



FORESTRY DEPARTMENT



Technical Report

Fire Management Assessment of Eastern Province, Zambia



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Cover Photo: Recently burned indigenous forest near Msipazi in Chipata District, Eastern Province. Photo by D. Johnson

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The assessment team is grateful to all individuals that took time to meet with us. This enabled the team to collect information with respect to the current status of fire use and management in Eastern Province of Zambia.

Executive Summary

The mission that produced this assessment was prompted by requests from Forestry Department personnel in Zambia to the United States Agency for International Development (USAID) for formal fire management training. USAID contacted the United States Forest Service's (USFS) International Programs (IP) with the training request. Together, USFS, USAID, and Zambian partners determined that this mission should contribute to understanding how, when, where, and why fire is used in Eastern Province of Zambia. The team would conduct an assessment and then produce this report, which describes the current status of fire management and fire use in Eastern Province, documents the role of fire in dominant vegetation types based on personal observations and available literature, and provides recommendations for formal fire management training and equipment needs.

Two individuals on the assessment team work for the U.S. Forest Service; Darren Johnson is seated with the Zambia Environmental Management Agency (ZEMA) in Lusaka as a Climate Change Advisor, and LaWen Hollingsworth works for the Rocky Mountain Research Station in Missoula, Montana as a Fire Behavior Specialist. The third team member, Sylvester Siame, works as the acting Principal Extension Officer for the Zambia Forestry Department in Eastern Province, and joined the team to share his vast knowledge of vegetation and personal contacts within the province. The final team member was Gift Sikaundi who works for ZEMA and manages the spatial fire detection data for Zambia.

The travel itinerary for Eastern Province developed based on the need to consult with as many community leaders and members within Eastern Province as possible, as well as personnel from the Zambia Forestry Department (FD), Zambia Wildlife Authority (ZAWA), and other critical agencies active in Eastern Province, such as Community Markets for Conservation (COMACO) and the Center for International Forestry Research (CIFOR). The team travelled 2,500 km from Lusaka, through Eastern Province, and then returned to Lusaka. In Lusaka, the team met with officials from pertinent ministries as well as additional stakeholders to understand the nature of fire management from the governmental and political perspective, and to learn about relevant fire management policies and projects in other provinces within Zambia.

Eight recommendations have been identified as a result of this assessment. We have not proposed that fire be excluded from Eastern Province. Rather, recommendations focus on potential changes or reviews within all levels of government, as well as essential formal training for personnel working in agencies that have been legislatively assigned fire management duties. In addition, we recommend enhanced sensitization within communities to decrease potential negative effects of fire to communities, wildlife, soils, and air quality while allowing for fire to be used in a sensible and judicious manner.

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Introduction

A team of four natural resource management experts convened in October, 2014 to conduct a fire regime assessment in Eastern Province of Zambia (Figure 1). The team included a multinational assemblage from the United States and Zambia tasked with the following objectives: 1) gain preliminary insights into the current status of fire management and fire use in Eastern Province, Zambia, 2) assess the role of fire in the regeneration and maintenance of the dominant vegetation present in the terrestrial ecosystems of Eastern Province, and 3) provide recommendations for fire management training and equipment needs for Zambia Forestry Department and partner agencies in Eastern Province.

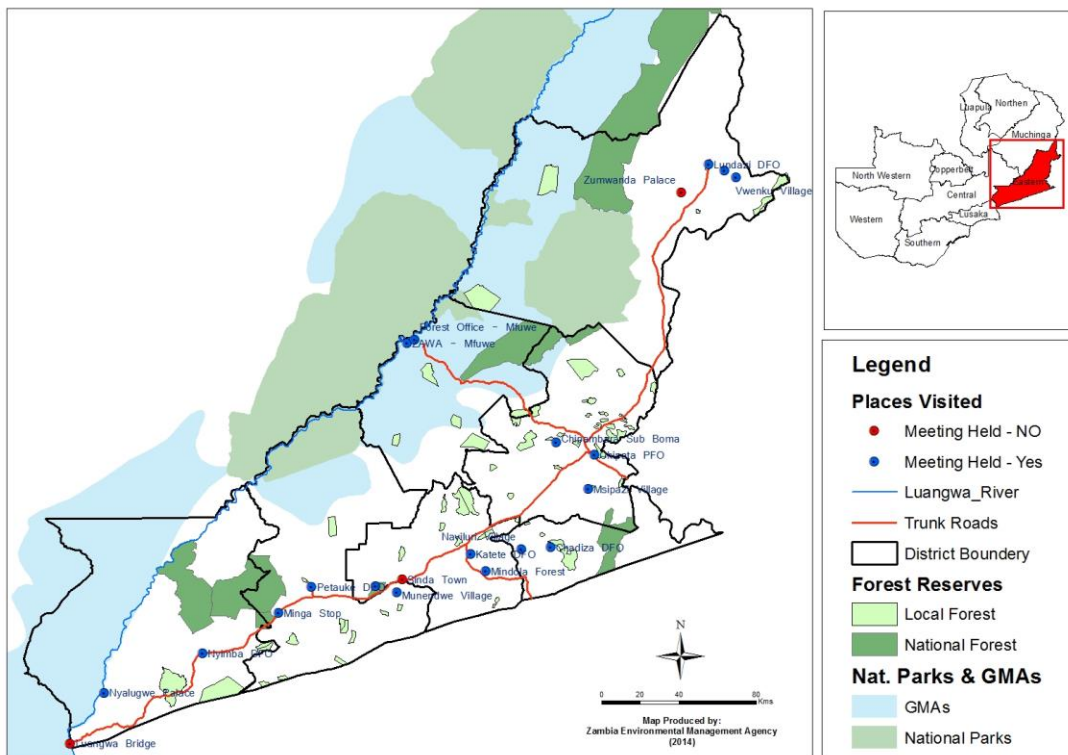


Figure 1. Eastern Province fire regime assessment meeting locations.

Team Members

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Background

Zambia is a landlocked country in southern Africa consisting primarily of high plateaus, hills, and mountains that are dissected by river valleys. With a total area of 752,614 km² (75.3 million ha), Zambia is ranked as the 39th-largest country in the world. Zambia's climate is best described as a tropical savanna with three distinct seasons: 1) a hot dry season from mid-August through October, 2) a hot wet season from November through March, and 3) a warm dry season from April through early August. Mean maximum temperatures range between 18°C and 27°C and mean minimum temperatures between 9°C and 15°C. The country is divided into ten provinces (Western, Northwestern, Southern, Central, Copperbelt, Lusaka, Eastern, Muchinga, Luapula, and Northern), which are further subdivided into 89 districts.

The combination of extensive burning late in the dry season, continued population growth, wood extraction, and agricultural expansion have resulted in a significant increase in the rate of deforestation and environmental degradation occurring in Zambia (Lawton 1982, Chidumayo 1988, Vinya et al. 2011). Eastern Province, and Zambia by extension, is dominated by vast tracks of fire-prone vegetation including woodland savannas and grasslands. Bush fire is a frequent process on the landscape, estimated to annually burn approximately 25% of Zambia's land area based on data from 2007 to 2012 (Sikaundi 2013). That estimate equates to an average of just over 18.8 million ha burned each year. Despite the magnitude of this annual disturbance, fire does not seem to be adequately recognized as a significant threat to Zambia's forestry sector and the environment. The sheer extent of fire occurrence in a geography that covers approximately 75.3 million ha makes it particularly difficult, if not impossible, for a centralized approach to fire management by the Zambian government. This is exacerbated by the fact that the majority of land ownership or tenure in Zambia can be categorized as either communal or traditional.

Fire is a readily available and inexpensive tool that impoverished rural populations in Zambia can utilize to participate in a multitude of traditional activities such as clearing vegetation for agriculture, improving pastures for grazing, hunting, and stimulating the growth of non-timber forest products (NTFPs). Indeed, the presence of fire-adapted plants and paleoecological studies indicate that fire has been used by humans in this landscape for millennia and as such is culturally ingrained and has helped to shape much of the existing Zambian landscape (Clark and van Zinderen Bakker 1964, Chidumayo 1997, Eriksen 2007). People, the ecosystems they inhabit, and fire are inextricably linked: there has always been fire and as a natural disturbance event there will always be fire. Fire can be an effective management tool when applied judiciously and therefore should not be excluded as a tool from those communities that have traditionally used it to hunt, cultivate crops and NTFPs, and to manage forests.

It is essential that contemporary fire management strategies, if they are to be effective, consider not only the technical aspects of fire management, but also the communities and the environment in which they live.

Ecological Descriptions

The geographic focus of this assessment is Eastern Province of Zambia, which covers approximately 5.12 million ha and is divided into 9 districts (Nyimba, Sinda, Petauke, Katete, Chadiza, Vubwi, Chipata, Mambwe, and Lundazi). The dominant biome found in Eastern Province has been classified by the World Wildlife Fund (WWF) as tropical and subtropical grasslands, savannas, and shrublands. This biome is characterized by rainfall levels from 90 to 150 centimeters per year and can be further sub classified into a number of ecoregions (WWF 2014). The three indigenous ecoregions associated with Eastern Province of Zambia are the Zambezan and Mopane Woodlands, the Southern Miombo Woodlands, and the Central Zambezan Miombo Woodlands (Campbell 1996; Figure 2). In addition, there are nurseries and plantations cultivated throughout Eastern Province.

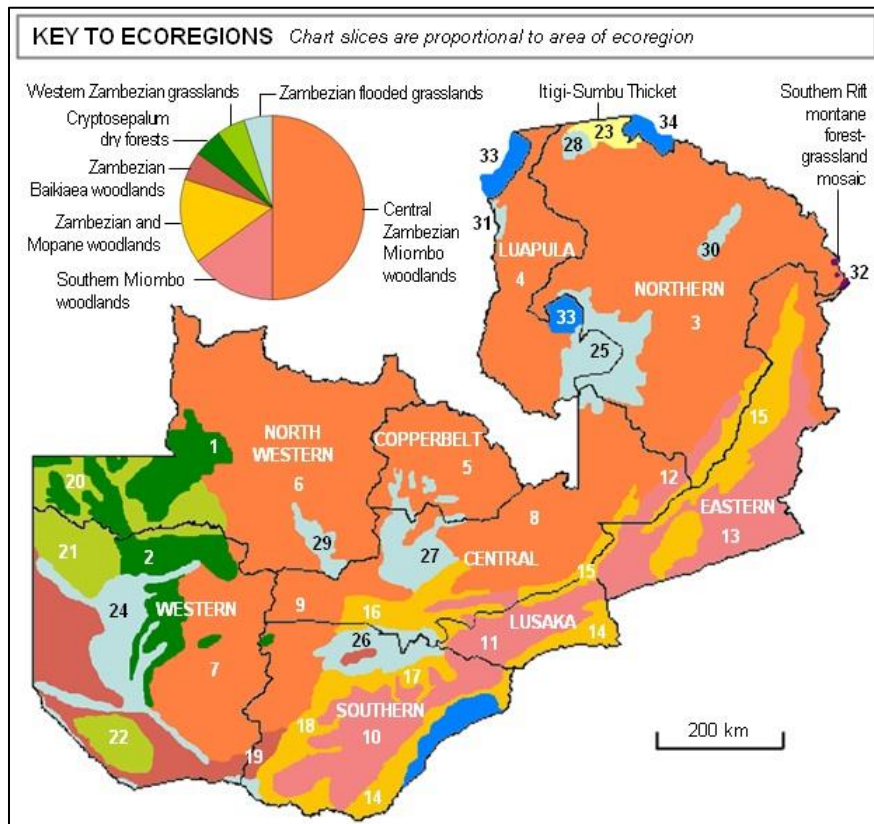


Figure 2. Map of ecoregions within Zambia (Wikipedia 2014).

Miombo Woodlands

Miombo woodlands are a biologically diverse ecoregion with approximately 4,590 plant species, 35 endemic mammals, 51 endemic birds, 52 endemic reptiles, 25 endemic amphibians, and an unknown number of endemic invertebrates (Bond et al. 2010). Miombo woodland typically occurs on well-drained soils that are both nutrient poor and acidic with low organic content (Cole 1986, Frost 1996).

