

The Forest Fire Problem of Degrading Tain II Forest Reserve in Ghana: Rethinking Community Participation in Fire Management and Sustainable Forestry

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ABSTRACT

Until 1983, uncontrolled wildfires were relatively uncommon especially in the forest zones of Ghana. However, the period following the 1980s has seen a significant rise in wildfires, with devastating effects on forest resources and sustainable agricultural livelihoods. Thus, the rise in wildfire incidence in Ghana since 1983 raises questions about the effectiveness of fire management strategies adopted over time. In this study, we compare the effectiveness of indigenous fire management systems before 1983 and conventional fire management systems introduced after the 1983 fires in fringed communities around the Tain II forest reserve. Participatory Rural Appraisal (PRA) techniques were used to collect data from five communities. A total sample of 438 respondents comprising household heads and fire volunteer squads were interviewed. The data were analyzed using descriptive statistics. Respondents were of the view that despite the current challenges associated with their use, indigenous fire management systems could be more effective in curbing wildfires than the conventional fire management systems currently being employed. It is concluded that the success or failure of wildfire management in forest-fringed zones of Ghana depends on the degree of participation of local communities and institutions and the adequacy of support given to local fire volunteer squads.

Keywords: Community forestry; fire management; local participation; forest degradation; Tain II Forest Reserve; Ghana

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INTRODUCTION

Fire is a paradox – it can kill plants and animals and cause extensive ecological damage, but it is also the source of forest regeneration and of nutrient recycling (Rowell and Moore, 2000). In most African ecosystems fire is a natural and beneficial disturbance of vegetation structure and composition as well as nutrient recycling and distribution. Fire has been used as a land-use tool for controlling the environment since the early evolution of humanity (Goldammer & de Ronde, 2004). Over the past decade, many regions of the world have experienced a growing trend of excessive fire application in the forestry and agriculture interface, land-use systems and land-use change, and an increasing occurrence of extremely severe fires (FAO, 2006). In sub-Sahara Africa, fire continues to be used in such different ways by people living in different ecosystems. As a result, the rich biodiversity of tropical and sub-tropical savannas, grasslands and forest ecosystem is attributed to the regular occurrence and influence of fire. However, wildfires have harmful ramifications on ecosystems, economies and human security. This is due to increasing population pressure and increased vulnerability of agricultural and residential lands (Goldammer & de Ronde, 2004).

Fire is a widespread seasonal phenomenon in Africa (Goldammer & de Ronde, 2004). Africa is a fire continent (Komarek, 1971; Pyne et al., 2004). Fire is widespread in Africa because of the occurrence of biomass burning, particularly in the savanna and grassland biomes. Fire flourishes because most of Sub-Saharan Africa has an environment to sustain it, and there exists a chronic rhythm of wetting and drying (Pyne et al., 2004). While estimates of the total economic loss from African fires are not available, ecologically and economically important resources are increasingly being damaged by fires crossing borders from a fire-adapted to a fire-sensitive environment (Goldammer & de Ronde, 2004). Also, huge areas of the West African savanna are burned annually (FAO, 2001; Wardell et al., 2004), but estimates of the extent and impact of the numerous fires are uncertain and are still debated (Wardell et al., 2004). However, it is generally established that fires have occurred in the environment since the evolution of terrestrial plants (Andreae, 1991), and that fire has existed in the region since the emergence of savanna in the tertiary period, approximately 65 million years ago (Wardell et al., 2004). The predominant lack of financial, infrastructure and equipment resources for fire management in the Southern African Development Community (SADC) region and neighbouring Sub-Saharan Africa occurs alongside the lack of adequately trained human resources in fire management (Goldammer & de Ronde, 2004).

As the number of forest fires appears to be on the increase, conventional suppression measures have also increasingly come under question. These measures have not solved the problem; instead, in some countries the scale and magnitude of forest fires has increased (IUCN, 2002). According to FAO (2007), fire prevention and suppression are often hampered, among several factors, by unclear lines of institutional responsibilities and by conflicting policies and legislations. Thus, the search for improved approaches has led to calls for revisiting traditional forest fire management systems that place emphasis on prescribed burning and prevention (Ganz and Moore, 2002; IUCN, 2002, Morgera and Cirelli, 2009). Many policy makers and development workers are debating

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whether communities are capable of managing forest fires. However, the academic community has supported this by clearly stating that the community is the key to the survival of forests through integrating indigenous knowledge, conservation values and sustainable livelihoods (Makarabhirom *et al.*, 2002).

Community-Based Fire Management (CBFiM) has emerged as an adaptive mechanism for working with and managing fire in Africa and in the South East Asian (ASEAN) Region (Ganz and Moore, 2002; Shields *et al.*, 2006). The catalysts behind CBFiM approaches are indigenous land and/or use rights, including the right to use fire as a management tool (Ganz *et al.*, 2003, Moore, 2003; FAO, 2003). Communities have strong traditions that help enhance forest richness – biological and cultural diversity – through innovative means of forest fire management and integrated forest management (Makarabhirom *et al.*, 2002). Although community empowerment has been recognized as a means to manage fires, the question is: are the communities in question adequately empowered or are they even aware that they can be empowered to enhance their traditional practices? In Ghana, the 2006 National Wildfire Management Policy recognizes the crucial role communities can play in the sustainable management of natural resources, but this is not backed by any legislative instrument to compel implementing agencies to recognize the role of communities in fire management (Barnes, 2008).

In Ghana, CBFiM has been practiced both formally and informally since the last century. The informal practice was done before the 1982/83 dry season when the country experienced severe drought which resulted in widespread fires. The formal CBFiM came into being when the then PNDC government passed the legislation on bushfire in 1983 (PNDC law 46). But PNDC Law 46 did not make provision for implementation arrangements in terms of responsibilities of government agencies and the roles of communities and traditional authorities. In 1990 PNDC Law 229, which replaced PNDC Law 46, assigned functions to district assemblies and made provision for village fire volunteer squads (Government of Ghana, 1983).

However, the law did not empower traditional authorities and communities to play a key role in its enforcement (Obiaw, 2004; MLFM, 2006). It is assumed that community involvement in fire management has not been effective since wildfires continue to destroy life and property and the general environment in many communities (Barnes, 2008). While community based fire control once helped protect sacred natural sites, today rural communities are increasingly vulnerable to political and economic pressures beyond their control (Steiner & Oviedo, 2004).

The major objective of this study was to assess community involvement in fire management around Tain II Forest Reserve. This study therefore compared the effectiveness of the indigenous fire management systems before 1983 and conventional fire management systems introduced after the 1983 fires in fringe communities around the Tain II forest reserve. This is captured in four sub-sections, beginning with an introduction, historical and theoretical context on fire management, followed by a brief description of the study area and a discussion of the methods used in the study. Section three discusses the main findings, which include the effectiveness and challenges of

indigenous and conventional fire management and changes in fire frequency. The concluding section looks at some recommendations.

FOREST FIRES PREVENTION: A HISTORICAL BACKGROUND OF ACTIONS AND REACTIONS

Bushfire policies in several West African countries continue to be informed by new bushfire discourse coalitions, and are now central in contemporary forest development practices (Leach & Fairhead, 2000; Amanor, 2001). For example, the use of fire for economic activities remains critical to rural communities, even though in many African countries fire supports the sustainable living in rural areas (Wardell et al., 2004). But these fire policies in West Africa have their origins in colonial forestry (Laris & Wardell, 2006). By the late 1940s, numerous colonial states had attempted campaigns to ban burning (Wardell *et al.*, 2004). The efforts to implement these fire restrictions were tempered by forestry agents and mediated by a number of pragmatic concerns. These concerns included general lack of funding for forestry personnel and equipment, as well as local inhabitants' resistance to fire suppression (Laris & Wardell, 2006). For that matter, governments relaxed restrictions on the use of fire though official policy considered fire a threat to the savanna environment (Laris, 2004; Wardell *et al.*, 2004).

By the 1950s field workers and some foresters had undoubtedly observed indigenous burning practices and thus realized the futility of total fire protection and the benefits of early burning. They were aware that the indigenous population resisted fire suppression by continuing to start fires. This led some to the conclusion that complete fire suppression was not possible and perhaps not even desirable in the established reserve areas. But in northern Ghana, colonial officers failed in their attempts to use customary chiefs to limit the use of fire. The pragmatic solution was to accept or even promote an early burning regime (Laris & Wardell, 2006). But there has been a slight move back towards a more pragmatic approach, as governments have moved from a strategy of fire exclusion to one of fire management (restricted inclusion), encompassing the use of early burning techniques (Republic du Mali undated; Government of Burkina Faso 1998). The latest reforms in policy resulted from a combination of factors, including local reaction to the anti-fire campaigns (Laris 2004), critical appraisals by intellectuals (Brinkerhoff 1995), and the shift towards decentralized natural resource management (Ribot 2002). The reform in fire policy during the past 60 years was implemented without the aid of data on the actual patterns of burning, and largely without consultation with the indigenous population (Laris & Wardell, 2006). Further, Laris & Wardell (2006) added that for the past 50 years fire policy in the savanna of West Africa has been guided by a simple fire triad model which holds that the timing of annual savanna fires is a major determinant of vegetation cover.

However, according to Wardell et al. (2004), although there has been a discernible and progressive shift from fire control to fire management by francophone forestry services in West Africa, a distinctly different pattern has developed in Ghana where the Chief, the Forester and the Fireman have become the main actors in rural bushfire policy discussions. The new partnerships have been

strengthened by three distinct trends which continue to influence the relationship between bushfire science and policy in West Africa. This partnership provides firstly the rapid expansion in the use of remotely-sensed spatial data (Malingreau, 1990; Gregoire, 1993; Nielsen, 2000; Eva & Lambin, 2000). Secondly, new theoretical layers of knowledge have been added to (but in practice have not displaced) the earlier foundations of ecology and imperial forestry science which assumed succession and climax vegetation types (Wardell et al, 2004). These have been fashioned by indigenous knowledge discourse (Richards, 1985; Baker, 2000; Haverkort et al., 2002); more recent non-equilibrium theories (Ellis & Swift, 1988; Sprugel et al., 1991; Behnke et al, 1993; Sullivan, 1996); and the growing recognition that socio-institutional and ecological systems function as strongly linked, complex and dynamic arenas (Leach & Mearns, 1996; Fairhead & Leach, 1996). Thirdly, the proliferation of donor-supported environmental projects and programmes after the Sahelian crisis, and the contemporary interests in decentralisation, community participation, environmentally sustainable development, and policy-orientated seminars have provided frameworks to construct (and re-construct) discourse coalitions, and to develop discursive practices (Amanor, 2001; Ribot, 2002).

