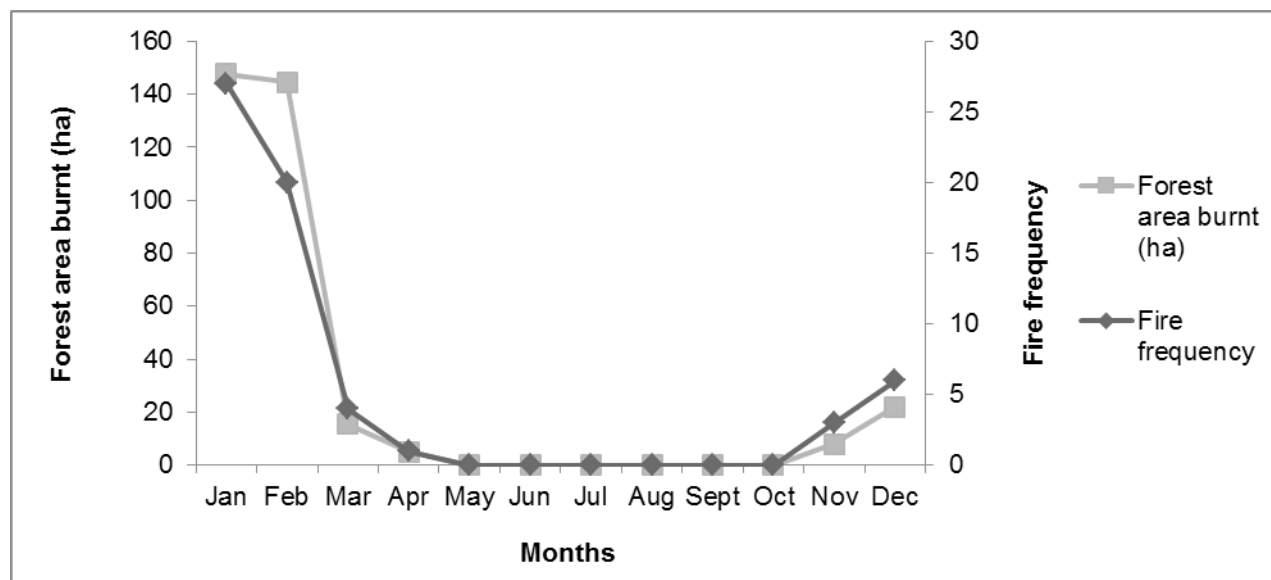


Figure 4. Seasonal pattern of forest fire frequency and area burnt over the period of 2000 to 2012 in Afram headwaters forest reserve.

fire for hunting. On the other hand, those fire season peaks are the time for burning slash for cultivation of crops by farmers (Amissah and others 2010). The fire season can also be related to prolongation of drought as rainfall reduces during this period of time. Rainfall as a climatic factor plays a significant role in forest fires.

Operational Forest Fire Management Strategies

The fire management strategies were divided into prevention, pre-suppression and suppression. Several stakeholders are supposed to be involved in forest fire management as indicated in the national policy. However, those pointed out by respondents were the FSD (55 percent), GNFS (10 percent) and communities (35 percent) located adjacent to the reserve. The prevention focused on actions and activities carried out to avoid the start of fire. The study revealed that prevention was focused on awareness creation, education and law enforcement excluding fire engineering. A combination of these elements is necessary for human caused ignitions (FAO 2006). Several means used to enforce prevention were signing, dramatization, community meeting, leaflet and pamphlet distribution, mobile van education, permits and inspections, talk show and use of national laws (Table 1). Questionnaires revealed that some practices were considered effective, while others were not. Communities around the Afram headwaters forest reserve considered community meeting as a more effective means of education than other approaches (54% agreement, Table 1).

These forms of prevention activities are considered as low-tech but somehow effective and preferred in sharing information (Appiah and others 2010; Blay and others 2011). Law enforcement plays an important role in fire prevention. However, the people around this forest reserve do not recognize the national laws and even the bye laws in the community concerning the use of fire. Although national and local laws punish offenders with arrest and fines, (between 50 to 100GH Cedis (US Dollar 26 to 53 June, 2012)), depending on the damage caused, these punishments seemed ineffective as a deterrent. A common problem in enforcement of these punishments is corruption, where in some cases, if the offender is a relative of the person in authority, they can

go scot free. In this case, a person would have little concern of starting another fire. Additionally, taking offenders to court requires a long process, which is considered too time-consuming by authorities; community leaders thus prefer fines instead of going through the legal process to prosecute offenders. Therefore fines and taboos as deterrent measures should be strengthened to reduce fire risk and fire causes (Appiah and others 2010).