In Zambia, miombo woodland covers approximately 398,885 km² (39.9 million ha) or about 53% of the country's total land area and is economically important for the supply of timber, poles, firewood, and charcoal (Fanshawe 1971, Chidumayo 1997). It is an ecosystem that has been shaped by humans through a long history of cultivation, harvesting, and frequent burning over the last 55,000 years (Lawton 1978). The trees that dominate this ecosystem include *Brachystegia* spp., *Julbernardia* spp., and *Isoberlinia* spp., which all belong to the sub-family Caesalpinioideae. *Brachystegia* is a genus of tree that is native to tropical Africa and tends to dominate miombo plant communities. Trees of this genus are commonly known as miombo, which is a Bantu word for the oak-like trees that characteristically shed their leaves for a short period in the dry season to reduce water loss, and produce a flush of new leaves just before the onset of the rainy season. *Julbernardia*, a genus of legume, are medium-sized trees in the Fabaceae family. *Isoberlinia* spp. is from the legume family Fabaceae and is closely related to the genera *Brachystegia* and *Julbernardia*. Miombo woodland mixes with mopane and smaller wetlands provide habitat for many species such as the African elephant (*Loxodonta africana*), African wild dog (*Lycaon pictus*), sable antelope (*Hippotragus niger*), black rhino (*Diceros bicornis*), and Lichtenstein's hartebeest (*Sigmoceros lichtensteinii*; Campbell 1996, WWF 2014).

Major threats to the woodland ecosystem in Zambia include expanding cultivation, fuel wood collection, overgrazing, rapid population growth, poaching, and frequent fires. Although tree cutting and fire directly contribute to the degradation of miombo woodland, cutting does not generally result in tree mortality but rather an increase in stem density due to a propensity to coppice from residual stumps and rootstocks (Chidumayo 2002). The ability to readily coppice may be an adaptation by tree species within this woodland as they typically produce short-lived seeds with limited capacity for dispersal.

Southern Miombo Woodlands

The southern miombo woodland ecoregion is distributed across the Central African Plateau. It covers central Zimbabwe and extends into Mozambique, southern Zambia, and Malawi. This ecoregion is part of a larger complex of Caesalpinoid woodland ecoregions that support wet and dry miombo, mopane, thickets, dry forests, *Baikiaea* woodland, and flooded grassland habitats (WWF 2014). Southern miombo woodland plant communities are dominated by *Brachystegia spiciformis* and *Julbernardia globiflora* belonging to the family Caesalpinaceae. Other common tree species found in the southern miombo woodland ecoregion include *Uapaca kirkiana*, *B. boehmii*, *Monotes glaber*, *Faurea saligna*, *F. speciosa*, *Combretum molle*, *Albizia antunesiana*, *Strychnos spinosa*, *Strychnos cocculoides*, *Flacourtia indica*, and *Vangueria infausta* (WWF 2014). Grass cover is usually sparse in the understory of mature woodlands due to the closed canopy; however, where drainage is poor, acacia savannas or grassland may become locally dominant (Werger 1978, Figure 3). Other associated vegetation includes dry deciduous forest and thickets, as well as deciduous riparian vegetation (White 1983). A large proportion of this woodland ecoregion has been completely transformed in Eastern Province, which is where the majority of this ecoregion occurs within Zambia. This deforestation and degradation are the results of a combination of factors including expanding cultivation, commercial logging, overgrazing, rapid population growth, and frequent fires (Chenje and Johnson 1994).



Figure 3. Mature Southern Miombo Woodland characterized by *Brachystegia spiciformis* and *Julbernardia globiflora*. Grass cover is usually sparse in the understory of mature woodlands due to the closed canopy. Chadiza District, Eastern Province, Zambia. Photo by D. Johnson

Protected areas in Zambia that overlap with this ecoregion include South and North Luangwa National Parks, Lukusuzi National Park, and Lower Zambezi National Park. The South and North Luangwa National Parks are bounded by the Muchinga Escarpment in the west and the Luangwa River in the east. Lukusuzi National Park, which is found in the eastern watershed area of the Luangwa River in Eastern Province, consists of a plateau where miombo is dominant, although areas of grassland can also be found on the plateau and along rivers. The expansive Lower Zambezi National Park lies on the northern bank of the Zambezi River where miombo vegetation covers the slopes of the escarpment, while mopane and acacia dominate in the valley closer to the river. A wide variety of game occurs in the area, although in recent years poaching has drastically reduced black rhino and elephant populations (Stuart and Stuart 1992).

Central Zambezan Miombo Woodlands

The Central Zambezan Miombo Woodlands ecoregion is situated in the Central African Plateau, a geography that is characterized by flat or rolling hills with local areas of higher relief and poor soils. The ecoregion covers a large area stretching northeast from Angola including the southeast section of the Democratic Republic of the Congo, the northern half of Zambia, a large section of western Tanzania, southern Burundi, and northern and western Malawi. The structure of these woodlands is one of high trees with a shrub and grassland understory. Central Zambezan Miombo Woodlands are typically interspersed with more evergreen trees than in most other miombo woodlands ecosystems. The tree canopy is dominated by *Brachystegia* spp., *Julbernardia* spp., *Isoberlinia* spp., and to a lesser extent *Uapaca* spp. and *Monotes* spp. The understory consists of herbaceous species including plants such as *Hyparrhenia* spp., *Themeda triandra*, and *Diheteropogon amplexans* (Cole 1986, Figure 4).

This woodland ecoregion is interspersed with riverside dambos, which may constitute up to thirty percent of the region (WWF 2014). Dambos are a class of complex seasonally waterlogged shallow valley depressions or wetlands in central, southern and eastern Africa, particularly in Zambia and Zimbabwe. They are generally found in higher rainfall flat plateau areas, and have river-like branching forms. Dambos are characterized by grasses, rushes, and sedges with few trees. They retain wet lines of drainage through the dry season and are waterlogged in the wet season but not generally above the height of the vegetation.



Figure 4. Central Zambezan Miombo Woodlands in the Copperbelt province of Zambia. The tree canopy is dominated by *Brachystegia* spp., *Julbernardia* spp., *Isoberlinia* spp., and to a lesser extent *Uapaca* spp. and *Monotes* spp. The understory consists of herbaceous species including plants such as *Hyparrhenia* spp., *Themeda triandra* and *Diheteropogon amplexans*. Photo by D. Johnson

Zambezan and Mopane Woodlands

The Zambezan and Mopane woodlands are an arid-eutrophic savanna dispersed throughout southeastern Africa. The ecoregion is considered to be one of the most important areas for mammal biodiversity in southern Africa (Turpie and Crowe 1994). These woodlands are usually found within the miombo region in the large valleys of the Zambezi and Luangwa Rivers and extend across portions of Botswana, Malawi, Mozambique, Namibia, South Africa, and Swaziland (Campbell 1996). The ecoregion is characterized by the dominance of the tree *Colophospermum mopane* (Caesalpiniaceae), which is the sole canopy species throughout much of this vegetation type (Wild and Fernandes 1967, White 1983). Mopane woodlands exhibit variable heights and densities, with trees growing to heights of more than 25 meters (80 feet) in fertile soil, but stunted and shrubby in appearance in poorly drained soils or clay (White 1983, Smith 1998). Although mopane often forms pure stands to the exclusion of other species, it can at times be associated with several other prominent trees and shrubs, such as *Kirkia acuminata*, *Dalbergia melanoxylon*, *Adansonia digitata*,

Combretum apiculatum, *Combretum imberbe*, *Acacia nigrescens*, *Cissus cornifolia*, and *Commiphora* spp. (Wild and Fernandes 1967, Farrell 1968, White 1983, Low and Rebelo 1996, Smith 1998). Grasses that make up the understory vegetation include *Aristida* spp., *Eragrotis* spp., *Digitaria eriantha*, *Brachiaria deflexa*, *Echinochloa colona*, *Cenchrus ciliaris*, *Enneapogon cenchroides*, *Pogonarthria squarrosa*, *Schmidtia pappophoroides*, *Stipagrostis uniplumis*, and *Urochloa* spp. (Wild and Fernandes 1967, Low and Rebelo 1996, Smith 1998; Figure 5).



Figure 5. Mopane woodlands, Zambia. Photo by J. Coyle

Mopane woodlands are generally located at lower elevations, and receive less rainfall, than the neighboring Central Zambeian Miombo Woodlands, Eastern Miombo Woodlands, and Southern Miombo Woodlands, which occupy the higher plateaus and escarpments (Burgess et al. 2004). Elevation and rainfall are the major biophysical factors distinguishing Zambeian and mopane woodlands from adjacent mopane woodland ecoregions. All three miombo ecoregions occur on the escarpments and uplands of the Central African Plateau in areas of higher rainfall (White 1983). In Zambia, isolated areas of mopane woodlands are located in Eastern, Lusaka, Southern, and Central Provinces.

The major threats to this ecoregion in Zambia in terms of deforestation and environmental degradation include unauthorized settlement in protected areas, livestock grazing, and uncontrolled bush fires (IUCN 1992). Elephant browsing activity and fire are the two major natural factors shaping the vegetation (White 1983, Trollope et al. 1998). Elephants crop the larger trees in savannas and woodlands, creating openings exploited by grasses, thus increasing fire frequency and intensity (White 1983, Smith 1998, Trollope et al. 1998). This interplay between fire and

elephants normally results in an open, two-tiered savanna, consisting of large trees interspersed with shrubs at various stages of growth (Smith 1998, Trollope et al. 1998).

Plantations and Nurseries

National Tree Planting Programme (NTPP)

The National Tree Planting Programme is financed by the government of Zambia as an initiative to expand the number of forest plantations. The principal objective of the program is to plant more than 10,000 ha of plantations at the provincial, community, and institution levels annually. The program is currently cultivating approximately 25 million tree seedlings in nurseries established around the country (Figures 6 and 7). The program was established to ensure sustainable wood supplies and offset the high rate of deforestation and forest degradation currently taking place in Zambia. Seedlings from these nurseries are used in the establishment of many of the plantations found on the national forests in Zambia.



Figure 6. A National Tree Planting Programme (NTPP) nursery located at the Forestry Department's Sinda National Forest headquarters. Seedlings being grown at this nursery include non-native species such as *Pinus kesiya* and *Eucalyptus grandis* in addition to a variety of indigenous tree species. Photo by D. Johnson



Figure 7. A recently established nursery in Chijemu Village, Lundazi District. Photo by L. Hollingsworth

Plantations

The Zambia Forestry Department (FD) has established and manages tree plantations primarily for commercial timber production in many of its national forests throughout the country. The two favored species that are cultivated in Eastern Province are *Eucalyptus grandis* and *Pinus kesiya*. The assessment team visited two plantations in Eastern Province at Sinda National Forest and Katete National Forest.



Figure 8. *Pinus kesiya* plantation on the Sinda National Forest. The plantation is buffered by *Gmelina aborea*. A firebreak can be seen in the foreground of the picture. Photo by D. Johnson

The pine plantations in the Sinda National Forest are protected from fire using a buffer of *Gmelina aborea*, a non-native hardwood species with minimal litter or understory (Figure 8). Firebreaks are also used in a limited fashion to protect the eucalyptus plantations within the national forest. Firebreaks are maintained manually, known as scuffing, by local community members using hand tools such as hoes. Firebreaks are limited to the plantations

due to a lack of funding. The remaining indigenous forest within the Sinda National Forest boundary is protected from fire using blacklining, or the process of burning fuels within a swath to reduce future fire intensity for a fire spreading onto the national forest, as it is a cheaper alternative to installing firebreaks.

Forestry staff in the 567 ha Katete National Forest have constructed and maintain approximately 14.2 km of firebreaks between and surrounding each of its plantation compartments (Figure 9).

The Katete National Forest currently has 84.2 ha of plantations. In addition to protecting the plantations from unwanted fire, the firebreaks also act as a road network allowing FD personnel to patrol the national forest. The primary form of transportation is bicycle; as such, the internal portions of the forest that have no roads or firebreaks are not accessible to FD staff. Annual maintenance of the firebreaks is usually completed by April using local community members. In return for their labor, the Forestry Department allows them to collect fuel wood from the plantations.



Figure 9. Firebreak between eucalyptus plantation and indigenous forest, Katete National Forest, Katete District. Photo by L. Hollingsworth

This fuelwood is competing vegetation, including shrubs and various understory species that have been slashed to reduce competition with the timber crop and reduce future fire intensity by reducing the amount of surface fuels (Figure 10). In addition to maintaining firebreaks, this arrangement reduces the amount of fuel wood collected by locals on the indigenous portion of the national forest. Locals provide their own tools (hoes) when maintaining the firebreaks.