However, championing community participation in bushfire management has been constrained by the limited autonomy of deconcentrated regional and district forest offices which remain separated from local government structures. Yet existing bushfire-related laws continue to include unenforceable sanctions as well as contradictory and inconsistent provisions. In practice, organisational “cultures” have tended to prevail (Grindle, 1997; Wardell et al., 2004).

FIRE MANAGEMENT IN GHANA

Fire is widely accepted throughout Ghana as a valuable tool in the management of natural ecosystems, agriculture (including livestock production) and other land use systems (Nsiah-Gyabaah, 1996). The perceived destructive influence of wildfire was identified in Ghana from as early as 1910 (Orgle, 1994; Wardell, 2004). It is also on record that Ghana experienced serious bushfires during the catastrophic Sahelian drought between 1973 and 1974 (Nsiah-Gyabaah, 1996). These experiences notwithstanding, before 1983 uncontrolled fires were relatively uncommon, especially in forest zones. The severe droughts of 1982/1983 and the accompanying wildfires marked the turning point (Korem, 1985).

However, early efforts to prevent, control and suppress wildfires in Ghana involving both colonial agricultural and forestry officers began in the 1920s (Wardell, 2004). Unfortunately, early attempts at controlling wildfires did not place emphasis on management. In 1934, the first official attempt to manage wildfires was seen in the Savanna Woodland Policy (MLFM, 2006; Apusigah, 2007). The 1930s and 1940s witnessed a number of attempts by the colonial government and its Native Authorities (Tater, 2004; MLFM, 2006; Apusigah, 2007). Taking a cue from this initiative, the Dagomba (1934, 1949), Lawra (1938) and Kassena-Nankana (1938) Native Authorities instituted measures to check burning (Apusigah, 2007).

In the late 1940s, new fire management strategies were formulated (Apusigah, 2007; MLFM, 2006). These included construction of fire belts, early burning, annual trace burning and patrols during the dry season, wildfire awareness campaigns and the establishment of green fire-belts. Although these new fire management strategies worked effectively in protecting areas and forest reserves, they did not address fires outside the forest reserves (MLFM, 2006). A bushfire experiment was established near the Red Volta River in 1949 and by 1963 the results confirmed that early burning techniques represented the only practical solution, given the diversity of interest groups in Northern Ghana (Wardell, 2004).

In view of these early lessons learned, the Forestry Department of Ghana became instrumental in constructing the conceptual dichotomy between the realms of the “modern and scientific” approach to fire control and the “traditional and haphazard” use of fire as a land management tool in Northern Ghana. This has veiled complex historical, ecological and socio-cultural realities and the persistence of the wildfire challenge in spite of repeated attempts by the state to legislate against the setting of wildfires throughout the period 1957-2000 (Wardell, 2004). Before 1983 when fires were rare, the local people were using the indigenous methods of fire prevention and control. In 1983 when wildfires apparently became uncontrollable in Ghana, conventional fire management systems were introduced and legislation (PNDCL 46 – Control of bushfire law) was enacted to control fires (Tater, 2004; Wasai, 2004; Obiaw, 2004; MLFM, 2006). The legislation did not make provision for implementation in terms of the responsibilities of governmental agencies and the roles of communities and traditional authorities (Obiaw, 2004 and NWMP, 2006). This was subsequently amended in 1990 (PNDCL 229 – control and prevention of bushfire law) (Obiaw, 2004; MLFM, 2006; Apusigah, 2007). However, the PNDCL 229 on bushfires, as it currently stands, does not provide a comprehensive framework for addressing the wildfire menace in Ghana. Its limitations include the lack of clear identification of the custodian of the law; the absence of a legislative instrument to guide and streamline the implementation of the law; penalties which are not deterrent enough to stop would be offenders; and the failure of this law to empower traditional authorities and communities to play key roles in its enforcement (Obiaw, 2004; MLFM, 2006).

In attempt to forestall these shortcomings, the Forestry and Wildlife Policy of 1994 came into force with the aim of maintaining a healthy environment and ensuring a perpetual flow of optimum benefits to all segments of society. However, the policy did not consider wildfire as a major issue in forest management and did not place wildfire management issues high on the national agenda (Obiaw, 2004; MLFM, 2006). Also, the National Fire Service Act of 1997 (Act 537) is flawed with respect to wildfire management, as it is highly skewed towards industrial and domestic fire management. The Act does not go far enough with respect to empowering local communities and groups; and it is silent on how logistics would be provided to assist the operation of fire volunteer squads even though it advocated the establishment of such squads in communities (Obiaw, 2004; MLFM, 2006).

Until 2006, Ghana did not have any formal and clear cut policy on fire management, a situation which led to inconsistencies in the implementation and enforcement of the bushfire/wildfire laws. The challenge for Ghana was to move away from the piece-meal approach to wildfire to a more

comprehensive and sustainable community based approach (MLFM, 2006). Although the 2006 wildfire management policy identified and allowed relevant institutions and stakeholders to develop individual action plans for the attainment of the policy objectives, it is silent on the time frame for the establishment of these institutional action plans. Also, though the Policy recognized the crucial role communities can play in the sustainable management of natural resources, this is not backed by any legislative instrument to compel implementing agencies to encourage communities to play their part (Barnes, 2008).

INDIGENOUS FIRE MANAGEMENT IN GHANA

In Ghana, burning is embedded in the cultural values and traditional farming systems of the people (Nsiah-Gyabaah, 1996). Traditional burning is peculiar to the northern parts of Ghana, especially among ethnic groups such as the Dagomba, Moshie, Mamprusi, Kusasi, Gonja, Gurima, Talensi, Komkomba, Wala and Dagaaba (Korem, 1985). The custom of burning is performed in the evening of the ninth day of the month of fire. It is believed that in the coming year something good will happen to those who partake in ceremonial burning (Korem, 1985). Ampadu-Agyei (1988) attributes the yearly occurrence of bushfires to what he describes as the perpetration of the culture of burning in the wake of disintegrating socio-cultural norms which regulated burning. The culture of burning as adduced by Ampadu-Agyei (1998) is perhaps what Akyea (1988) described as a 'crazy culture'. Kirby (1988) explored the less visible but perhaps more fundamental reasons for bush fires, which are attitudinal – the ways in which the issue is understood by the rural communities who set the fires. Kirby also contextualized bush burning as a cultural problem.

Beyond the practical realm however, in rural communities in Ghana, there also exist vast knowledge, skills and experiences regarding wildfire management. According to Millar (2004); Wulugu Community (2004); Bowku Community (2004); Agubie Community (2004) and Kalbeon Community (2004), there is in-depth knowledge on the bushfire menace and the various technologies devised by communities to control and manage the fires. Many of the rural communities, as part of their way of living, have developed environmentally sensitive strategies for living with and managing nature. These communities have developed knowledge and skills and even spiritualities that enable them to conserve their sources of livelihood and their way of life. Taboos, sacred places, festivals and cultural practices have conservation ethics built into them (Apusigah, 2007).

Local people, according to FORIG (2003), have some indigenous knowledge of forest fires, which is reliable but remains to be tapped and processed into scientific knowledge to enhance its effectiveness. Researching into indigenous fire management practices in Ghana, Amissah (2008) remarked that present indigenous practices for fire usage and management in Ghana are comparable to scientific practices. Amissah, however, was quick to add that these practices are fraught with certain weaknesses such as repeated burning, inappropriate timing of burning and a not too well developed set of alternatives to the use of fire.

Amissah (2008) indicates that over the past two decades, indigenous people in Ghana have managed fires through prevention and suppression activities. Fire pre-suppression was carried out through the construction of fire breaks and early burning which were not common in the forest zone in the past. In order to suppress fires, community members are assembled through beating of gong-gong or drums authorized by the chief. Also local people construct fire breaks directly or indirectly by beating fires with palm fronds and by sprinkling water.

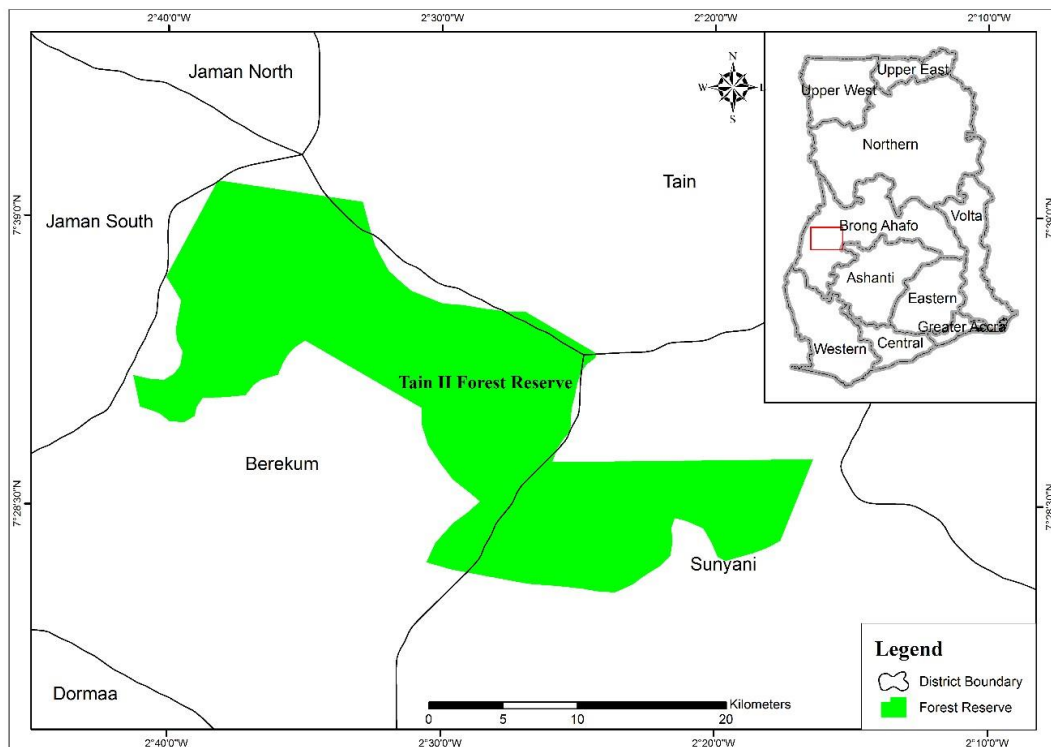
Historically, traditional authority has always been in the forefront of management of wildfires. Various institutions, structures and systems still exist as traditional management systems to regulate wildfire management and the general uses of fire. If left alone, this traditional responsibility system could have been relied on for sustainable fire management. Tinkering with these authorities has led to the diminishing of their effectiveness and efficiency (Mbow et al., 2004; Wardell, 2004).