Pre-suppression were strategies laid down to ensure preparedness for suppression. As at the time of the study, there were only low-tech detection systems, monitoring systems and operational fire early warning systems or alarms in Afram headwaters forest reserve. Major detection methods were through flame (1 percent), smoke (65 percent), fire embers (22 percent) and report from people (11 percent). All these activities were dependent on the abilities of the communities and considered ineffective. All these methods differ from other methods of accomplishing effective forest fire detection (FAO 2006). The methods cannot be used to identify fire danger in advance of their occurrences until fire started. Delay in fire detection strongly affects forest area burnt as preparedness is delayed. This gives fire the chance to grow steadily in size until the fire is brought under control (Alexander 2000). As a result, severe damages occur to the natural resources. In some cases, firebreaks that had been established around the reserve had many weeds and accumulated dead leaves serving as fire hazard. Bare-ground firebreaks or fire roads were not maintained sufficiently well to serve as barriers to fire spread. Training of community members to manage fire was also irregular due to lack of funds and logistics. However, other pre-suppression activities such as early burning and fuel treatment at fire hot spot areas were sometimes carried out to reduce fire frequency and severity.

Suppression appears to be spontaneous, with little formal procedures of preparedness, training and safety mechanisms to fight fires. However, in case of fire outbreak, all the people available within the community, and particularly the fire volunteers, help in extinguishing the fire. Equipment available for fire suppression were hand tools (71 percent) such as machetes, gallons of water, pick axes and mattocks. Improvised tools (23 percent) like palm fronds were also used with farm clothes, wellington boots and slippers as protective clothes (5 percent), while the only power equipment (1 percent) was the chainsaw at the community level. From the study, it was revealed that tools for suppression belong to the individual people and are considered ineffective for suppressing fires. Appiah and others (2010) found out that these simple tools are effective for suppressing small-scale fires but not large-scale fires. Respondents explained that when fire is large they resort to indirect method of suppression and as a result, burnt area increased. Meanwhile, the Manual of Procedures (2002) mentioned that proper equipment enhances effective fire suppression. However, this statement has been ignored without enforcement. According to respondents, no incentives were given for suppression at the time of the study and the suppression operations were considered as voluntary service. According to respondents, this adversely affected

Table 1. Respondents response on means of prevention activities.

Prevention means	Percentage of response	Ranking
Signing (bill boards)	4.6	5
Dramatization	2.8	6
Community meeting	54.1	1
Leaflet and Pamphlet	1.8	7
Mobile van education	18.4	2
Patrol and inspection	9.2	3
Talk shows	7.3	4
National and bye laws	1.8	7

their response to fire calls. Blay and others (2011) indicated that due to lack of incentives and law enforcing involvement has made people reluctant to engage themselves in fire suppression.

Conclusion

Most fires in the Afram headwaters forest reserve were originating from human activities. The most dominant cause of forest fires was carelessness and negligence (37 percent), farming (19 percent) and hunting (15 percent). Between the periods of 2002 to 2012, forest fires adversely affected forest area through repeated occurrences, with at least six fire occurrences with mean area burnt of 31 hectares annually. The forest fires occurred in the dry season from November and ended April. Peak forest fire seasons were identified in January and February. The existing management strategies were focused on fire prevention more than pre-suppression and suppression. However, fire prevention excluded fire engineering. Pre-suppression strategies were considered low-tech. The significance of fire monitoring, detection systems and early warnings were less regarded. Fire suppression activities were typically carried out without prior planning while suppression equipment were often inadequate and ineffective. Finally, the absence of incentives has affected the response of local people to fire calls.

Recommendation

Though fire is important for many local livelihoods, those contributing to forest fires must not be carried in and near the forest. Additionally, the causes, underlying drivers and effects are still unclear and inadequate which calls for more detailed research in other forest types in Ghana. Detailed analysis on cost of damage, quantity of trees and carbon emission can be significant for estimating economic and environmental losses. The Forest Services Division should actively collect all data and characteristics of forest fires to understand the trend and behaviour of fire to ensure effective forest fire management. Considering management interventions under prevention, there should be continuous education and capacity building particularly in the dry season in all forest communities. Farmers should opt for other farming methods than the use of fire. Ploughing and other forms of land preparation can be used by local people. There are many relevant laws and documentation on forest fires which need to be enforced to reduce forest fire losses while instilling strong punishments to deter offenders. For pre-suppression, detection of forest fires must be a major priority which has to be intensified to reduce damages. Firebreaks and bare-ground fire breaks must be maintained to serve intended purposes. Management should include scheduled prescribed fires to try to reduce fuel accumulation in the forest. Concerning suppression, appropriate equipment and protective wear should be provided by the Forestry Commission to ensure safety and successful

suppression. Finally, there should be better collaboration among all stakeholders involved in forest fire management.

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