While firebreaks can serve as an effective method to remove combustible vegetation, the annual maintenance can be overwhelming if funds are not available or there are too many kilometers of fireline to maintain. If new firebreaks are installed, they may provide ingress for local people to areas that were previously inaccessible. It is important to note that the same effect can often be achieved by blacklining along roads or trails early in the dry season while interior herbaceous fuels still have considerable moisture.



Figure 10. Surface fuels that have been slashed within a eucalyptus plantation to limit competition and reduce potential fire intensity, Katete National Forest, Katete District. Photo by L. Hollingsworth

Pinus kesiya

Pinus kesiya (sometimes known as *P. khasya* or khasi pine), a native of Asia, is a moderate sized tree with a straight, cylindrical trunk and a rounded crown that reaches heights of 30 to 35 m. The bark is thick and dark brown, with deep longitudinal fissures. Khasi pine usually grows in pure stands or mixed with broadleaved trees, but does not form open pine forests (Luu 2004). It is intensively used for timber. They grow, for instance, scattered in fire-prone grassland and woodland. They are shade intolerant and habitually grow in pure stands (Orwa et al. 2009).

Eucalyptus grandis

Eucalyptus grandis, commonly known as the flooded gum or rose gum, is a tall tree with smooth bark that appears rough and fibrous or flaky at the base, generally grey to grey-brown in color. At maturity, it reaches 50 meters (160 feet) tall, though the largest specimens can exceed 80 meters (250 feet). Flooded gum is an attractive straight-trunked tree much in demand outside its native Australia for timber and pulp, and extensive plantations exist in South Africa and Brazil (Wrigley et al. 2010).

Fire Ecology

It is estimated that approximately 25% or an average of 188,000 km² (18.8 million ha) of Zambia's total land base burned annually between 2007 and 2012 (Sikaundi 2013). The vast majority of fires occurs in miombo woodlands and is anthropogenic in nature resulting from activities such as

hunting, cultivating land, improving grazing by stimulating herbaceous growth, and collecting a variety of NTFPs such as honey. The use of fire by humans in Zambia has most likely been carried out in miombo woodland ecosystems for millennia, ultimately shaping these systems in terms of species composition and geographic extent (Clark and van Zinderen Bakker 1964, Chidumayo 1997, Eriksen 2007). Fires occur throughout the dry season from May to November; however, the majority of these fires occur during the hot dry post-harvest season between late August and October (Chidumayo 1995). The primary fuels available to burn are made up of an herbaceous (grassy) understory. As a result, fire intensity and fire frequency are thought to be directly correlated to rainfall, grazing intensity that removes herbaceous fuels thus reducing fire spread, and canopy closure (Chidumayo 1995).

In the 14 year period from 2000 to 2013, fires burned a total of 14 million hectares in Eastern Province (Figure 11). This number equates to an average of about 1 million hectares or 20% of the province being burned annually.

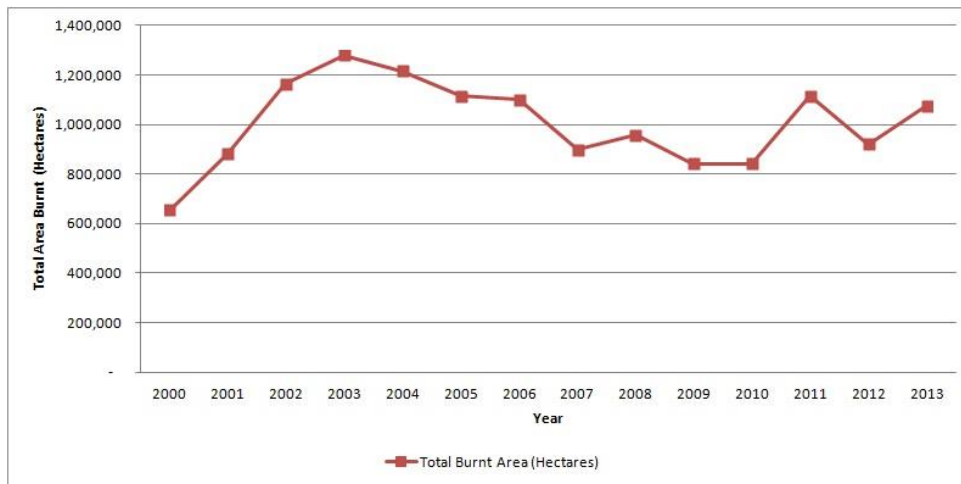


Figure 11. Total area burned per year from 2000 to 2013 in Eastern Province based on MODIS satellite data.

Mid-season fires from July through August burn the greatest average annual area, followed by late-season fires (September through November), and early-season fires (April thru June) that burn 507,502 ha, 354,290 ha, and 143,632 ha, respectively (Figures 12 and 13). According to Trapnell (1959), early season burning when woody plants are dormant will not critically damage the trees and may promote regeneration. Late season burning after new leaf flush results in new coppice growth and may damage the crowns of canopy trees. Frequent late season fire may eventually destroy the canopy and reduce the woodland to coppice.

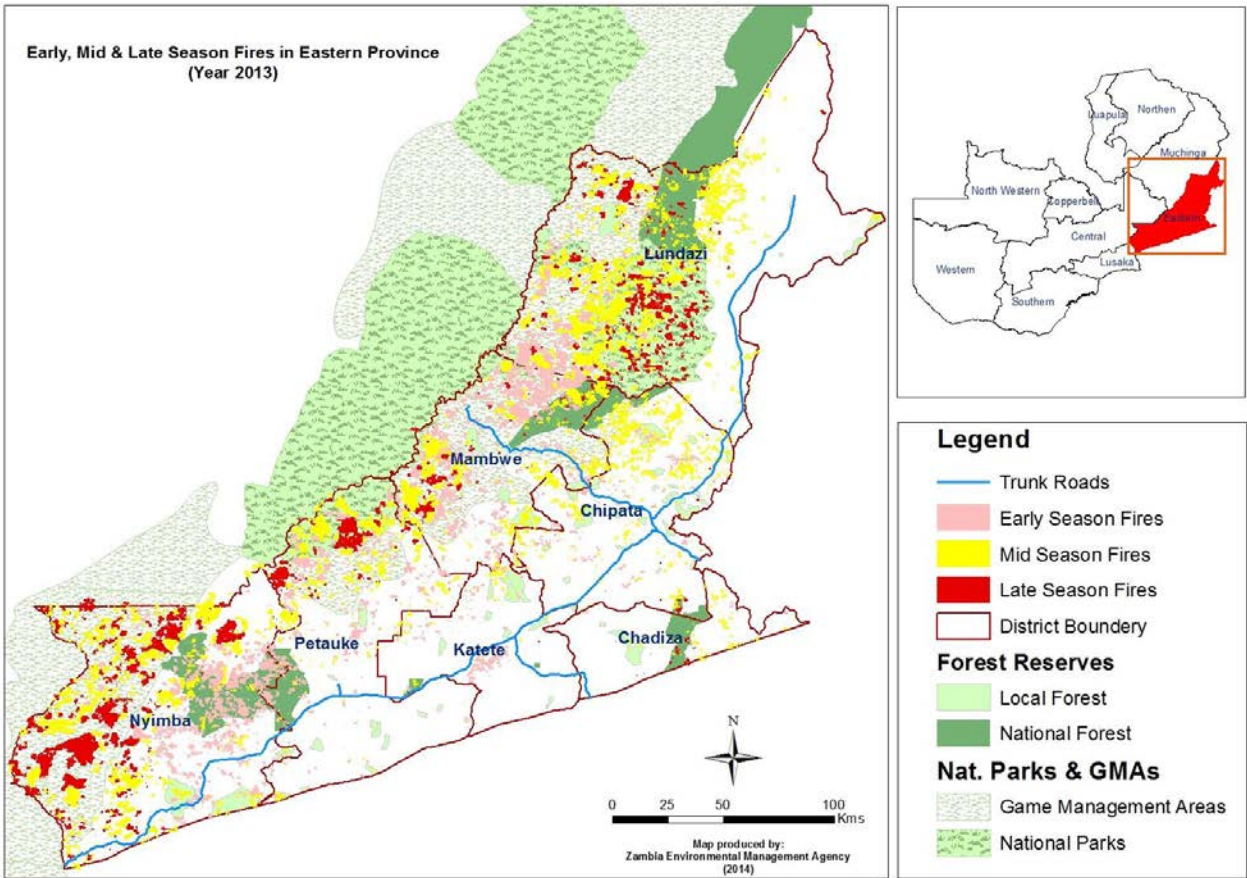


Figure 12. Fire occurrence in Eastern Province illustrating early (March – June), mid (July – August), and late (September – December) season fires in 2013 based on MODIS data.

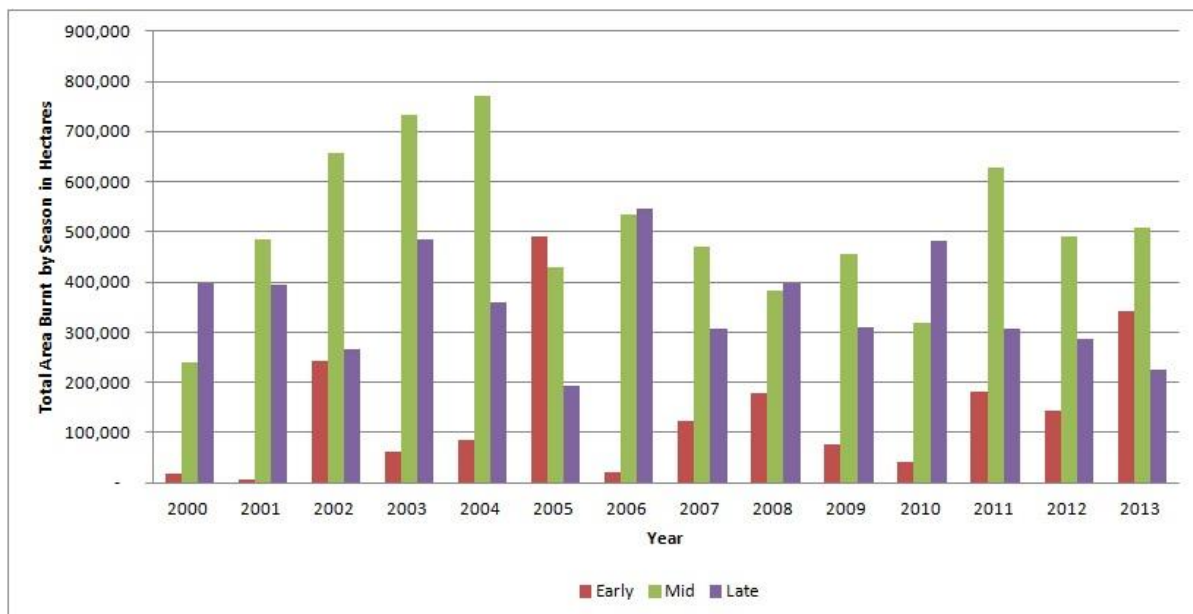


Figure 13. Total land area burnt during early (March – June), mid (July – August), and late (September – December) season fires from 2000 to 2013 in Eastern Province based on MODIS satellite data.

General observations made by the assessment team in Eastern Province indicate that late dry season fires in miombo woodland are more intense and destructive than fires burning in the early dry season when much of the vegetation is still partially green and moist. Research conducted in miombo woodland by Chidumayo (1989) support these observations. Chidumayo (1989) concludes that stem mortality measured over a two-year period was less than 10% when burned in mid-June (early dry season), but ranged from 18% to about 55% when burned in mid-October (late dry season). According to Scholes et al. (1996), Barbosa et al. (1999), and Mouillot et al. (2005), the miombo region exhibits a mean fire return interval of 2 to 4 years in contrast with the shorter mean fire return interval of 1.6 years cited by Chidumayo (1995).

Anecdotal evidence gathered during interviews with rural community members in Zambia's Eastern Province indicate that many areas are burned at least once every two years or as soon as there is enough understory fuel available (grass and/or shrubs) to effectively carry fire. An analysis was performed by the assessment team using the MODIS Burnt Area Product in an attempt to substantiate these findings. The analysis revealed that of the area in Eastern Province that has burned in the last 14 years (2000 - 2013), 28% burned with a frequency of every 1.6 years, 37% burned every 3.5 years, 14% burned every 7 years, and 21% of the area burned every 14 years (Figure 14).