STUDY AREA AND METHODOLOGY

Site Description

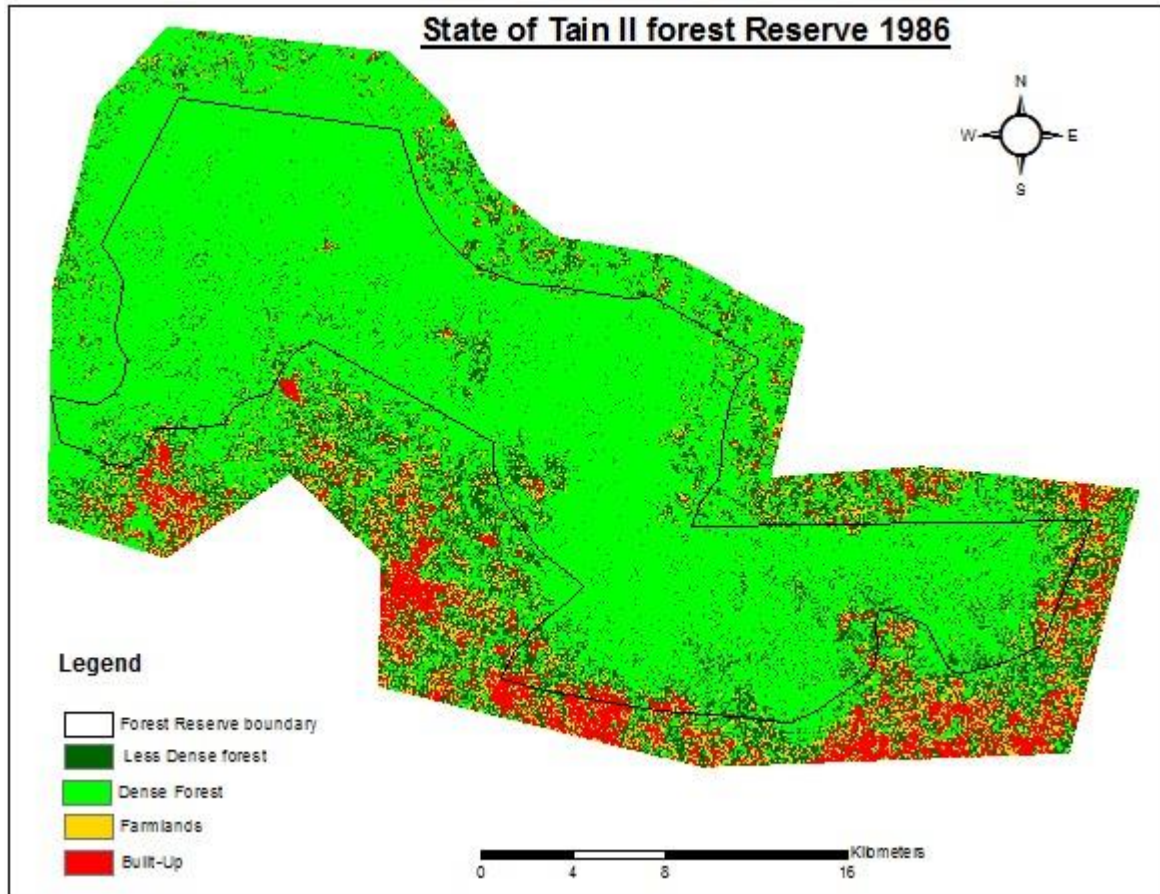
The Tain II Forest Reserve was established in 1934. Ownership is vested in the stools of Berekum, Odumasi and Nsoatre. Little is known of the history of the area prior to the conservation initiative. The reserve is located in the Dormaa Ahenkro District in the Brong Ahafo Region and lies between latitude 7° 22' and 7° 41' N, and longitudes 2° 17' and 2° 27' W. Tain II Forest Reserve was reserved to be managed under a protection working circle to prevent the southward encroachment of the savanna.

Figure 1: Tain II Forest Reserve



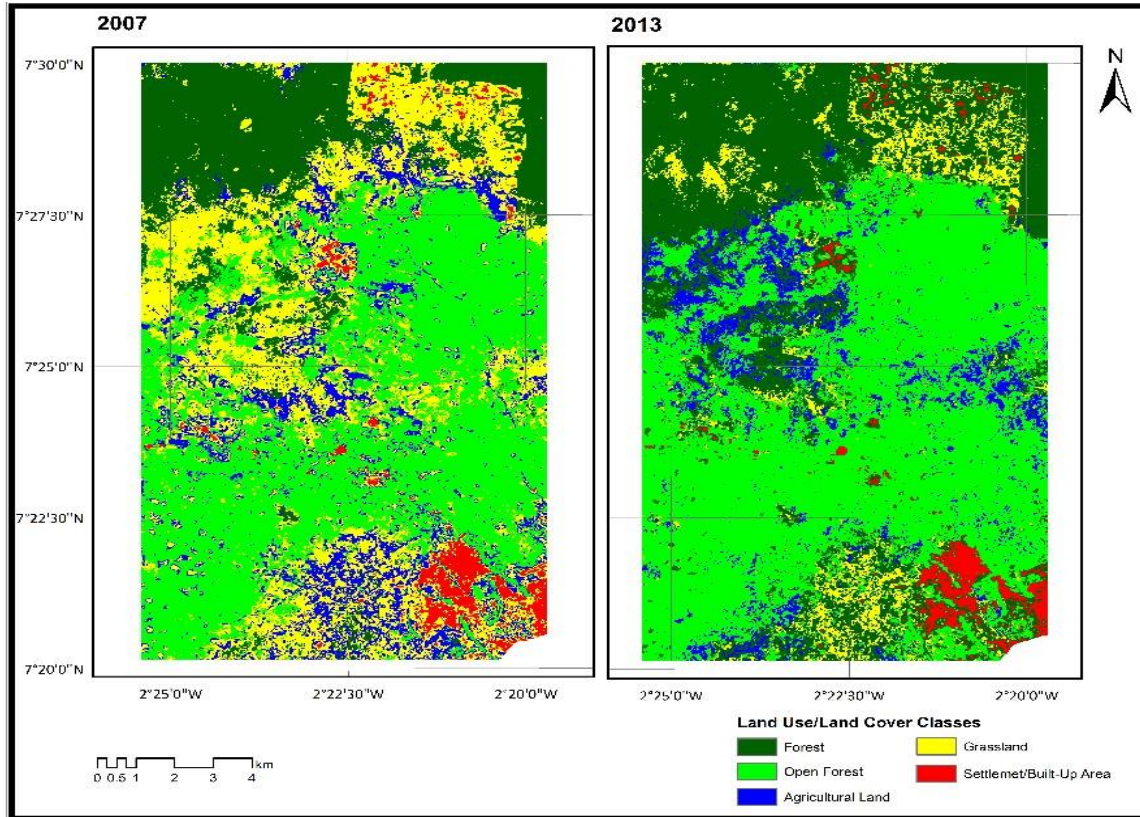
Tain II Forest Reserve forms part of the Dry Semi-Deciduous Fire Zone (DSFZ) forest (Hall and Swaine, 19981). This corresponds with the *Antiaris-Chlorophora* Association of Tropical Moist Semi-deciduous Forest Type (Taylor, 1960). The bulk of the reserve is a transitional high forest with areas of derived savanna grassland intruding into the forest along parts of the external boundary (FMU 23, 1993).

Figure 2: Tain II Forest Reserve in 1986



In 1934 the Reserve covered 509.20 Sq Km. In the year 1986, the area of forest cover was 499.10 Sq Km while in 1991 it was 451.37 Sq Km. In the year 2000, the forest cover was 108.87 Sq Km, while in 2007 the forest cover was 87.53. The reduction in the forest cover of the Tain II forest reserve is significantly attributed to fire incidents affecting the reserve. These frequent fire scenarios and their consequent destruction of the forest resource of the region can have grave implications for climate change mitigation measures in the country.

Figure 3: Forest Cover Changes



Source: APERL Project Office, (2014). Some proportion of area covered by remnant natural forest, some significant amount of (mmmaa kube) and a greater portion covered by forest plantation mainly teak and ciderala with little amount of fuel load.**

It is evident that forest cover of the project catchment (Tain II Forest Reserve) has improved slightly from 17.71% to 22.05% within the course of the project (APERL) (from 2007-2013) due to plantation activities (Establishment of woodlots). Another significant change of interest is the increase in Agricultural activities. Agricultural Activities doubled from 11.52% to 22.17% (table 1).

Table 1: Land Cover Classes

Land cover Classes	2007		2013	
	Hectares	%	Hectares	%
Forest	3375.54	17.71	4202.22	22.05
Open Forest	7861.41	41.25	8037.96	42.18
Agricultural Land	2195.46	11.52	4224.9	22.17
Grass Land	5047.47	26.49	1819.99	9.55
Built-Up Area	575.78	3.02	770.59	4.04
	19055.66		19055.66	

According to Ashiagbor and Laari (2013), the project catchment (Tain II Forest Reserve) has a massive influx of migrant farmers. These farmers have replaced the perennial tree crops with annual crops, mainly cassava and maize, due to land tenure issues. These crops, they normally cultivate on a large scale, and the cheapest means of clearing the land is through the use of fire and weedicides. They further explained that the migrant farmers have replaced the traditional composting system with slash and burn, which is the major cause of forest fire. Also Ashiagbor and Laari (2013) indicated that 39% of the project area (Tain II Forest Reserve) falls within the high to very high fire risk zones. Results from the study show that the main causes of forest fire in the project area are human activities.

Methodology

The procedure adopted for the study comprised a preliminary literature search, a familiarization visit to the study area, a reconnaissance survey, the design of questionnaires, a pre-test of questionnaires and the main field survey (data collection). Participatory Rural Appraisal (PRA) tools were used to collect field data. The adoption of PRA data gathering techniques facilitated the collection of reliable data for the study.

An Orthorectified Landsat image of 1986 was acquired from the United States Geological Service Department (USGS). The region of interest was chipped out and a false color band combination of 4,3,2 was used for the image separation, after which contrast stretches were performed on the image. A supervised classification was adopted using 30 classes which were later recoded into 5 – dense vegetation, less dense vegetation, farmland and built up. Ground truth data were collected and used to train samples for the signature file used in the supervised classification. Image processing was done using Erdas Imagine 2010 and the classified image exported to ArcMap (ArcGIS 10.1), from which a map layout was produced.

The simple random sampling technique was used to select households for questionnaire administration. The questionnaire was administered to household heads and in their absence an

elder (male) or spouse (elderly woman) was interviewed. In all a total of 438 respondents were interviewed in five communities. The communities were Adoe (54), Ayakomaso (66), Dumesua (134), Fiapre (155) and Motoase (29). Also, twenty-four (24) persons comprising four key informants each in six institutions were interviewed. These institutions were Ghana National Fire Service (GNFS); National Disaster Management Organization (NADMO); Forestry Services Division (FSD) - Sunyani, Ministry of Food and Agriculture (MOFA); Faculty of Forest Resources Technology (FFRT), KNUST Sunyani Campus; and Forestry Commission (Regional). The analyses were done based on comparative and descriptive statistics using frequencies and percentages. Chi Square tests were used to establish significant differences in the responses given during the study. Statistical software that was used included the Statistical Package for Social Scientists (SPSS) version 16.0.

RESULTS

This section deals with the community members' perception of the effectiveness of indigenous fire management and conventional fire management systems before and after 1983.

Effectiveness of Indigenous Fire Management

Table 2 indicates the distribution of responses on the effectiveness of indigenous fire management in general in the five communities before 1983. A total of 374 (85%) out of the 438 respondents interviewed agreed to the view that indigenous fire management in general helped curb the menace of wildfires before the severe wildfires of 1983, compared to 15 (3%) who disagreed.

Table 2: Community Perceptions on the Effectiveness of Indigenous Fire Management

Community	Indigenous fire management before 1983 was effective in curbing wildfires			Total
	Disagree	Neither agree nor disagree	Agree	
Adoe	2	4	48	54
Motoase	0	0	29	29
Fiapre	3	14	138	155
Dumesua	10	19	105	134
Ayakomaso	0	12	54	66
Total	15	49	374	438

Table 3 illustrates the distribution of responses on the effectiveness of the individual indigenous fire management systems in the five communities. The study indicated that the majority of the respondents agreed that all the fire management strategies: prevention [381 (87%)], pre-suppression [381 (87%)] and suppression [381 (87%)] contributed to the effectiveness of indigenous fire management before 1983 (table 2).

The claim by the five communities (table 3) that indigenous fire management in general has helped curb wildfires was supported by the responses from personnel of the six institutions interviewed. Of the 24 key informants interviewed 11 agreed, eight disagreed while five neither agreed nor disagreed that indigenous fire management helped curb the menace of fire.

Table 3: Perceptions on Indigenous Fire Prevention, Pre-suppression and Suppression

Categories	Responses			Total
	Disagree	Neither	Agree	
Fire Prevention	6	51	381	438
Fire Pre-suppression	13	44	381	438
Fire Suppression	3	54	381	438

From these results, it was identified based on the respondents' perceptions that indigenous fire management succeeded in curbing wildfires mainly by indigenous fire prevention through the use of local rules and regulations. A total of 284 (65%) respondents indicated that local rules and regulations were used to prevent fires, while 154 (35%) indicated that local authorities did not use local sanctions to curb fires in the communities.

Challenges of Indigenous Fire Management Systems

The study revealed that the majority of respondents are of the view that traditional rules and regulations (bye laws/sanctions) and respect for traditional authority which were once used as measures to curb fire incidence have been widely ineffective since 1983. This finding is in consonance with the views of Sarfo-Mensah & Oduro (2010) that in sub-Saharan Africa, extensive habitat destruction, degradation, and severe depletion of wildlife, which have seriously reduced biodiversity and undermined the livelihoods of many people in rural communities, have mainly been a result of the erosion of traditional strategies for natural resources management. In Ghana, studies point to an increasing disregard for traditional rules and regulations, beliefs and practices that are associated with natural resources management. Ntiamoah-Baidu (1995) agreed with this stance but was also of the view that though these rules and regulations have no legal backing, the beliefs have been strong enough in the past to make people obey the regulations. A total of 338 (77%) respondents agreed with this assertion compared to the 100 (23%) respondents who believe that traditional norms are still effective in curbing the fire menace.

Respondents were of the opinion that practicing indigenous early burning was extremely difficult as a measure to suppress and control fire. This is confirmed by the majority of respondents of the study, 278 (63%) as compared to 160 (37%) respondents who disagreed with that assertion. They (majority) were of the view that the once thick vegetation and forest around Tain II Forest Reserve which enhanced suppression and pre-suppression has been removed, leaving most of the area covered with grass.

Effectiveness of Conventional Fire Management

Table 4 shows the distribution of responses on the effectiveness of conventional fire management systems used around Tain II. Of the total 438 respondents interviewed, 177 (40%) agreed that conventional fire management has helped curb perennial fires, while 157 (36%) neither agreed nor disagreed. However, a further 104 (24%) respondents flatly disagreed that conventional fire management has contributed in curbing perennial fires.

Table 4: Community Perceptions on the Effectiveness of Conventional Fire Management in Curbing Fire Menace

Community	Conventional fire management after 1983 was effective in curbing perennial wildfires			Total
	Disagree	Neither agree nor disagree	Agree	
Adoe	23	6	25	54
Motoase	2	13	14	29
Fiapre	50	61	44	155
Dumesua	24	53	57	134
Ayakomaso	5	24	37	66
Total	104	157	177	438

The distribution of responses on the effectiveness of the individual conventional fire management systems is shown in table 5. A total of 175 (40%) respondents agreed that conventional fire prevention has helped curb perennial fire, but 150 (34%) respondents neither agreed nor disagreed with the assertion. However, the majority of respondents neither agreed nor disagreed that the conventional fire management strategies, pre-suppression [171 (39%)] and suppression [174 (40%)], contributed to the effectiveness of the conventional fire management after 1983.

Table 5: Perceptions on the Effectiveness of Conventional Fire Prevention, Pre-suppression and Suppression After 1983

Categories	Responses			Total
	Disagree	Neither	Agree	
Fire Prevention	113	150	175	438
Fire Pre-suppression	105	171	162	438
Fire Suppression	95	174	169	438

Of the 24 key informants in the six institutions, 15 agreed that conventional fire management in general after 1983 has helped curb wildfires, four disagreed with the assertion while five neither agreed nor disagreed.

Challenges of Conventional Fire Management Systems

The following challenges were identified by respondents concerning the conventional fire management systems used around Tain II Forest Reserve. The study results show that opinions were divided on whether punishments of culprits in the five communities are deterrent enough. A total of 271 (62%) respondents agreed that culprits are not punished when arrested for setting wildfires, while 167 (38%) respondents are of the view that culprits are punished. However, a total of 312 (71%) respondents stated that punishments given to culprits are not deterrent enough to stop the continuous occurrence of fires in the study communities, compared to 126 (29%) respondents who were of the opinion that punishments are enough to deter offenders.

These local rules and regulations instituted by local authorities usually came in the form of taboos and or bye laws/sanctions. Tradition prohibits farmers from burning their farmlands or any surrounding lands without first constructing clear fire breaks. Fire belts are created around the portion of the forest, which is torched and burnt to mark the advent of bushfires on farms. It could be argued that these cultural practices make up the practical sphere of indigenous wild fire management in Ghana. Another challenge uncovered by the research in a group discussion and confirmed by some staff of the Ghana National Fire Service is the interference by political parties and state officials in the punishment of offenders. As a result, culprits are arrested for fire offences, but are not punished.

Regarding awareness of national laws and policy concerning wildfire management, 239 (55%) respondents are not aware of any national laws and policy while 199 (45%) are aware of these laws and policy. This was confirmed by 14 (58%) respondents from six institutions interviewed who said that at the community level the majority may not be aware of these laws and policies, while 10 (42%) disagreed. Furthermore, 331 (76%) stated that wildfire laws are not effectively

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applied in dealing with perennial wildfires, compared to 107 (24%) respondents who said the laws are effectively applied.

The study results revealed that fire-fighting equipment is not available and even where it is, it is not enough to be distributed among fire volunteer squads (Fig. 4). A total of 266 (61%) respondents agreed with the assertion that fire volunteers are not well equipped; 61 (14%) respondents disagreed; and 111 (25%) respondents did not know whether fire volunteers are equipped or not. Of the 24 respondents from the six institutions, 15 (62.5%) agreed that fire volunteers are not equipped, while 9 (37.5%) disagreed.

Figure 4: Fire Fighting Equipment for Fire Volunteer squads



It was also gathered from a group discussion that fire management was carried out by various government agencies, which in the opinion of the study communities, does not help the current situation of annual fires because it brings with it conflicting implementation strategies and programmes.

Changes in Fire Frequency

Of the total 438 respondents from the five communities, 282 (64%) agreed that indigenous fire management was more effective in curbing wildfires than the conventional fire management systems introduced after the 1983 fire scenarios, while 78 (18%) disagreed. A further 78 (18%) neither disagreed nor agreed.

Table 6 indicates the distribution of responses on the frequency of wildfires five to ten years before 1983. Of the 438 respondents, 361 (82%) were of the view that wildfires rarely (not yearly) occurred before the 1983 fires. All the five communities had the majority of their respondents indicating that wildfires rarely occurred around the Tain II forest reserve before 1983.