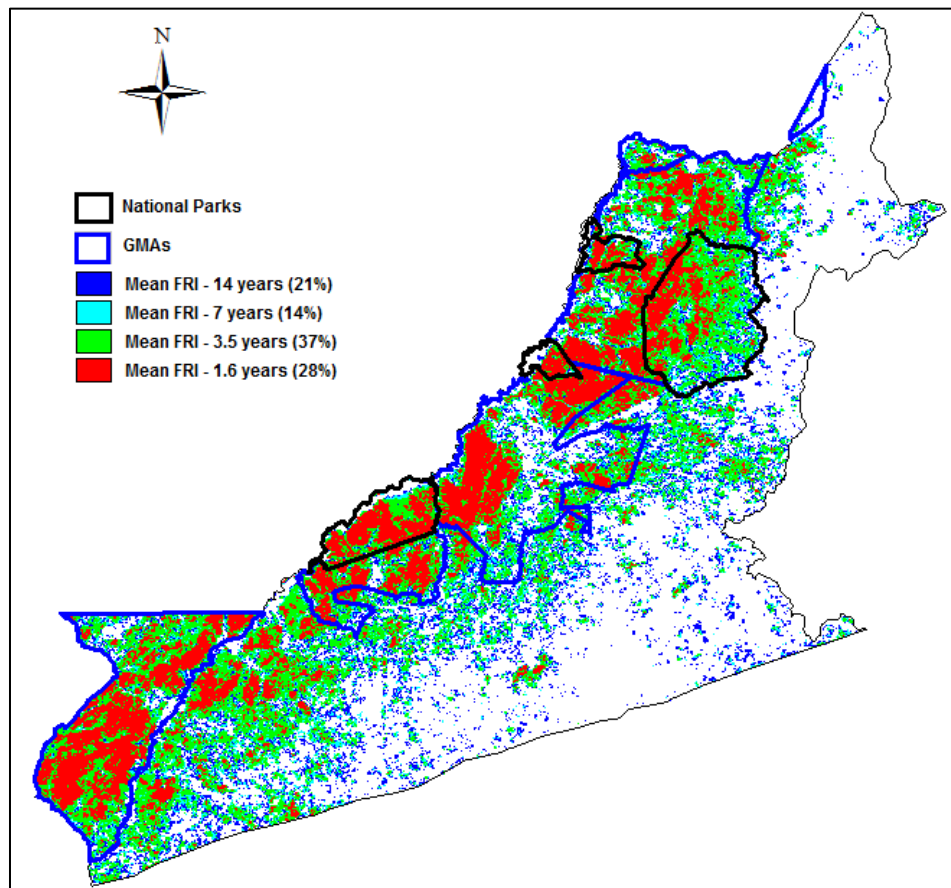


Figure 14. A map illustrating the mean fire return interval in Eastern Province over a 14 year period spanning 2000 to 2013. Game management areas (GMAs) and national forests are outlined in blue and black, respectively.

Adaptation to Fire

In terms of adaptation to fire, each of the ecological groups composing the various successional stages of miombo woodland ecosystems in Eastern Province can be broadly defined as fire dependent, fire sensitive, or fire independent.

Fire dependent ecosystems

Fire dependent ecosystems require fire in order to perpetuate. When fire is excluded as a natural disturbance process, these ecosystems will often transition to systems consisting of plant species less tolerant of fire. Two primary characteristics of fire dependent vegetation include fuels that are flammable and facilitate fire's spread.

Fire sensitive ecosystems

Fire sensitive ecosystems are composed of plant species that are not well adapted to survive fire. In these ecosystems fire is often destructive if it occurs during protracted dry seasons. Ecologically appropriate fire introduced at a moderate frequency can be important in creating specific habitats and initiating successional processes. However, if fires become more frequent there can be greater mortality to trees which may result in a change in species composition to one that is more flammable; for example, miombo woodlands can be converted to grassland or shrubland.

Fire independent ecosystems

Fire independent ecosystems occur in environments that are too wet, too dry, or too cold to burn and as such fire often plays a minimal role.

Successional Stages of Miombo Woodland

There are four primary ecological species groups that characterize the distinct successional stages of miombo woodland following disturbance by fire (Trapnell 1959, Lawton 1978; Figure 15).

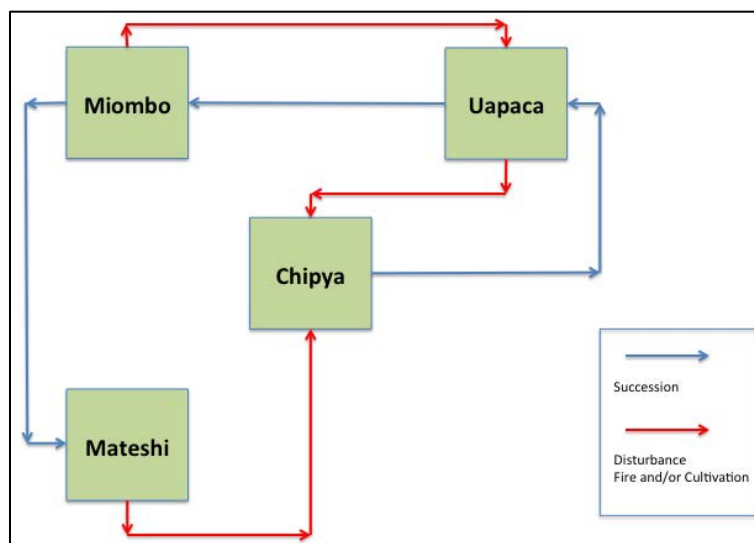


Figure 15. The four primary ecological species groups that characterize the distinct successional stages of miombo woodland following disturbance by fire in order of succession.

These ecological species groups or seral states facilitate gradual closure of the tree canopy over time which diminishes the effects of fire and promotes the establishment of later successional fire-sensitive species. The species groups in order of development are chipya, uapaca, *Brachystegia-Julbernardia* (miombo), mateshi, and a group of ubiquitous species which persist throughout. It should be noted that these groups are not necessarily discrete as there can be overlap in their occurrence within each seral state (Lawton 1978, Robertson 1984, Kikula 1986, Stromgaard 1986).

Chipya Ecological Group (Fire Dependent)

Chipya is a fire dependent wooded grassland ecosystem characterized by vegetation that has adapted to frequent and intense fires. It is dominated by scattered groups of fire-resistant woody species, tall grass, and an herbaceous layer composed of indicator species such as *Aframomum albobiolaceum*, *Smilax anceps*, and *Pteridium aquilinum* (Lawton 1978, Figure 16). The term chipya is derived from the Bemba verb *kupya* meaning to burn. It represents a regressive stage following semi-closed miombo woodland (uapaca) after sustained damage by frequent and intense fires (Trapnell 1959, Storrs 1995, Smith et al. 2000). Chipya vegetation takes advantage of open habitats where fire intensity is high but will transition to the uapaca species group if fires become more infrequent (Lawton 1978). Trapnell (1959) observed that chipya was often associated with patches of dry evergreen forest. His research eventually led him to hypothesize that chipya occurs in areas formerly covered by evergreen forest that have since been degraded by fire. Trapnell's (1959) hypothesis has been supported by a number of studies including Trapnell (1943), Schmitz (1950), Lawton (1963), Fanshawe (1971), and White (1983), which have all suggested that chipya is a result of a regression from the mateshe type driven by disturbance events such as fire and/or cultivation.



Figure 16. Chipya fire-dependent wooded grassland ecosystem in Katete District. Planted mango trees are evident in the foreground. Photo by L. Hollingsworth

Large trees that grow as coppice in the chipya ecological group include *Amblygonocarpus* spp., *Burkea* spp., *Combretum* spp., *Erythrophleum* spp., *Pericopsis* spp., and *Pterocarpus* spp. These trees are considered part of the chipya group because they persist in open habitats after severe fire events and do not require protection from fire that is a requisite for the survival of woodland and forest canopy species (Lawton 1978). Canopy tree species characteristic of this ecological group include *Ozoroa* spp., *Pericopsis* spp., and *Swartzia* spp. Shade intolerant small tree species that persist in this ecological group include *Diplorhynchus* spp., *Hymenocardia* spp., *Maprounea* spp., *Syzygium* spp., *Chrysophyllum* spp., *Combretum* spp., *Dalbergia* spp., *Diplorhynchus* spp., *Faurea* spp., *Hexalobus* spp., *Hymenocardia* spp., *Lonchocarpus* spp., *Maprounea* spp., *Ochna* spp., *Stereospermum* spp., *Strychnos* spp., *Terminalia* spp., and *Vitex* spp. Understory shrub species include *Annona* spp., *Maytenus* spp., *Psorospermum* spp., and *Ximenia* spp.

Uapaca Ecological Group (Fire Sensitive)

The uapaca ecological group consists of fire sensitive plant species that are not particularly well adapted to withstand frequent fire. When fire frequency declines, broadleaf *Uapaca* spp. with moderate fire resistance will gradually invade and dominate chipya vegetation to form scattered tree canopies that eventually suppress grass production in the understory (Lawton 1978, Figure 17). Reducing understory fuel often results in decreased fire frequency and fire intensity which creates favorable conditions for the establishment of miombo tree species. Uapaca will regress to chipya if exposed to fire.



Figure 17. Fire sensitive Uapaca ecological group consisting of *Uapaca* spp. dominating the canopy and immature *Brachystegia* spp. and *Julbernardia* spp. beginning to colonize the understory. Kasanka National Park, Zambia. Photo by D. Johnson

Miombo Ecological Group (Fire Sensitive)

Miombo woodlands are characterized by vegetation that can be defined as fire sensitive. In the absence of fire or significant reduction in fire frequency *Brachystegia* spp., *Julbernardia* spp., and

Isoberlinia spp. saplings have the opportunity to become established in the uapaca vegetation type. In the continued absence of fire, saplings will continue to grow and eventually develop into mature miombo woodland that in turn suppresses the uapaca canopy which then dies back to coppice. Understory tree species include *Bridelia* spp., *Monotes* spp., and *Protea* spp. (Figure 18).



Figure 18. Fire sensitive miombo ecological group dominated by *Brachystegia* spp., *Julbernardia* spp., and *Isoberlinia* spp. in Petauke District, Eastern Province. Photo by D. Johnson

Where miombo woodland has been exposed to fire, it regresses to an earlier uapaca successional stage (Smith et al. 2000). This observed regression in response to frequent fires is supported by results from the Ndola burning experiments conducted by Trapnell (1959). Trapnell's (1959) research demonstrated that the burning of miombo does not produce chipya but rather an eventual regression to uapaca.

Mateshi Ecological Group (Fire Independent)

Mateshi is a closed canopy dry evergreen forest that can be characterized as a fire independent ecological group (Lawton 1978). This ecological group consists of evergreen and semi-deciduous trees unable to withstand dry season fires. Mateshi typically occurs as small scattered patches within chipya and is commonly found in close proximity to wet miombo woodlands which inhibit dry season fires (Figure 19). Dominant canopy tree species include *Entandrophragma delevoyi* and *Parinari excels*. Other canopy tree species characteristic of this ecological group include *Azelia* spp., *Brachystegia* spp., *Bridelia* spp., *Canthium* spp., *Cryptosepalum* spp., *Entandrophragma* spp., *Erythrophleum* spp., *Faurea* spp., *Marquesia* spp., *Parinari* spp., and *Syzygium* spp. Understory tree species present in this ecological group include *Anisophyllea* spp., *Apodytes* spp., *Memecylon* spp., *Ochna* spp., *Podocarpus* spp., and *Xylopia* spp. Shrub species in the understory include *Bequaertiodendron* spp., *Bridelia* spp., *Canthium* spp., *Cremaspora* spp., *Dichapetalum* spp., *Dracaena* spp., *Erythraxylum* spp., *Euclea* spp., *Phyllanthus* spp., *Salacia* spp., and *Tecomaria* spp. Lawton (1978) proposed that a gradual succession from chipya to mateshe may occur in the absence of fire.

This theory is supported by the fact that many of the chipya species persist in the understory of the mateshe ecological group forming a dense impenetrable thicket below the canopy. Fire is precluded in this vegetation type as the surface fuels are extremely sparse consisting primarily of mosses, ferns, and broad-leaved grasses.