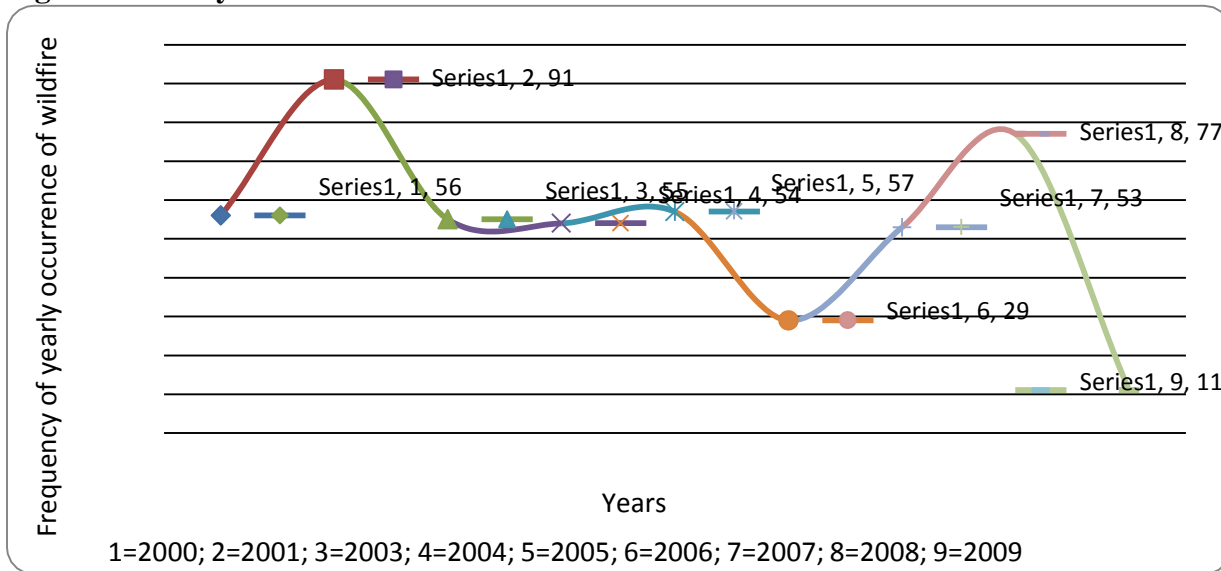
Table 6: Frequency of Wildfires Before 1983

Community	What was the frequency of wildfires before 1983 fires?			Total
	Yearly	Not yearly	Never	
Adoe	5	48	1	54
Motoase	0	29	0	29
Fiapre	10	122	23	155
Dumesua	5	114	15	134
Ayakomaso	7	48	11	66
Total	27	361	50	438

Of the 438 respondents interviewed, 397 (91%) were of the opinion that after the 1983 wildfires, each year, communities experience wildfires; 36 (8%) indicated that fires did not occur yearly; while 5 (1%) stated that wildfires never occurred yearly. Records from the GNFS indicated that generally wildfire incidences had reduced between 2001 and 2009. However, the fires occurred every year irrespective of the magnitude (Figure 5).

As regards the distribution of responses on the changes in fire frequency in the study communities after 1983, 327 (75%) respondents were of the view that the incidences of fires are decreasing in the study communities; 85 (19%) noted that the incidence of perennial fires are increasing. Also 26 (6%) respondents indicated that there are no changes in the incidence of perennial wildfires in the study area. Responses from 24 individuals in the six institutions affirm this decreasing trend in fire frequency in the study communities. On fire frequency, 14 (58.3%) respondents noted that the incidence of wildfires was decreasing, whereas 10 (41.7%) were of the view that the incidence of wildfires is increasing.

Figure 5: Yearly Occurrence of Wildfires around Tain II Forest Reserve



DISCUSSION

The discussion covers the perceived effectiveness of indigenous fire management before 1983 and the conventional fire management system introduced by the government after the 1983 wildfires.

Effectiveness of Indigenous Fire Management

The results indicate that indigenous fire management helped curb wildfires in the years before the 1983 El Nino engulfed Ghana. In their (respondents') estimation, indigenous fire management in general was successful in curbing wildfires because community members revered their traditional leaders. As a result, they adhered to the traditional rules and regulations associated with the use of fire that governed their farming activities and natural resources management. The perceptions of the respondents thus confirm earlier findings by Ntiama-Baidu (1995) and Abayie Boateng (1998) that in Ghana traditional natural resource management is shaped around local rules and regulations. These local rules and regulations instituted by local authorities usually came in the form of taboos and/or bye laws/sanctions. Offenders were made to make sacrifices to community gods for disobedience to authority and for bringing the name of their clan and/or community into disrepute.

This particular finding is comparable to what pertains in communities such as Kalbeon and Wulugu where indigenous fire management triumphs through the use of taboos and sanctions given to culprits (Millar *et al.*, 2004). Sacrifices are made to maiden gods to appease them for protection from any calamity that might occur as a result of disobedience by burning. It is prohibited for anyone to set fire to his/her farm before the sacrifices are made (Millar, 2004). These

rules and regulations are most often enshrined in religious or cultural beliefs and enforced by prohibitions which have no legal backing, but take their efficacy from customary beliefs which were strong enough in the past, thus commanding strict adherence (Ntiama-Baidu, 1995). Millar's (1995) position that the spirituality of local people serves as the basis for all human endeavours and is reflected in their worldview perhaps offers a verifiable reason for the central role of these beliefs. Responses gathered from focus group discussions lend credence to the stance of individual community members and institutions and it can thus be inferred that these rules and regulations might have also worked because community members revered and feared their local chiefs and as such obeyed laid down traditions. Tradition also did forbid any farmer to burn a farm land or any surrounding area without first constructing clear fire breaks.

Challenges of indigenous fire management systems

Traditional leaders and authorities who once wielded power and control over their subjects to manage fire effectively through the use of traditional rules and regulations before the 1983 El Nino no longer exert that absolute control over their subjects. This weakening of traditional authority, according to community members and key informants from the six institutions, could be traced to the introduction of Christianity and Islam. Inhabitants in recent times disregard the traditional norms and beliefs, leading to chiefs and elders losing control over their subjects in these communities. The situation has further been aggravated with the influence of modernization which has impacted on the biophysical and socio-economic activities of the people around Tain II Forest Reserve. But according to Sarfo-Mensah & Oduro (2010), several Christians and Moslems, to a large extent, expressed belief in some concepts of traditional religion. However, concerns have been expressed about traditional African religions and animist beliefs, which underpin most traditional natural resources management, due to the rapid spread and entrenchment of Christianity and Islam in many communities on the continent (Appiah-Opoku & Hayman, 1999; Ejizu 2000). These concerns have been re-emphasized in the recent debate on the change of traditional natural resources management practices. Increasingly, it is being stressed that changes in these practices may lead to loss of their value and the impact they have on conservation (Sarfo-Mensah & Oduro, 2010).

This does not deviate from the literature, as Sarfo-Mensah and Oduro (2007) reported that it is increasingly being acknowledged that the rapid loss of control by the chieftaincy institution is due to the breakdown of traditional beliefs and associated taboos. However, Dorm Adzorbu *et al.* (1991), Fargey (1991), Falconer (1992), Ntiama-Baidu (1995), Gyasi (1996) and Abayie-Boateng (1998) all agree with the respondents who still believe that traditional norms could be used to curb the current fire menace. They argue that although traditional beliefs and taboos are undergoing changes, they have retained some of their intrinsic practice despite pressures. This has partly been attributed to local people's perception that such traditional norms are associated with gods and ancestors who are still revered. Ntiama-Baidu (1995) further maintains that these rules and regulations are most often enshrined in religious or cultural beliefs and superstitions and enforced by prohibitions. These have no legal backing, but the beliefs have been strong enough in the past to make people obey the regulations.

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Generally, rural inhabitants begin an annual burning regime early in the dry season in order to fragment the landscape, with the goal of preventing later fires that can damage natural resources (Laris, 2002). According Wardell et al. (2004), the acceptance of early burning as a necessary tool was endorsed by the results of bushfire experiments; localised efforts in Anglophone states to understand, recognise and protect customary rights to use fire; and in some Francophone states, by new decrees adopted in the mid-1950s authorising the use of preventive early burning techniques.

On the contrary, the study discovered that the indigenous practice of early burning can no longer be used as a measure to reduce fire incidence. The factor adduced by the respondents for this outcome is that loss of tree cover makes suppression and pre-suppression difficult due to large areas of grass cover. But in observing indigenous fire practices, field staff and some foresters realized the futility in trying to achieve complete fire protection. According to them, indigenous people resisted fire suppression by continuing to set fires. This led to the conclusion that complete fire suppression was not possible and perhaps not even desirable in the established reserve areas. But the pragmatic solution was to accept or even promote an early burning regime (Laris & Wardell, 2006).

Effectiveness of Conventional Fire Management

Conventional fire management systems practiced in the study communities around Tain II Forest Reserve are prevention, pre-suppression and suppression. These conventional systems identified by respondents are in line with the assertion by Barnes *et al.*, (2005), Barnes *et al.*, (2004) and Ninnoni *et. al.* (2003) that they are the main conventional fire management systems used in Ghana.

From the results (Table 4), conventional fire management has reduced fire incidence around Tain forest reserve since 1983. Although this assertion was supported by responses from community members and those of the personnel from the six institutions that conventional fire management helped curb wildfires, responses on conventional pre-suppression and suppression (Table 5) do not support such view. The majority of respondents remained neutral because wildfires are perennial events around Tain II Forest Reserve. This observation is in line with the records (Figure 5) obtained from Ghana National Service (GNFS) that wildfires are yearly affair around Tain II Forest Reserve. To this end, no conclusion can be drawn regarding the effectiveness of the conventional fire management system (prevention, pre-suppression and suppression) in curbing the menace of wildfires in the study communities.

In an interaction with personnel of the GNFS and the District Forest Service Division (FSD), it was gathered that conventional fire management in the study area largely depended on wildfire prevention (law enforcement and annual radio and mobile van education). In contrast, the community members indicated that law enforcement is not effective in deterring culprits, as they are not punished, and even when they are, the punishment is not deterrent enough. It was also gathered from the group discussions that wildfire management was carried out by various government agencies, which in the opinion of the study communities do not help the current situation of annual wildfires because it brings with it conflicting implementation strategies and

programmes. The study also found that there are no properly laid down coordination channels for monitoring the activities being carried out by these agencies that have a different mandate by law to manage wildfires. This situation follows FAO's (2007; 2009) argument that fire prevention is often hampered by unclear lines of institutional responsibilities and by conflicting policies and regulation. Similarly, Shields *et al.* (2006) wrote that without clear understanding of the linkages between fire cause and fire prevention actions, and more particularly, who causes them and why, it will remain a difficult task to effectively target sound fire management practices, particularly fire prevention. Nevertheless, FAO (2006) argues that effective monitoring and assessment of the prevention measures can reduce the occurrence of fires.