Figure 19. Patches of the mateshi ecological group scattered throughout a chipya ecosystem adjacent to a wet miombo woodland area in the background. Kasanka National Park, Zambia. Photo by D. Johnson

Governance, Policy, and Legislation

The role of governments, at all levels, in effective and sustainable fire management is critical and cannot be emphasized strongly enough. Governments provide the necessary legal and to some extent cultural framework critical in enabling successful and sustainable fire management practices. These practices can only be implemented in a sustainable fashion if the institutional setting in a given location has in place policies, laws, regulations, and fire management authorities. At a minimum, these elements are necessary in order to provide a contextual framework for participatory approaches and to establish the rights and benefits of communities and individuals using fire. The successful implementation of any fire management program often requires changes at three distinct levels of society: 1) the national level, 2) the intermediate or province level, and 3) the local level, including both districts and communities.

Governance

The development and implementation of relevant policy and supporting legislation at a minimum require good governance. The term "governance" is used extensively and in many contexts, but is

extremely difficult to capture in a simple, comprehensible definition. In a natural resource context, governance is used to refer to the body of formal and informal policies and arrangements developed between relevant stakeholders to manage and make decisions about a particular resource. Thus, governance provides the framework by which groups, such as communities, define their interests, rights, responsibilities, and the ways in which they will interact with each other and with institutions of authority to manage a particular resource (GOI 2001, Blomley 2009). Good governance typically has at least 8 major characteristics: 1) participatory, 2) consensus oriented, 3) accountable, 4) transparent, 5) responsive, 6) effective and efficient, 7) equitable and inclusive, and 8) follows the rule of law (UNESCAP 2007). Inadequate governance, or the absence of clearly defined processes, roles and responsibilities for decision-making, is often at the root of many problems associated with effective fire management.

Policy and Legislation

The terms policy and legislation are often confused and used interchangeably. Policy can be defined as a set of principles and objectives that are oriented toward the achievement of a long-term vision, whereas legislation refers to proposed or enacted laws. Policies guide the development and implementation of laws and regulations, but also provide orientation for strategic planning and the development of processes and mechanisms to realize long-term objectives in a particular sector. For example, a specific objective articulated in an official document on forestry policy might be to include local communities in fire management activities. This policy may guide and inform the strategic planning of the forestry department or responsible agency, who could then adopt a more participatory approach to fire management with local communities by, for example, establishing co-management arrangements. To support the co-management arrangements, legislation may be enacted that defines the roles and responsibilities of communities in co-management and articulates the process for their formal recognition. In this example, the legislation supports the implementation of the policy. In sum, policy guides legislation while legislation gives content and specificity to a particular policy.

Inadequate policy and legislation can result in a number of issues directly related to the successful implementation of effective fire management strategies. Legislation can support or hinder the participation of local communities or individuals in fire management. Increased involvement in fire management by communities often results in those communities being better informed, more likely to use fire in a judicious manner, and adhere to local policy and legal regulations relating to fire management (Morgera and Cirelli 2009). Legislation can empower communities through promoting their involvement in fire management by providing for the establishment or recognition of community committees and decision groups. More specifically, legislation can be enacted that allows for community members to actively participate in a variety of fire management activities including the development of local fire management plans. To encourage community involvement, legislation should also provide adequate incentives for members of those communities involved in fire management activities and to compensate those individuals should they suffer personal injury or damage to property as a result of fire.

Similarly, legislation can include provisions that permit the use of fire by communities for certain activities under specific requirements and regulations. This approach not only encourages the responsible use of fire but also addresses the fact that prohibiting fire use is often ineffective and can in some cases be counterproductive. In many developing countries fire is a cheap and effective tool and one that is readily available to rural communities for a variety of livelihood activities. These communities are likely to use fire whether it is legally permitted or not. Establishing appropriate legal guidelines can be an effective way to allow traditional fire use practices under certain circumstances and to promote the sharing of that knowledge with contemporary land and fire managers.

The development of appropriate policy and legislation combined with education and training can result in a situation where communities are engaged and have a strong sense of ownership, and fires are likely to be more effectively managed. This in turn can lead to an increase in the sustainable management of resources and opportunities for collaboration between communities, commercial interests, and governments. The FAO publication written by Morgera and Cirelli (2009) is an excellent resource that provides additional information on the linkages between sound legislation and fire management. This document provides recommendations and examples of legal frameworks related to the various components of “integrated” fire management, including participatory and community based approaches to fire management.

Land Tenure

Land tenure and its linkages to effective resource and fire management is another important consideration in the development of appropriate policy and legislation. Poorly crafted policy and legislation can result in a lack of clearly defined and established land tenure, which is a major issue in many developing nations for both indigenous and non-traditional groups. There is often a strong cultural association between indigenous peoples and the traditional or ancestral lands they inhabit. These peoples have managed and shaped their surroundings over centuries, adapting their livelihoods to very specific local natural, physical, and climatic conditions. However, in many cases land tenure and access rights of indigenous communities are not legally recognized. As a consequence, their land and resources are often exploited and encroached upon by outsiders. Unfortunately, history provides many examples of the exploitation of indigenous groups from the First Nations people of North America, to the Aborigines of Australia, to the ethnic hill tribes in Vietnam, Laos, Burma, and Thailand (Jennings 1975, Goodman 1997, Hampton and Mattingley 1988).

In terms of fire management, poorly defined tenure can result in a lack of incentive by those using fire to manage it safely and responsibly. If there is no clear ownership of land, people are less likely to care if it burns or is managed poorly.

Overlapping tenure rights or other issues that muddle ownership rights can also lead to conflicts between individuals or groups that simultaneously claim an area as their own. This situation is exacerbated when local peoples’ uses and needs are not considered in the development of legal and regulatory systems (Murdiyarto and Adiningsih 2006). Resulting social conflict has often become

an indirect cause of fires. In Borneo, for example, government granted concessions ignore indigenous claims to land and trees and are at the root of many forest and fire management problems (Colfer 1997). Similarly, lack of recognition of local peoples' property rights in management and planning can lead to conflicts where stakeholders may resort to the use of fire as a weapon to claim lands (Tomich et al. 1998). Government policies that disallow the traditional use of fire by communities can also lead to those communities using fire illegally as it is often the cheapest and most readily available tool.

In contrast, when people have formal and legally recognized ownership of resources and can see long-term benefit from the land that they are managing, they will tend to be concerned with the protection and sustainable management of those resources and the land that supports them. Clearly defined land tenure that provides legal ownership, clear boundaries, and security in the form of enforceable rights is most likely to provide the necessary incentives for communities to manage fire judiciously, both in the short term and long term. Similar incentives are necessary in order to gain the involvement and support of communities in managing wildfires that have origins outside their traditional or legal boundaries. In most instances these incentives require the formulation of appropriate policy followed by its implementation and enforcement.

Land tenure and use rights continue to pose significant challenges in the sustainable management of Zambia's natural resources. The Lands Act of 1995 and the national constitution enacted in 1996 recognize two types of land tenure systems including customary land and state land. All land in Zambia is vested in the President of the Republic and held on behalf of the Zambian people. Leasehold land is a form of private land ownership that applies to both customary and state land. On state land leasehold property can be leased by an individual or private entity for a period of 99 years with possibility of contract renewal. On customary land the contract period covers a period of 14 years with the possibility of renewal subject to the chief's approval. Customary lands account for 61% of the total land in Zambia, which is managed *de facto* by village headmen. Within the social hierarchy, chiefs serve as custodians of the land on behalf of the people. Chiefs make decisions on land-use and allocation, but the state maintains *de jure* ownership. The majority of forest resources (31 million ha or 63%) are found on customary land with only 14 million ha located on state land (24%) and about 5 million ha are leasehold land.

Further complicating the issue of land tenure is the recent increase in the implementation of carbon-related climate change mitigation projects, and the increasing demand for bio-fuels. These types of initiatives often lead to a marked increase in the value of natural resource commodities making it more desirable for non-traditional groups to claim ownership of those resources. The unfortunate result is that the land rights of resident traditional and indigenous peoples can become increasingly challenged and disputed (Macchi et al. 2008). Climate change mitigation strategies such as Clean Development Mechanism (CDM) and Reducing Emissions from Deforestation and Forest Degradation (REDD) are discussed in more detail in the section on climate change.

Community Resource Boards

In Zambia, the benefits to community resource boards are also governed by a revenue sharing agreement (Chundama 2009). While community organizations do receive benefits from the revenue sharing agreements with the government these often have to be applied for and payments are frequently delayed for months, even years, thus weakening the fundamental premise that these are valuable resources owned and managed by the community (Chundama 2009).

Fire Management

In Zambia, fire management is primarily the responsibility of the Zambia Forestry Department and the Zambia Wildlife Authority (ZAWA). The following section describes the roles of these government agencies and the legislation that provides agency direction.

Zambia Forestry Department

The Forestry Department falls under the Ministry of Lands, Natural Resources, and Environmental Protection. The Forestry Sector legal and institutional framework is based on the National Forest Policy of 1998 and Forests Act Cap 199 of 1973 of the Laws of Zambia. The updated 2009 version of the National Forest Policy is still in draft format but is expected to be officially endorsed by the Zambian government in early 2015. Operations of the sector are planned through the Zambia Forestry Action Plan, the Sixth National Development Plan (2011-2015), the Vision 2030, and the Millennium Development Goals. Each of the ten provinces within Zambia has a Provincial Forestry Office; the Forestry Department currently has representatives in 75 districts, and offices are being established in newly created districts.

The National Forest Policy of 1998, Forests Act - CAP (Chapter) 199

The current Forests Act (1998) provides for the establishment and management of national forests and local forests; to make provision for the conservation and protection of forests and trees; to provide for the licensing and sale of forest products; and to provide for matters connected with or incidental to the foregoing. Specific sections within the Act that contain provisions for fire management include:

Part XI (Powers of Forest Officers)

67. Calling for assistance in extinguishing fires

Part III (National Forests)

16. (c) No person shall without a license do any of the following acts in a national forest: fire any tree, undergrowth, grass or forest produce, or assist in lighting any fire, or allow any fire lit by himself or his employees or agents to enter a national forest.

34. (2e) Conditions attached to a license may relate to the prevention and fighting of fires.

Part X (Forest Offences, Penalties and Forfeitures)

55. (h) A person shall be guilty of an offence if he being liable under section 67 to render assistance in the case of fire....in a national forest or local forest, refuses or fails to do so, without reasonable excuse, when called upon by a forest officer or police officer.

67. (1) In the case of fire, other than any controlled fire started by or on the authority of a forest officer, or in the case of other accident or emergency involving danger to a national forest or Local Forest, every male person of not less than eighteen years of age normally resident within ten kilometers of the boundary of any such forest shall be bound forthwith to assist any forest officer who reasonably demands his aid in extinguishing such a fire or averting such a danger, and the Chief Conservator may pay to such person such consideration as he may deem fit in respect of any such aid.

67. (2) It shall be a condition of every license that, in the event of an outbreak of fire through whatever cause in any national forest or local forest or in any other land in which forest produce is being cut, carried or stored under license, the licensee shall, when called upon to do so by a forest officer, forthwith provide all available employees, tools, plant, machinery and equipment which he may have in the vicinity of such forest or land to assist in extinguishing such fire, and the licensee shall be paid such consideration therefore as the Chief Conservator may, with the approval of the Minister, deem adequate: Provided that the fire was not, in the opinion of the Chief Conservator, occasioned willfully by, or through the carelessness or neglect of, the licensee or his employees or agents.

68. (2n) The Minister may, by statutory instrument, make regulations for carrying the provisions of this Act into effect. In particular, and without prejudice to the generality of the foregoing power, the Minister may make regulations concerning-the prevention and fighting of fires in national forests and local forests and in coupes in State Lands and Customary area.

Part IV (Protection from Fire) - Regulations

19. Licensee to prevent and to extinguish fire in coupes.

A licensee shall, unless it is otherwise stated on any license held by him, be responsible for the prevention of fire in any coupe in which he is licensed to work, and, if any fire breaks out within or in the vicinity of the coupe, the licensee and his employees or agents, if any, shall immediately take effective steps to extinguish the fire.

20. Licensee to carry out fire-protection works.

A licensee shall, unless it is otherwise stated on any license held by him, execute within the coupe in which he is licensed to work such fire-protection works, including the clearing of fire-breaks and the burning of branchwood and waste, as may be required by a forest officer: Provided that, unless a forest officer gives written permission to the contrary, no burning of branchwood or of waste may be carried out except under the supervision of a forest officer.

21. Licensee's failure to carry out fire-protection works.

In the event of a licensee failing to carry out fire-protection works to the satisfaction of a forest officer, the work may be done by employees of the Forest Department and the cost of the work recovered from the licensee.

22. Restrictions concerning smoking, carrying of matches, etc.

No person shall, within any national forest or local forest

(a) Smoke, where by notice smoking is prohibited;

(b) Kindle, carry or throw down any fire, match, lighter, torch or other lighted or combustible material or article within, or adjacent to, any nursery, forest, plantation, mill, plant or depot, except as may be permitted under the conditions of a license: Provided that any forest officer, or any other employee of the Forest Department acting under the authority of a forest officer, may do any of such acts for the purpose of controlled burning or of other forest operation.

23. Forest officer may order surrender of cigarettes, etc.

Any forest officer may, in any national forest or local forest, order any person to extinguish or surrender to him any fire, match, lighter, torch or other lighted or combustible material or article if in the opinion of such officer the extinguishing or surrender of such material or article is necessary to safeguard any nursery, forest, plantation, mill, plant or depot from the possibility of damage by fire, and any person who is given such order shall promptly comply with such order.

Part VIII (Obstruction of Roads and Rivers)

24. Any tree or forest produce which as a result of a licensee's operations obstructs, or is liable if left to obstruct, any road, track, way-leave, fire-break, drain or river in a national forest or local forest shall be removed immediately by the licensee.

25. Any forest officer may order a licensee or his employee or agent or any driver or other person in any vehicle carrying or used for carrying forest produce to remove any tree or forest produce which is obstructing, or which is liable if left to obstruct, any road, track, way-leave, fire-break, drain or river in a national forest or local forest, and it shall not be good grounds for refusing to comply with such order that the person so ordered did not cause such obstruction or, as the case may be, potential obstruction.

Part VIII (Demarcation of Boundaries)

34. The boundaries of a national forest or local forest shall, except where such boundaries are formed by natural features, roads, way-leaves or railways, consist of cleared lines not less than three meters wide or, where any boundary follows open land, lines or beacons or posts: Provided that any such boundaries may also include a boundary road, path, scuffled line, fire-break or fence.

Sections 5 and 6 (National and Local Forests) – Declarations by the Minister

National and Local Forests Nos. 1, 6, and 8

The areas described in the Schedule are hereby declared to be National and Local Forests, and the following acts are hereby prohibited within the said areas except under license:

(c) Firing any grass or undergrowth, or lighting or assisting in lighting any fire, or allowing any fire to enter the said area: Provided that, notwithstanding the foregoing prohibitions, any *bona fide* picnic or camping party may without license camp and light fires in any portions of the said areas set apart for these purposes on condition that any fires so lighted shall be effectively prevented from spreading and shall be extinguished before being left by the person or persons who lighted them.

Zambia Wildlife Authority (ZAWA)

The Zambia Wildlife Authority (ZAWA) is mandated under the Zambia Wildlife Act No. 12 of 1998 to manage and conserve Zambia's wildlife; lands managed as national parks and game management areas (GMAs) cover 31 percent of the country's land mass. The 19 national parks in Zambia cover an area of 3,580 km² and the 35 GMAs cover 167,557 km², 8.5 percent and 22.3 percent of the total land area, respectively. Approximately 490 forest reserves also cover large areas of approximately 75,000 km² or 10.2 percent of the country (Global Environment Facility 2004). ZAWA integrates the wildlife policy with economic, environmental, and social policies to ensure an effective contribution to sustainable national development.

ZAWA recognizes that uncontrolled bush fires represent a considerable threat to biodiversity in national parks and GMAs. Principal causes of uncontrolled fires include: 1) a breakdown in the authority of traditional leaders, 2) inadequate staff and lack of fire control programs in protected areas, and 3) inadequate research and knowledge on the impacts of fire to wildlife and habitat. Biological impacts include the degradation of forests and woodlands and loss of species, especially those that are fire sensitive. Alternative strategies posited by ZAWA include: 1) the development of fire control programs as part of national park and GMA management plans, 2) development of a research program focusing on fire monitoring and impact assessment, and 3) involvement of the traditional authorities and local people in fire control activities. Specifically, this includes collaboration with traditional authorities to develop/reinstate fire management programs including controlled early burning (Global Environment Facility 2004).

Zambia Wildlife Act (1998)

The Zambia Wildlife Act (1998) is an Act to establish the Zambia Wildlife Authority and to define its functions.

Part VIII (Hunting of Wild Animals)

Section 71. Any person who, for the purpose of hunting or assisting in hunting any game animal or protected animal or protected animal, causes any fire or drives or surrounds any game animal or protected animal with fire, shall be guilty of an offense.

Other Relevant Acts

The National Policy on Environment (2007)

The National Policy on Environment (2007) was developed by the Zambian Government to avoid conflict of interest, harmonize sectorial strategies, and rationalize legislation that concern the use and management of the environment in order to attain an integrated approach to development through a national cross-cutting consensus.

Page 4: Forestry Sector

States that there is “far too much uncontrolled burning”. However, there does not seem to be any other direct reference to fire in the 63 page publication.

The Natural Resources Conservation Act (1970)

CAP 315, No. 53 of 1970

Provides for the appointment of a Fire Authority for a designated area.

Climate Change

In recent years, as awareness of its causes and effects increase, climate change has become an important consideration in conservation and the sustainable management of global natural resources. The effects of climate change are implicitly felt by rural communities in many countries and can have profound effects on the ecosystems they inhabit. Although the science remains imprecise, it is acknowledged that climate change has contributed to altered fire regimes in major ecosystems around the world, which also renders many traditional fire use practices by indigenous groups and communities obsolete (Shlisky et al. 2007). Understanding the role that fire plays in climate change, as well as its role in various strategies used to mitigate the effects of climate change, has become essential in the successful management of fire in many parts of the world today.

The term climate change is commonly used interchangeably with both global warming and the greenhouse effect. To clarify, global warming relates to an increase in the earth’s average temperatures. The rise in temperature is often associated with increased concentrations of greenhouse gases (GHGs) that trap the energy from the sun in the atmosphere. The term climate change is more general and as such recognizes not only an increase in average temperatures but

also other types of changes to the climate that are often reflected in extreme weather events. The Intergovernmental Panel on Climate Change (IPCC) established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) defines climate change as “any change in climate over time, whether due to natural variability or as a result of human activity”.

The effects of climate change are being felt the world over. Perhaps the most visible signs of climate change can be seen in Alaska where sea ice has retreated by 14% since 1978 and thinned by approximately 60% since the 1960s (Parson et al. 2001). These reductions in the extent and depth of Alaska’s sea ice have had profound effects on marine ecosystems, critical wildlife habitat, and many remote native Alaskan communities. Temperature increases in Alaska may also explain increases in forest disturbances including insect attacks and large-scale forest fires. While a place that experiences extreme temperatures such as Alaska may exhibit some of the most visible effects of climate change, there are many countries that are being impacted by the change in global climate from a social, economic and environmental standpoint. The majority of these are developing countries in which climate change is likely to create additional challenges for indigenous communities in terms of maintaining or improving standards in health, security, and prosperity. This is particularly true of those living in places that are susceptible to natural and man-made disasters such as flooding and fire (DFID 2004). Unfortunately, the occurrence of such disasters are likely to increase as a result of rising sea levels, more dramatic weather events, reduced precipitation, and increasing atmospheric temperatures.

In general, Zambia is a low greenhouse gas (GHG) emitter. Total GHG emissions increased by 6.2% from 51.52 million tons carbon dioxide (CO₂) equivalent in 1994 to 54.72 million CO₂ equivalent in 2000, ranking in the bottom percent of country emissions overall and per capita. In the year 2000, the largest contribution to GHG emissions came from land use change and forestry at 73.7% followed by agriculture at 18.9%. Energy registered a low 4.8% followed by industrial processes and waste at 1.8% and 0.8%, respectively. Accounting for emissions in the forest and land-use sectors will significantly contribute to government efforts in addressing deforestation and forest degradation as well as contribute to international efforts in reducing emissions.

Zambia is currently developing climate change mitigation and adaptation strategies designed primarily to reduce the rapid pace of deforestation and forest degradation in the country. As a result there has been an extraordinary increase in interest and investment in national forest inventories, forest monitoring, forest carbon estimations, forest resource assessments, and related efforts in Zambia. This increased interest reflects the important linkages between landscape resources, economic development, food security, and climate change in a region where livelihoods and ecosystem services are derived from forests and agricultural land for millions of people. It is expected that Zambia’s climate change mitigation and adaptation strategies will result in: 1) the conservation of and sustainable management of its forests, 2) improved forest monitoring reporting and verification, 3) increased resilience to natural disasters, and 4) an increased adaptive capacity to threats such as forest fires, flooding, drought, and loss of biodiversity. In addition the improved understanding and implementation of accurate carbon monitoring, reporting, and verification of landscape resources will also contribute significantly in developing strategies that

will reduce loss of forests through a REDD+ mechanism in Zambia, and increase access to emerging financing mechanisms such as the Forest Carbon Partnership Facility (FCPF), the Forest Investment Program (FIP), and UN-REDD.

Fire and Climate Change

Wildfire contributes to significant levels of deforestation and atmospheric emissions in many parts of the world. An increased number of wildfires in many of the world's fire prone ecosystems in the last two decades can be attributed to a changing climate (Westerling et al. 2006). Specifically, warmer temperatures and reduced precipitation as a result of changes in global climate are some of the factors that may be resulting in this global increase.

Fire is a significant threat to the ecological health and subsequent sequestration ability of many tropical forests. In addition, fire poses major risks to the people that depend upon those forests in terms of reducing potential income generating activities, degradation of habitat for food sources (both non-timber forest products (NTFPs) and wildlife), and reduced air and water quality. This is of particular concern in many developing countries where most forests are considered to be fire sensitive. Fire sensitive ecosystems typically have not evolved with fire as a significant recurring process. Species in these areas lack adaptations to respond to fire and mortality is high even when fire intensity is very low. Unmanaged or poorly managed fire is a key component in the



Figure 20. Typical hazy day in Eastern Province, due to suspended particulate matter from fires. Photo by L. Hollingsworth

deforestation and degradation process for many of these fire sensitive ecosystems and can often result in significant GHG emissions. Specifically, wildfires in densely forested ecosystems can produce emissions of up to 113 tons/ha (46 tons/acre) (Bonnicksen 2008). Indonesia, for example, has experienced levels of deforestation and peatland degradation resulting in part from forest fires that have put it among the top three largest emitters of greenhouse gases in the world. Emissions resulting from deforestation and forest fires in Indonesia are almost five times those from non-forest emissions and clearly illustrate the magnitude of this problem (Sari et al. 2007). However, the situation is not unique to Indonesia. It is thought that wildfires, wherever they occur, in addition to their potential negative effects to ecosystem health may contribute to global warming via the significant emissions of GHGs (Shlisky et al. 2007, Figure 20).

The global increase in wildfire occurrence as a result of climate change, wildfire as a contributor to GHG emissions, and wildfire's contribution to forest degradation and destruction underscores the need for the development and implementation of more effective fire management approaches. In order to be effective, fire management strategies must recognize the integral role that fire plays in shaping ecosystems and its linkages with the inhabitants of those systems. In response to these issues a number of multi-lateral and non-governmental organizations (NGO)-funded Community Based Natural Resource Management (CBNRM) projects with a focus on carbon sequestration and storage have been implemented around the world. Significantly, many of these projects have acknowledged the importance of local community involvement in the development and implementation of effective fire management strategies. The underlying theme is that wildfire can be prevented by employing fire management approaches that support and recognize the legitimacy of fire use by communities and rural populations. This in turn can result in a significant reduction in GHG emissions typically attributed to wildfire events.

The contribution of savanna woodland fires to global GHG emissions is significant. Andreae (1996) suggests that savanna (miombo) woodland fires in Africa contribute approximately 22% of the biomass burned globally. This is supported by the London-based Environmental Investigation Agency (EIA); however, at a global scale the total land-based emissions from miombo ecosystems are relatively small compared with the massive GHG emissions from the extensive tropical forest ecosystems found in countries such as Brazil, Indonesia, and Nigeria. In miombo dominated Zambia, deforestation and degradation across the entire country is estimated to contribute 3% of the total GHG production (Environmental Investigation Agency 2008).