The unavailability and/or lack of pre-suppression and suppression equipment (fig. 4) and the lack of incentives for stakeholders at the grassroots; the inability of GNFS to monitor the performance of fire volunteers in the discharge of their duties; and the lack of insurance schemes for fire volunteer squads were the reasons given by both respondents in the five communities and personnel of the six institutions interviewed as contributing to the ineffectiveness of the conventional fire management systems. But Ganz and Moore (2002) stated that governments' responses to fires have tended to focus on fire suppression and costly technology based solutions.

Challenges of conventional fire management systems

One major challenge uncovered by the research is interference by political parties and state officials. Culprits are arrested for fire offences, but are not punished. The community members were quick to allege and register their displeasure at the continuous intervention and interference from officialdom, especially political parties, in the use of the law, thereby rendering the law ineffective. This interference, according to them, has culminated in the release of culprits and their confiscated items. Also, punishment meted out to culprits for setting fires was not deterrent enough to stop the continuous occurrence of fires in the study communities. This assertion agrees with Karki's (2002) suggestion that community-enforced fines and penalties work better than government legislation in enforcing wildfire sanctions.

The study discovered that fire-fighting equipment is not available and even where it is, the equipment is not enough to be distributed among fire volunteers. This does not allow fire volunteers to give of their best in fighting wildfires. In a discussion with some staff of the Ghana National Fire Service, it was further stressed that the Department of Rural Fire and Fire Volunteers are not equipped for effective wildfire management. The Department is under-staffed and has limited logistics for educational campaigns and training in communities. Although the Ghana National Fire Service gets some support from the District Assemblies and Regional Coordinating Councils during the annual National Farmers' Day Celebration and the annual dry season campaign which is also done during the Farmers' day celebration, these are only isolated cases and often the support is given only on this occasion. Furthermore, due to lack of resources and a feedback channel the Ghana National Fire Service is not able to monitor the activities of fire volunteers; neither are the fire volunteers able to give feedback to the Service.

Changes in Fire Frequency and Losses

Tain II Forest Reserve is situated in the fire-zone subtype of the Dry Semi-deciduous forest type which has a long history of forest fires. The Fire Zone subtype accounts for 31% of fires in the forest zone (Orgle, 1994). Prior to the severe drought of 1983, this forest type was occasionally encroached upon by ground fires (Hall & Swaine, 1981), presumably in years of severe drought, but since 1983, fires have recurred in years of less severe drought. The incidence and effects of these fires have been quite dramatic, reducing forest productivity substantially (Amissah et al., 2011)

In comparing fire frequency before and after 1983, it came to light that wildfires continue to occur around Tain II Forest Reserve just as they do in most parts of Ghana. Wildfires have become an annual event in most parts of Ghana (Barnes, 2008; Barnes, 2004; Swaine et al., 1997). This trend was identified in the records (periods of 2000-2009) of the GNFS in Sunyani. It was also given as a reason by respondents who neither agreed nor disagreed that conventional fire pre-suppression and suppression have helped curb annual wildfires around Tain II Forest Reserve. A study by Amissah et al. (2011) conducted in the forest transitional zone of Ghana including the Tain II forest reserve showed that a major factor which has affected farming systems is the change in vegetation in the transition zone due to recurrent wildfires. The invasion of exotic weeds and savannah species in the area has resulted in increased labour inputs for clearing and weeding, changes in rainfall pattern, reduced soil fertility and depressed crop yields. Also comparing the changes in the vegetation on farm lands cleared by farmers during land preparation in the study settlements before and after 1983 (1983-2001), Amissah et al. (2011) discovered that there has been a shift from thick woody vegetation like primary and secondary forest to herbaceous dominated vegetation.

Fire records before 1983 were not readily available, but in the opinion of the respondents and key informants (elderly men and women) the occurrence of fires was rare. They attributed this to vegetation cover, as according to them, the area was densely covered with trees which did not allow easy spread of fires in and around the reserve. This point about vegetation cover also confirms why uncontrolled fires were relatively uncommon especially in the forest zone before 1983; invariably opposing the assertion by Nsiah-Gyabaah (1996) that Ghana experienced serious bushfires during the catastrophic Sahelian drought between 1973 and 1974. According to Amissah et al. (2011), farmers' perception that there has been a change in vegetation, which is one of the major forms of natural capital for farming, is in line with earlier observations that indicated both a 30% change in the structure and composition of semi-deciduous forest (Hawthorne, 1994) and a loss of 50% vegetation cover (Ampadu-Agyei, 1988) following the 1983 wildfires.

Also, it was established that whilst before 1983 it took between three and four weeks for the cleared slash to dry well enough for effective burning, it now requires just one or two weeks (Amissah et al., 2011). In separate discussions held with opinion leaders in the five communities, NADMO, GNFS and FSD, it was revealed that losses being incurred both at the individual and community

levels are greater than those which pertained before 1983. These losses are mainly incurred on their farms, but on a few occasions they spread into their villages. Also, the lack of suppression tools and equipment; weather patterns; infrequent monitoring by fire volunteer squads; and lack of early detection mechanisms were cited as contributing factors to the increase in losses.

Conclusion

Findings from the study have revealed the respondents' view that indigenous fire management helped to curb wildfires years before the 1983 El Nino that engulfed Ghana. It was gathered that indigenous fire management systems are similar to the conventional fire management system. Indigenous fire management worked efficiently and effectively through the use of traditional norms and taboos which were enforced by traditional leaders. The study therefore concludes that indigenous fire management can still play a major role in wildfire management if it is integrated into current wildfire management programmes. It is recommended that traditional authorities should be empowered to enforce laws on wildfires as they are the authorities on the ground. As the National Wildfire Police calls for empowering and supporting traditional authorities, district assemblies should take up the responsibility for coordinating wildfire issues (MLFM, 2006). Communities should also be given training in the management of communal property such as natural resources in order that they may see the need to control the annual fires. It is recommended that the wildfire management programme be based on a cordial relationship between community and resource managers. This can be created through a participatory approach.

Conventional fire management was identified to be an important management strategy in curbing wildfires. The findings however revealed that conventional fire management strategies are not effective around Tain II Forest Reserve due mainly to the failure of communities to report culprits because of family ties and interference from politicians and persons of high status in law enforcement. Again, fire volunteer squads are not well equipped, and where equipment is available, it is unevenly distributed. These inadequacies do not allow fire volunteers to give of their best in fighting wildfires. In the opinion of the communities, wildfire management carried out by various government agencies does not help the current situation of annual wildfires because it brings with it conflicting implementation strategies and programmes which particularly affect the planning, implementation and monitoring of wildfire management. It is recommended that wildfire management should be delegated to an independent institution solely responsible for the implementation and monitoring of fire management instead of the piece meal attitude currently being practised.

References

Abayie Boateng, A. (1998): 'Traditional conservation practices: Ghana's example'. Institute of African Studies Research Review, Vol. 14, No 1, 42-51. In Sarfo-Mensah P. and Oduro W. (2007). Traditional Natural Resources Management Practices and Biodiversity

The Forest Fire Problem of Degrading Tain II Forest Reserve in Ghana: Rethinking Community Participation in Fire Management and Sustainable Forestry

- Conservation in Ghana: A Review of local Concepts and Issues on Change and Sustainability. FondazioneEni Enrico Mattei Working Papers. FondazioneEni Enrico Mattei. Paper 149
- Adhikari R. J., (2001): Community Based Natural Resource Management in Nepal with reference to Community Forestry: A Gender Perspective. *A journal of the environment*, Vol. 6, No 7, pp. 9 – 22.
- Agubie Community (2004): The Agubie Experience on Traditional Bushfire Management. In: Millar D.; Apusigah A. A. and Berinyuu A. (eds.). *The Chief, The Forester and the Fireman: Proceedings of the Bushfire Workshop of February 2004*. (21 -25). Tamale, Ghana: UDS/Care International
- Akyea W. N., (1988): Bush Fires: Causes and Consequences. Report on Bush Fires in West Africa: The Human Factor. Pp. 24 – 32, UNESCO/Faculty of Social Sciences of the University of Cape Coast.
- Amanor, K. (2001) Discourse coalitions and the politics of fire in Ghana Paper presented at the workshop Changing perspectives on forests: ecology, people and science/policy processes in West Africa and the Caribbean 26–27 March 2001 Institute of Development Studies, University of Sussex
- Amissah L., (2008): Indigenous Fire Management Practices in Ghana. *Traditional Forest-Related Knowledge and Sustainable Forest Management in Africa*. IUFRO World Series Volume 23
- Amissah L., Kyereh B., and Agyeman V. K. (2011): Wildfires As Dominant Force Driving Farming Systems in the Forest Transitional Zone Of Ghana. *Ghana J. Forestry*, Vol. 27 (2), 2011, 52-65
- Ampadu-Agyei O., (1988): Bush Fire and Management Policies in Ghana. *The Environmentalist* Volume 8, No. 3, Pp. 221 – 228
- Andreae O.M., (1991): Biomass burning: Its history, use and distribution and its impact on environmental quality and global climate. Eds. Levine, J.S. *Global biomass burning, atmospheric, climatic and biospheric implications*. MIT Press,3-22.
- Appiah-Opoku, S. and Hyma, B. (1999): Indigenous institutions and resource management in Ghana. *Indigenous Knowledge and Development Monitor*, Vol. 7, Issue 3, 15-17.
- Apusigah A. A., (2005): Women in sustainable bushfire management promotion in Northern Ghana. In Millar D., Apusigah A. A. and Berinyuu A. (Eds.), *The harmattan series*. Occasional Paper 1 UDS-Ghana/DANIDA

- Apusigah A. A., (2007): Promoting Sustainable Wildfire Management in Northern Ghana: Learning from History. *European Journal of Social Sciences* – Vol 5, No 1, 2007, pp. 61 – 67
- Baker K.M., (2000): *Indigenous Land Management in West Africa. An Environmental Balancing Act.* Oxford University Press, Oxford, 157-158 and 167-170.
- Barnes V.R., (2008), Proposal for Community Fire Management in and around Tain II Forest Reserve in Sunyani Forest District. For Agro-forestry Practices to Enhance Resource – Poor Livelihood Project (APERL). Faculty of Renewable Natural Resources and Faculty of Forest Resources Technology, KNUST. Unpublished Document
- Barnes V.R., (2008), Proposal for Community Fire Management in and around Tain II Forest Reserve in Sunyani Forest District. For Agro-forestry Practices to Enhance Resource – Poor Livelihood Project (APERL). Faculty of Renewable Natural Resources and Faculty of Forest Resources Technology, KNUST. Unpublished Document
- Barnes V.R., Gaisie B.A. and Kuunuor J., (2004), Wildfire suppression training manual for community fire organizations. Forestry Commission and Ghana National Fire Service. University press, KNUST-Kumasi
- Barnes V.R., Orgle K. T., Obiaw E., Ninnoni K. R., Brown H. C., Boakye J., (2005). Guidelines for the Establishment of Green Fire Breaks in the High Forest Zone (HFZ) of Ghana. Agyemang A. O., and Owusu-Afriyie (Eds.). Resource Management Support Centre. Forestry Commission, Ghana.
- Behnke R.H., Scoones I. and Kerven C., (eds.) (1993): *Range ecology at disequilibrium: new models of natural variability and pastoral adaptation in African savanna.* ODI and IIED, London.
- Bowku Community (2004): *Bushfire Management in Bowku Community.* In: Millar, D.; Apusigah, A. A. and Berinyuu, A. (eds.): *The Chief, The Forester and the Fireman: Proceedings of the Bushfire Workshop of February 2004.* (14 - 20). Tamale, Ghana: UDS/Care International
- Brinkerhoff D., (1995): African state–society linkages in transition: the case of forestry policy in Mali *Canadian Journal of Development Studies* 16 201–28
- Castro P. A., and Ettenger K (1996): *Indigenous knowledge and conflict management: exploring local perspectives and mechanisms for dealing with community forestry disputes.* Paper Prepared for the United Nations Food and Agriculture Organization, Community Forestry Unit, for the Global Electronic Conference on "Addressing Natural Resource Conflicts Through Community Forestry," January-April 1996.

The Forest Fire Problem of Degrading Tain II Forest Reserve in Ghana: Rethinking Community Participation in Fire Management and Sustainable Forestry

- Communicating International Development Research (CIDR), (2007): Community- based natural resources management. Questioning the ‘success stories’. id21 natural resources highlight 4.
- Creswell W. J. (2003): *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*, Second Edition
- Dorm Adzorbu C., Ampadu-Agyei O., and Veit. P.G., (1991): *Religious Beliefs and Environmental Protection: The Malshegu sacred grove in Northern Ghana*. WRI Washington, DC, USA and Acts Press, Africa Centre for Technology Studies, Kenya. In Sarfo-Mensah P. and Oduro W. (2007). *Traditional Natural Resources Management Practices and Biodiversity Conservation in Ghana: A Review of local Concepts and Issues on Change and Sustainability*. FondazioneEni Enrico Mattei Working Papers. FondazioneEni Enrico Mattei. Paper 149
- Ejizu, E.I. (2000): *African Traditional Religions and the Promotion of Community-Living in Africa*, in Isizoh, C.D (ed.), *African Traditional Religion: Special Topical Issues*. Africa world
- Ellis J.E. and Swift D.M. (1988): *Stability of African pastoral ecosystems: alternative paradigms and implications for development*. *Journal of Range Management* 41: 450-459.
- Eva, H. and Lambin, E.F., (2000):. *Fires and land-cover change in the tropics: A remote-sensing analysis at the landscape scale*. *Journal of Biogeography* 27: 765-776.
- Everett Y., (2002): *Community Participation in Fire Management Planning: A case from California, USA*. In Moore P., Ganz D., Tan C. L., Enters T., and Durst B. P.,(Eds) (2002): *Communities in Flames: Proceedings of an International Conference on Community Involvement in Fire Management*. RAP Publication 2002/25. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, 2002
- Fairhead J. and Leach M., (1996): *Misreading the African Landscape: Society and Ecology in a Forest-Savanna Mosaic*. Cambridge University Press, Cambridge
- Falconer, J. (1992): ‘Non-timber Forest Products in Ghana’, Main Report, ODA. In Sarfo-Mensah P. and Oduro W. (2007). *Traditional Natural Resources Management Practices and Biodiversity Conservation in Ghana: A Review of local Concepts and Issues on Change and Sustainability*. FondazioneEni Enrico Mattei Working Papers. FondazioneEni Enrico Mattei. Paper 149
- FAO (1999): *Meeting on Public Policies Affecting Forest Fire*. FAO Forestry Paper 138. FAO Rome pp. 181 – 202

FAO (2001): State of the World's Forests. FAO, Rome

FAO (2003): Community-based fire management: case studies from China, the Gambia, Honduras, India, the Lao People's Democratic Republic and Turkey. RAP Publication 2003/08; Forest Resources Development Service Working Paper FFM/2. Bangkok, Thailand, FAO Regional Office for Asia and the Pacific.

FAO (2006): Fire Management: Review of International Cooperation. Fire Management Working Paper 18, Rome. www.fao.org/forestry/site/firemanagement/en. 2/08/09. 4:00pm

FAO (2006): Fire Management: Voluntary Guidelines, Principles and Strategic Actions. Fire Management Working Paper 17, Rome. www.fao.org/forestry/site/35853/en 2/08/09. 4:00pm

FAO (2007): Fire Management- Global Assessment 2006. A Thematic Study Prepared in the Framework of the Global Forest Resources Assessment 2005. FAO Forestry Paper 151. Rome

FAO (2009): Forest Fires and the Law: A Guide for National Drafters Based on the Fire Management Voluntary Guidelines. FAO Legislative Study 99. www.fao.org/docrep/011/i0488e/i0488e00.htm 10/03/10. 8:00am

Fargey, P.J. (1991): Assessment of the conservation status of the BuabengFiema Monkey Sanctuary, Report submitted to the Flora and Fuana Preservation Society.

Fire Fight West Africa (FFWA, 2003): Pre-project Workshop on Fire Fight, Kumasi, Ghana. Workshop Report 22 – 23 May, 2003. Sponsored by: International Tropical Timber (ITTO). Organised by: The World Conservation Union (IUCN).

Forest Fire Management in Ghana (FFMG) (1998): Project Document PD 32/98 Rev. 1 (F) ITTO, Yokohama pp. 4

Forest Management Unit 23 (FMU) (1993): Tain Tributaries Block II Forest Reserve Working Plan

Forestry Research Institute of Ghana (2003): Final Technical Report: Forest Fire Management in Ghana

Ganz D. and Moore P., (2002): Living with Fire: Summary of Communities in Flames International Conference. RAP Publication 2002/25. Pp. 1-9. Moore P., Ganz D., Tan C. L., Enters T., and Durst B. P., (Eds): Communities in Flames: Proceedings of an International Conference on Community Involvement in Fire Management. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, 2002

The Forest Fire Problem of Degrading Tain II Forest Reserve in Ghana: Rethinking Community Participation in Fire Management and Sustainable Forestry

- Ganz D., Moore P., and Reeb D., (2003): Prologue: Community-Based Fire Management Case Studies from China, the Gambia, Honduras, India, Lao People's Democratic Republic and Turkey. RAP Publication 2003/08. Forest Resources Development Service, Working Paper FFM/2. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, 2003
- Goldammer J. and de Ronde C., (eds.) (2004): Wildland fire management handbook for sub-Saharan Africa Oneworldbooks, Freiburg
- Government of Burkina Faso (1998): Décret no. 98-310/PRES/PM/MEE/ MATS portant utilisation des feux en milieu rural au Burkina Faso
- Government of Ghana (1983): Control of Bushfires Law. PNDCL 46
- Gregoire, J. M., (1993): Description quantitative des regimes de feu en zone soudanienne d'Afrique de l'Ouest. Sécheresse 4: 37-45.
- Grindle M.S., (1997): Divergent Cultures? When Public Organizations Perform Well in Developing Countries. World Development 25 (4): 481-495
- Gyasi, E.A. (1996): Gyamfiase, Ghana: A Study in Threat and Counteracting Threat to Indigenous Forest Groves and Sustainable Forest Management Systems'. Paper presented at Workshop on Contested Terrain: West African Forestry Relations, Landscapes and Processes. Centre of West African Studies, University of Birmingham, Egbaston, 12-13 April 1996. In Sarfo-Mensah P. and Oduro W. (2007). Traditional Natural Resources Management Practices and Biodiversity Conservation in Ghana: A Review of local Concepts and Issues on Change and Sustainability. FondazioneEni Enrico Mattei Working Papers. FondazioneEni Enrico Mattei. Paper 149
- Hall J. B., and Swaine M. D., (1981): Distribution and ecology of vascular plants in a tropical rain forest. Forest vegetation in Ghana. Geobotany 1, W. Junk Pub
- Haverkort B., K. van 't Hooft and W. Hiemstra. (eds.) (2002): Ancient Roots, New Shoots. Endogenous development in practice. London, Compass/Zed Books, London.
- Hawthorne W. D., (1994): Fire damage and forest regeneration in Ghana. Forestry inventory and management project of the Ghana Forestry Department. ODA Forestry Series No. 4 pp 1-18.
- Kalbeon Community (2004): Kalbeon Bushfire Management Experiences. In Millar, D.; Apusigah, A. A. and Berinyuu, A. (eds.). The Chief, The Forester and the Fireman: Proceedings of the Bushfire Workshop of February 2004. (26 - 32). Tamale, Ghana: UDS/Care International