Specific estimates of total GHG emissions from deforestation and degradation of miombo woodlands do not currently exist. In general there is a lack of information on carbon cycles and the impacts of the frequent disturbances from fire and human use of miombo woodlands. The most recent and detailed study was undertaken as part of the N'hambita Carbon Project, Sofala Province, Mozambique and investigated carbon stocks in miombo woodlands versus abandoned agriculture fields. The fields, known as machambas, had been abandoned from 2 to 30 years prior to the study; machambas are often abandoned after a few seasons of cultivation once fertility declines. Williams et al. (2008) found there was no significant difference in stem carbon stocks of miombo woodlands and machambas abandoned more than 20 years ago; in addition, the abandoned machambas revealed a gradual increase in stem carbon stocks over time. Although median soil carbon stocks were higher in miombo woodlands than abandoned machambas, there were no distinct trends over time in soil carbon stocks in the abandoned machambas (Williams et al. 2008).

In savanna (miombo) woodland ecosystems, flaming combustion resulting from fire in the understory grasses and shrubs tends to be more common than smoldering combustion. Emissions resulting from this rapid and more complete type of combustion are primarily comprised of gases such as nitrogen dioxide (NO₂) as opposed to reduced trace gases such as carbon monoxide (CO) and methane (CH₄). Smoldering combustion is more typical of tropical forests in which the majority of the biomass being burned is concentrated in the tree trunks, branches and stems and thus burns slowly and less completely (Andreae 1996).

The miombo woodlands have great potential to either add to the growing carbon dioxide content of the atmosphere or help reduce it. In both cases, about half of the change in carbon stocks occurs in the soil and the rest in the biomass (Scholes et al., in press). It is likely that one of the most effective ways to increase carbon uptake in savanna (miombo) woodlands is to reduce fire frequency. Experiments in African miombo woodlands have shown woody biomass and soil carbon to increase if fires are excluded (Trapnell et al. 1976). However, permanent fire exclusion is virtually impossible due to a number of corresponding factors including: 1) the geographic extent of the ecosystem, 2) existing land tenure structure, 3) low capacity of enforcement agencies, 4) prevailing cultural norms, and 5) the seasonal miombo climate found in Zambia.

That being said, a reduction from the current mean fire return interval of 1.6 years (Chidumayo 1995) to four or five years may be achievable if the opportunity cost of less frequent burning by rural communities can be determined and compensated appropriately. A reduced fire return interval would promote woody plant regeneration and the development of a mature tree component which may simultaneously increase carbon dioxide uptake and decrease emissions of methane and ozone precursors. The carbon uptake in this scenario would persist between twenty to fifty years, as the woodlands mature and reach a new equilibrium carbon density. The carbon-storage benefits of long-term miombo management could then be extended beyond the initial twenty to fifty year period by harvesting the timber sustainably, and either converting it to long-lived products such as furniture, or by using it as an energy source in place of fossil fuels. However, since a longer fire return interval would promote more woody plant regeneration and increased biomass, there is also the potential for spikes of emissions should these areas burn late in the dry season.

REDD+

REDD+ is an acronym that describes a set of strategies used in Reducing Emissions from Deforestation and Forest Degradation. The "plus" includes conservation, the sustainable management of forests and enhancement of forest carbon stocks. REDD+ presents a key opportunity to generate the funding, political will, and mechanism necessary to protect forests while combating climate change and improving human well-being in developing nations. It also represents a suite of policies, institutional reforms, and programs that provide monetary incentives for developing countries to reduce greenhouse gas emissions and sustain economic growth by halting or preventing the destruction of their forests.

In addition to reduced emissions, forests that are not burned can also act as valuable carbon storage mechanisms (also referred to as carbon pools.) In the last decade a number of projects have been implemented that place an emphasis on reducing emissions from deforestation and forest degradation (REDD+). The majority of these projects trade carbon on the voluntary carbon markets as opposed to the regulatory or compliance markets. This can in part be attributed to the lower transaction costs associated with the voluntary markets in comparison to those of Clean Development Mechanism (CDM) or other compliance market projects. A lower transaction cost often allows for innovative or experimental niche type micro projects to prosper in the absence of the administrative burdens associated with CDM.

Until recently, the threat of fire has not been addressed sufficiently in the planning or implementation of many REDD+ pilots. In Borneo for example, government-granted concessions ignore indigenous claims on land and trees and are at the root of many forest and fire management problems (Colfer 1997). During the 1997-1998 fire season, 25 billion tons of CO₂ were released in Indonesia alone, equivalent to 40% of global greenhouse gas emissions. It is important to note that over 90% of those fires were human-caused. Such an event, should it occur again, has the potential to wipe out all of the gains achieved through REDD+ globally. This type of scenario highlights the need for effective fire management planning within the context of REDD+ that addresses the need for community involvement through integrated approaches to fire management. Many existing REDD+ projects are located in areas of the world where fire plays a significant role as both a land management tool and primary agent of forest loss. In these instances fire is an important risk factor that should be addressed in the development of an effective REDD+ mechanism. The potential for the adoption of REDD+ into future iterations of the 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change gives urgency to the need for testing and improving its effectiveness as a carbon sequestration strategy. Without appropriate and effective fire management considerations that also address community involvement in planning and/or implementation, this objective is not likely to be achieved.

Meetings in Eastern Province with Stakeholders

Numerous meetings were convened throughout Eastern Province with a variety of stakeholders including: local community members, chiefs, headmen, village leaders, forestry and wildlife officers, and non-governmental organizations (NGOs). With these constituents the team discussed fire management and fire use in protected areas and around communities, as well as challenges pertaining to the use and management of fire.

Nyimba District

Nyimba District is the second largest district in Eastern Province, covering an area of 10,509 km² with a population of 85,025 people in 2010 (CSO 2012). The town of Nyimba serves as the district capital. More than 90 percent of the population lives in a rural setting and their livelihoods are dependent on the agriculture sector, including raising crops such as maize and cotton, and livestock including cattle, pigs, and goats. Within the Nyimba District there are four chiefdoms: Ndake, Luwembe, Mwape, and Nyalugwe. Nyimba District has three national forests: Mvuvye, West Mvuvye, and Minga Forests. The district also has four local forests including Nsangwe North, Nsangwe South, Kacholola, and Musima.

In Nyimba the team briefly met with District Commissioner George Phiri, who serves as the administrative head of the district. Mr. Phiri acknowledged that fires have been a challenge within

the Nyimba District and often destroy resources upon which local people depend. The team also met with multiple stakeholders at the Nyimba District Office for the Forestry Department and the palace of Chief Nyalugwe (Figure 21).

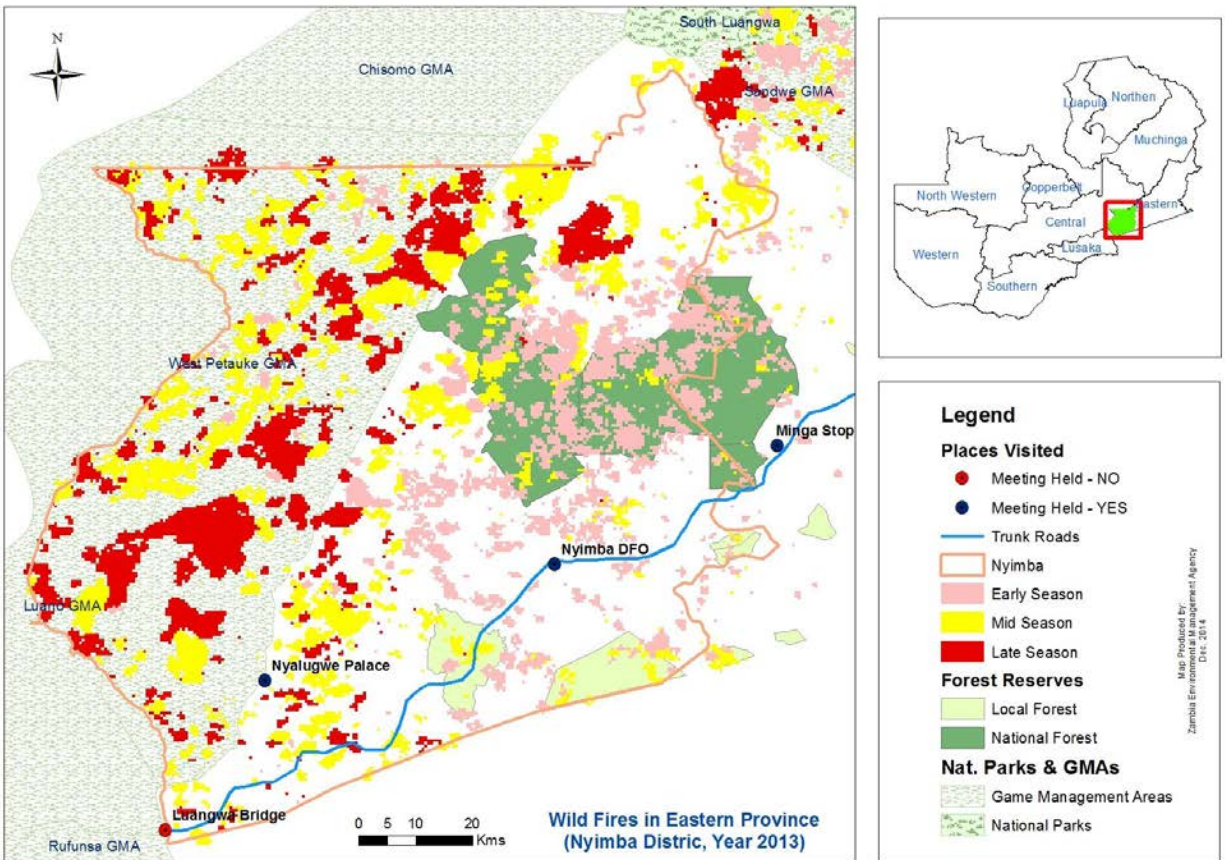


Figure 21. Meeting locations in Nyimba District.

Nyimba District Forestry Office

Stakeholders: Stella Banda, Zambia Wildlife Authority (ZAWA)
 Shadrick Ngoma, Center for International Forestry Research (CIFOR)
 Lukunka Stanely, ZAWA
 Raymond Ngulube, District Forestry Officer (Forestry Department)
 Mwiinga Converse, Community Markets for Conservation (COMACO)

Uses and Seasonality of Fire

1. Both ZAWA and the Forestry Department engage in early burning from April through June in game management areas (GMAs), national parks, and forest reserves. The purpose for restricting prescribed fire early in the dry season is to limit tree mortality and effects to other resources. Burning is conducted while live herbaceous fuel moisture remains fairly high; when fuels become too dry prescribed burning ceases for the year.
2. Cattle herders use fire to improve forage.
3. Fire is used for hunting small animals such as mice and rabbits in both forests and agriculture fields.

4. Burning crop residues occurs following harvest from July through November, but often late in the dry season.
5. Fire is used in honey collection, as the smoke from fire is used to drive bees from the hive.
6. Poachers illegally burn forests in protected areas to clear surface fuels for better visibility and tracking of animals.

Observations

- Officers have noticed that most of the damage to trees in the area is caused by wildfires (and wildlife to a lesser extent).
- Villagers harvest grass as thatch for houses. This harvest must precede the use of fire or this resource is lost for the year.
- The officers have noticed that villagers often do not monitor fires once they are started nor do they take into account adjacent fuels. There is a penalty for burning within protected areas but is generally not enforced. Therefore there are no real incentives to manage fire.
- Early season burning is favored as a tool in the conservation of wildlife habitat and community livelihood activities such as wild honey collection, as it is more easily managed and perceived as being far less destructive than late season burning. One objective of early burning is to burn the vegetation in a patchy mosaic, therefore leaving unburned areas suitable for grazing by wildlife and domestic livestock.
- Late burning is generally used to burn crop residues, hunt mice, poach, or collect honey.

Sensitization and Education

ZAWA coordinates its fire management and associated training with local communities, private landowners, and other stakeholders. Community members often assist in fire management activities through the Community Resource Boards (CRBs) who work with ZAWA.

Miscellaneous Information

A CIFOR project will conclude in December, 2014 that evaluates general tree health throughout the Nyimba District. If a tree was unhealthy or dead, the causal agent was noted. Preliminary results indicate that fires cause most of the damage to trees. Typically damage is the result of late season fires, though early season fires also cause damage when fuels are dry.

Challenges

- Neither the Forestry Department nor ZAWA have dedicated fire management personnel in the district. Early burning is conducted by game scouts.
- Capacity building is needed for ZAWA and Forestry Department staff so they better understand when it is appropriate to conduct prescribed burning, possess knowledge of different ignition patterns and tactics, and establish methods to monitor fuel moistures due to the variability of the seasons in Nyimba District.
- There is a need to have a coordinated approach to fire management by all stakeholders including ZAWA, Forestry Department, the Ministry of Agriculture, and communities. It was noted that increased collaboration and coordination between stakeholders should occur and will be key to success, as all stakeholders are confronting the same issues.