- Kamnap P., (2003): The Impact of Local People's Participation on Forest Concession Management in Cambodia: A Case Study of The Colexim Forest Concession Company in Kampong Thom Province. Master Thesis Submitted to Asian Institute of Technology School of Environment, Resources and Development Thailand. web.idrc.ca/uploads/user-S/10936165071PhanKamnapThesis.doc
- Karki S., (2002): Community Involvement in and Management of forest fires in South East Asia. The World Conservation Union (IUCN) and The World Wide Fund for Nature funded by the European Union (WWF) Project FireFight South East Asia 2002
- Kirby J. P., (1988). Bush Fires and the Domestication of the Wild in Ghana. Report on Bush Fires in West Africa: The Human Factor. Pp. 34 – 64, UNESCO/Faculty of Social Sciences of the University of Cape Coast.
- Komare, E.V., (1971): Lightning and fire ecology in Africa. Proc. Tall Timbers Fire Ecology Conf. 11, 473-511.
- Korem, A. (1985): Bushfire and Agricultural Development in Ghana. Ghana Publishing Corporation.
- Langaa, S., (1995): Wildfires, satellites, the atmosphere and geography – an introductory essay. Night-time observations of West-African bushfire from space. Studies on methods and application of thermal NOAA-AVHRR satellite data from Senegal and the Gambia. ISBN 82-7648-006-3, Akademityck AB, Edsbruk 1995.
- Laris P. (2002): Burning the Seasonal Mosaic: Preventative Burning Strategies in the Wooded Savanna of Southern Mali. *Human Ecology*, Vol. 30, No. 2
- Laris P., (2004): Grounding environmental narratives: the impact of a century of fighting against fire in Mali in Moseley W and Logan B eds *African environment and development: rhetoric, programs, realities* Ashgate Publishing, London 63–85
- Laris P., and Wardell D. A., (2006): Good, bad or 'necessary evil'? Reinterpreting the colonial burning experiments in the savanna landscapes of West Africa. *The Geographical Journal*, Vol. 172, No. 4, December 2006, pp. 271–290
- Leach M. and Mearns R., (eds.) (1996): *The Lie of the Land: Challenging received wisdom on the African environment*. London: The International African Institute in association with James Currey and Heinemann
- Makarabhirom P., Ganz D., and Onprom S., (2002): Community involvement in fire management: cases and recommendations for community-based fire management in Thailand. In Moore P., Ganz D., Tan C. L., Enters T., and Durst B. P., (Eds.): *Communities in Flames:*

The Forest Fire Problem of Degrading Tain II Forest Reserve in Ghana: Rethinking Community Participation in Fire Management and Sustainable Forestry

- Proceedings of an International Conference on Community Involvement in Fire Management. RAP Publication 2002/25. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, 2002
- Malingreau, J. P., (1990): The Contribution of remote Sensing to the Global Monitoring of Fires in Tropical and Sunropical Ecosystems: 337-370. In: Goldammer, J.G. (ed.) Fire in the Tropical Biota. Ecosystem Processes and Global Challenges. Springer-Verlag, Berlin
- Millar D., (2004): Bush Fires Discourses in West Africa – The Role of Policy. In: Millar, D.; Apusigah, A. A. and Berinyuu, A. (eds.). The Chief, TheForestor and the Fireman: Proceedings of the Bushfire Workshop of February 2004. (7 - 13). Tamale, Ghana: UDS/Care International
- Millar D., (2005): Marginalisation and Stigmatisation of Settlers: A Bushfire Narrative. In Millar D., Apusigah A. A. and Berienyuu A. (Eds.), The harmattan series. Occasional Paper 1 UDS-Ghana/DANIDA
- Millar, D., Aniah R. and P. Atoyure (1999): Shrines and Groves. COMPAS Newsletter Number 2, October 1999, 34-36.
- Millar, D.; Apusigah, A. A. and Berinyuu, A. (Eds.) (2004): The Chief, TheForestor and the Fireman: Proceedings of the Bushfire Workshop of February 2004. (7 - 13). Tamale, Ghana: UDS/Care International
- Ministry of Land, Forestry and Mines (2006): National Wildfire Management Policy. Accra, Ghana: Government of Ghana
- Ministry of Lands, Forestry and Mines (2006): National Wildfire Management Policy. Accra, Ghana: Government of Ghana
- Moore F. P., (2003) Community Based Fire Management (CBFiM): International Wild land Fire Summit Paper No 5. Global Fire Summit, Sydney, Australia, 8 October 2003
- Morgera E., and Cirelli T. M., (2009): Forest Fires and the Law: A Guide for National Drafters Based on the Fire Management Voluntary Guidelines. FAO Legislative Study 99. www.fao.org/docrep/011/i0488e/i0488e00.htm 11/01/10. 12:45pm
- Nielsen, T.T., (2000): Satellite Remote Sensing of Fire Regimes in West Africa. unpub. PhD. Dissertation, Copenhagen, Institute of Geography, University of Copenhagen
- Ninnoni K. R., Wordell A. T., Orgle. K. T, Kyere B., Agyeman K.V., Amissah L., (2003): Manual of Procedures. Wildfire Management. Forest Resource Management Planning in the HFZ. Forestry Commission, Ghana. Pp 1-51

Nsiah-Gyabaah K., (1996) Bushfires in Ghana. IFFN No. 15 - September 1996, p. 24-29.

Ntiamoa-Baidu, Y. (1995): 'Indigenous vs. Introduced Biodiversity Conservation Strategies: The case of protected areas systems in Ghana'. African Biodiversity Series, Number I, May 1995, 1-11. Washington: The Biodiversity Support Program. In Sarfo-Mensah P. and Oduro W. (2007). Traditional Natural Resources Management Practices and Biodiversity Conservation in Ghana: A Review of local Concepts and Issues on Change and Sustainability. FondazioneEni Enrico Mattei Working Papers. FondazioneEni Enrico Mattei. Paper 149

Obiaw E., (2004): The National Bushfire Strategy and Wildfire In: Millar, D.; Apusigah, A. A. and Berinyuu, A. (Eds.). The Chief, The Forester and the Fireman: Proceedings of the Bushfire Workshop of February 2004. Tamale, Ghana: UDS/Care International

Obiri D. K. O. (1998). The Role of Ghana National Fire Service in Bush Fire Prevention, Control and Mitigation. Draft Proceedings of the National Workshop on Strategies for Bush Fire Intervention in Ghana. Remote Sensing Applications Laboratory of the Department of Geography and Resource Development – University of Ghana

Orgle T.K. (1994): Ecology of Burnt Forest in Ghana PhD Thesis. University of Aberden pp. 14 – 39

Pyne S. J., Goldammer J. G., de Ronde C., Geldenhuys C. J., Bond W. J. and Trollope W. S.W., (2004): Introduction. In Goldammer J. and de Ronde C., (eds.) (2004): Wildland fire management handbook for sub-Sahara Africa Oneworldbooks, Freiburg

Republic du Mali Undated Projet de loi (undated) /AN-RM. Portant Code des Feux de Brousse President de la Republique, Republique de Mali, Bamako

Ribot J., (2002): Democratic decentralisation of natural resources: institutionalizing popular participation World Resources Institute, Washington

Richards P., (1985): Indigenous Agricultural Revolution. Ecology and Food Production in West Africa. Westview, Boulder

Robin L., (1997) Ecology: a science of empire? in Griffiths T and Robin L eds 1997 Ecology and empire environmental history of settler societies Keele University Press/University of Natal Press, Pietermaritzburg 63–75

Rowell A. and Moore F. P., (2000): Global Review of Forest Fires. The World Conservation Union (IUCN). data.iucn.org/dbtw-wpd/edocs/2000-047.pdf

The Forest Fire Problem of Degrading Tain II Forest Reserve in Ghana: Rethinking Community Participation in Fire Management and Sustainable Forestry

- Sarfo-Mensah P. and Oduro W. (2007): Traditional Natural Resources Management Practices and Biodiversity Conservation in Ghana: A Review of local Concepts and Issues on Change and Sustainability. FondazioneEni Enrico Mattei Working Papers. FondazioneEni Enrico Mattei. Paper 149
- Sarfo-Mensah P. and Oduro W. (2010): Changes in Beliefs and Perceptions about the Natural Environment in the Forest-Savanna Transitional Zone of Ghana: The influence of Region. Fondazione Eni Enrico Mattei Working Papers. Paper 398
- Schweithelm, J. (1999): The fire this time: An overview of Indonesian Forest Fires 1997/98. WWF Indonesia.
- Shields J. B., Smith W. R., and Ganz D., (2006): Fire Management Working paper: Global Forest Resources Assessment 2005. Report on fire in the South East Asian (ASEAN) region. Fire Management Working Paper FFM/10
- Sprugel D.G., (1991): Disturbance, equilibrium and environmental variability: What is 'natural' in a changing environment? *Biological Conservation* 58, 1-18.
- Steiner A. and Oviedo G. (2004): Indigenous Knowledge and Natural Resource Management. Indigenous Knowledge Local Pathways to Global Development (2004). Publisher: World Bank, Pages: 30-33.
- Sullivan S., (1996): Towards a non-equilibrium ecology: perspectives from an arid land. *Journal of Biogeography* 23: 1-5.
- Swaine M. D., Hawthorne W. D., and Orgle K., (1992): The influence of Fire on Savanna Vegetation at Kpong, Ghana. *Biotropica*, 24: 166-172
- Tater, R. (2004). Critique of Bushfire Laws in Ghana. In Millar, D.; Apusigah, A. A. and Berinyuu, A. (eds.). *The Chief, The Forester and the Fireman: Proceedings of the Bushfire Workshop of February 2004.* (90-99). Tamale, Ghana: UDS/Care International
- The World Conservation Union (IUCN, 2002): *Arborvtae: Future Fire - Perpetuating Problems of the Past.*
- Wardell A. D. (2004). Historical Review of the Development of Forest Policy in the Northern Territories of the Gold Coast Colony 1901 – 1957. In: Millar, D.; Apusigah, A. A. and Berinyuu, A. (eds.). *The Chief, The Forester and the Fireman: Proceedings of the Bushfire Workshop of February 2004.* (7 - 13). Tamale, Ghana: UDS/Care International

Wardell D. A, Nielsen T, Rasmussen K and Mbow C., (2004): Fire history, fire regimes and fire management in West Africa: an overview in Goldammer J and de Ronde C eds Wildland fire management handbook for sub-Sahara Africa Oneworldbooks, Freiburg 350–81

Wasai, Z. (2004). Development of a National Action Programme to Combat Dissertification. In Millar, D.; Apusigah, A. A. and Berinyuu, A. (eds.). *The Chief, The Forestor and the Fireman: Proceedings of the Bushfire Workshop of February 2004.* (46-50). Tamale, Ghana: UDS/Care International

Wulugu Community (2004): Traditional Bushfire Management Practices in Wulugu. In: Millar, D.; Apusigah, A. A. and Berinyuu, A. (eds.). *The Chief, The Forestor and the Fireman: Proceedings of the Bushfire Workshop of February 2004.* (7 - 13). Tamale, Ghana: UDS/Care International