- It is difficult to penalize anyone for starting a fire that damages property or burns into a protected area as it is not usually known who starts the fire.
- There are virtually no firebreaks on any lands within the district to control fire spread, protect resources, or defend villages.
- Fires often burn into protected areas.
- Crops are sometimes not harvested until July, so burning adjacent areas may be postponed until crops and grass for thatch are harvested. Herbaceous fuels may be quite dry by this time. There have been incidents in the past when crops were damaged by fire in the field prior to harvest.
- Defining early burning as taking place in certain months may be problematic as the end of the wet season and total precipitation received during the wet season vary every year. It may make more sense to define early burning by season based on fuels conditions that promote low to moderate intensity fire and therefore limits tree mortality. Rainfall can be variable and unpredictable in the amount received by month during the wet season. Questions for consideration include: Are there any quick, inexpensive methods to calculate moisture content? Is there a correlation between live herbaceous and soil moisture?

Chief Nyalugwe's Palace

The team met with Chief Nyalugwe, Smart Zulu (palace secretary), the ward counselor, and other local leaders at the Chief's palace. We were joined by Catherine Tembo of USAID and Heather



Figure 22. Photo taken at Chief Nyalugwe's palace in Nyimba District. The Chief is in the front in traditional leopard garb. Team members Gift Sikaundi (second from left), Darren Johnson (middle front next to Chief Nyalugwe), and Sylvester Siame (right) were joined by Catherine Tembo (USAID, third from right), Heather Huntington (USAID contractor, second from right), and local leaders. Photo by L. Hollingsworth

Huntington, a Cloud Burst contractor for USAID (Figure 22). Chief Nyalugwe indicated that his chiefdom is one of the richest in the country in regard to natural resources and his dream is that these resources will be protected for future generations. The Chief stated that the source of Chilinga stream, which is very important to his people, must be protected along with other streams that emanate from the same area. He fears the rate of deforestation will damage this important source.

The Chief emphasized the existing partnership with

ZAWA and COMACO and that conservation of resources is critical for people within his chiefdom. COMACO buys much of the produce from the local people as an incentive for sustainable use and conservation of natural resources in the area. Chief Nyalugwe further encourages partnerships with donor agencies, NGOs, and other organizations that can help educate local community members in his chiefdom with respect to conservation and sustainable management practices. The Chief does not promote charcoal production within his chiefdom. Chief Nyalugwe stated that income from charcoal cannot be compared to income that would be earned by communities if natural resources were conserved.

Uses and Seasonality of Fire

1. While hunting mice, the grass is burned to expose the mouse holes (burrows).
2. Fires may be started to clear areas to sleep while traveling.
3. Some fires start near the Great East Highway from travelers.
4. Fire is used while manufacturing charcoal, especially near Kacholola.
5. Poachers burn to improve their line of sight, to locate tracks, to herd animals, and protect themselves by creating escape routes.

Observations

- Community members in this Chiefdom rely heavily on grass for thatching their roofs and to sell to supplement their incomes. As a result, fire is considered a threat to this resource and burning is discouraged prior to the harvesting of the thatch grass which typically occurs in June and July. It is important to protect these areas from fire until the grass can be harvested.
- Roads help protect many villages from fire.
- Suppression of late season fires is not attempted by locals due to the intensity of those fires. As a precaution from such fires, the locals often create defensible space and create firebreaks around dwellings and other structures.

Sensitization and Education

Chief Nyalugwe emphasized the importance of protecting villages from fire as most houses have a thatch roof. He requires that the area surrounding each house be kept clean of burnable items. The social hierarchy is used to implement this policy as sub-authorities help spread the message to all villages. All community members are cautioned to not carelessly start fires. If a destructive fire is observed coming from a particular village, all village members may be held accountable. Burning is generally discouraged until crops and grass for thatch have been harvested.

The Chief indicated a need for education about early burning. Chief Nyalugwe believes that due to a lack of knowledge and understanding by local people of how to properly manage fire, uncontrolled fires often result spreading far and wide, and affect other communities and landowners. However, he also believes that given the right training and education, communities can and will effectively protect themselves from fire. The Palace Secretary has coordinated an education and outreach effort within the Chiefdom. The focus of this effort is to encourage early season burning (March through May) in order to minimize the negative effects of fire on the local environment.

Community Resource Boards have originated from the organization of sub-authority representatives (village headmen) with the objective to practice conservation and sustainable management practices. The CRBs may serve as a natural conduit for future sensitization efforts. The fact that communities need to be involved in fire sensitization efforts cannot be overstated.

Challenges

- The Chief felt that poachers are not usually from his kingdom and they show little respect for the resources. Their fires are typically not managed but are allowed to burn indiscriminately. According to Chief Nyalugwe, a large amount of poaching occurs in nearby West Petauke GMA. ZAWA and the Forestry Department should work closely with communities to protect and conserve wildlife and other forest resources.
- Chief Nyalugwe believes that funding has not been adequate to provide enough personnel throughout the district with duties including fire management (specifically Forestry Department and ZAWA). He believes that without funding to build greater capacity, fire training of Forestry Department and ZAWA personnel will not be effective in the long term.
- Poaching, charcoal production, and village encroachment into protected areas are not adequately enforced. The Chief indicated that some communities have illegally settled along roads in the forests and are degrading the forests through charcoal production, fires, and illegal harvesting of the forests' resources.
- Many community members do not take responsibility or manage fires they start. When community members hunt mice they do not manage these fires, which are allowed to burn indiscriminately often resulting in escaped fires.
- Oftentimes, fires burn the grass before it can be harvested to use as thatch.

Petauke District

The town of Petauke is the capital of Petauke District, which is mainly an agricultural area producing maize, cotton, sunflowers, groundnuts (peanuts), and soybeans. Petauke District covers a total land area of 8,359 km² and the population is 307,889 (2010 estimate). In 2012, Sinda District was created between the districts of Petauke and Katete. The official district boundaries have not yet been established, therefore Petauke District will be much smaller in both land and population once the official district boundaries are designated.

More than 90% of the district's population reside in rural areas and rely on natural resources for their livelihood. There are eight local forests in Petauke District covering an estimated area of 14,200 ha. Portions of Mvuvye National Forest, Minga National Forest, South Luangwe National Park, and Sandwe GMA are located in Petauke District. Petauke District includes six chiefdoms: Kalidawalo and Mumbi in Petauke Central Constituency; Mwanjawanthu and Nyanje in Kapoche Constituency; and Sandwe and Msanzala in Msanzaila Constituency.

In Petauke District, the team met with multiple stakeholders at Petauke District Forestry Office and Minga Stop village (Figure 23).

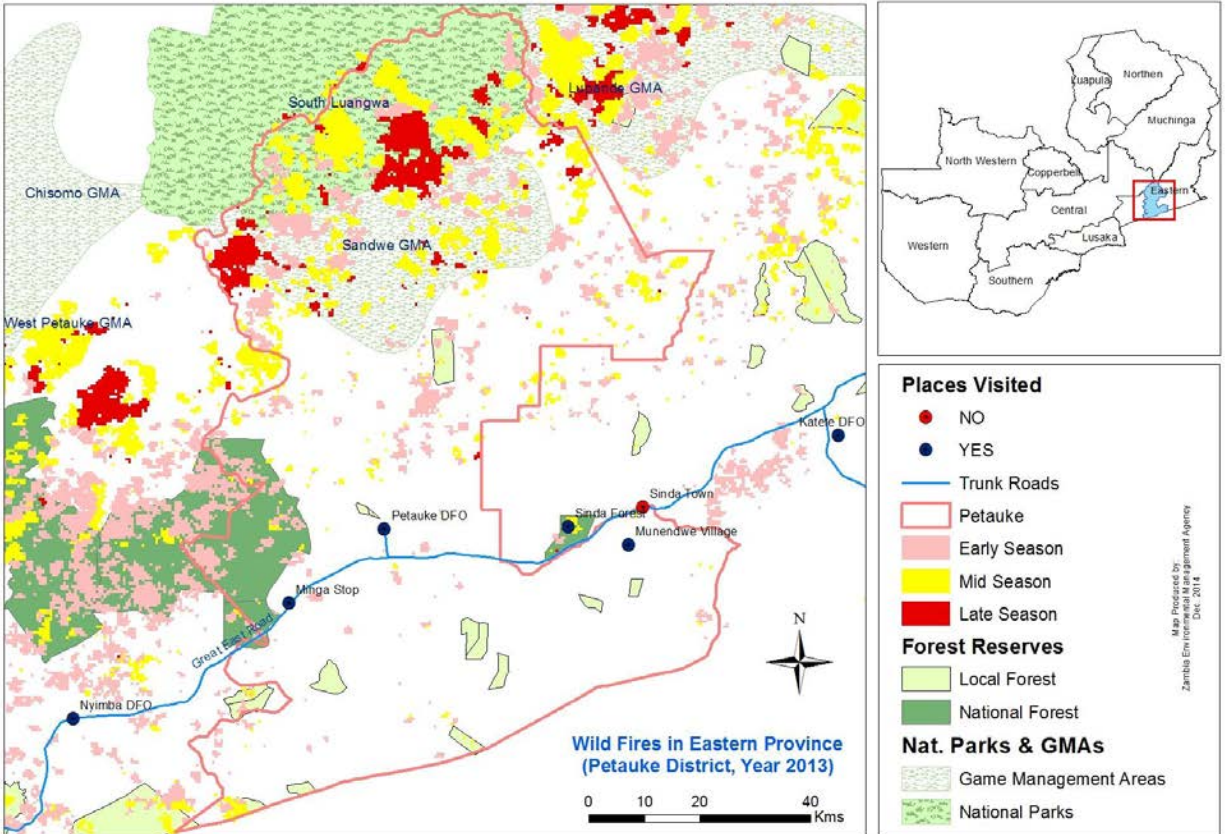


Figure 23. Meeting locations in Petauke District (light red line indicates old Petauke District boundary).

Petauke District Forestry Office

Stakeholders: Lottie Katebe, District Forestry Officer (Zambia Forestry Department)
 George Mwanza, Community Markets for Conservation (COMACO)
 Mathews Phiri, Zambia Wildlife Authority (ZAWA)

Uses and Seasonality of Fire

1. ZAWA officers participate in some early season burning in May through June to promote grass growth for wildlife; they also believe it reduces the tick population (cited Mosi-Oa-Tunya National Park in Livingstone where fire was excluded for five years and the tick population increased). ZAWA does not burn as many hectares as in the past, as they have diminished capacity (training and funding) to do so.
2. The Forestry Department burns their plantations but otherwise does not conduct prescribed burning.
3. Fires are started early in the dry season (May and June) to promote grass growth for grazing livestock.
4. Community members will burn to expose holes while hunting mice. Most often agriculture fields are burned, but the fires may spread to adjacent forests. Burning associated with mice hunting is most commonly done following crop harvest in July.

5. Fire is used to clear grass and shrubs while hunting small game such as rabbits and impalas, and to provide a clear view and enable easier hunting with dogs.
6. Fire is used to burn crop residues, generally September through October.
7. Villagers burn to clear an area, which may occur any time during the dry season.
8. Villagers will burn an area to scare snakes away and make them easier to see.
9. Fires are used for cooking and heat.
10. Poachers burn to clear brush and surface fuels.

Observations

- ZAWA personnel try to burn when the grass is moderately cured in order to control fire intensity while still allowing its spread in the chosen area. Officers for ZAWA conduct early burning while patrolling the GMAs.
- There was an interesting discussion regarding the importance of using fire as a management tool versus complete fire exclusion. ZAWA officers discussed how important fire is as a tool to promote different species, specifically for wildlife habitat.
- Some community members will establish a firebreak around their homes or farms using hoes and axes while others will blackline (remove combustible fuels) around their field or home.

Sensitization and Education

While it is illogical to remove fire from the landscape, it is possible to minimize its negative effects by burning early in the dry season and properly managing fire to keep it within a defined area. It was noted that clear objectives need to be developed for effective fire management, as fire exclusion is not considered an effective strategy. Considerations should include: Where is fire useful and beneficial? What areas are not suited for prescribed fire (such as agroforestry fields)?

Sensitization efforts should focus both within and outside protected areas including communities located near protected areas. The officers felt the local communities would benefit from education about the effects of fire and greater understanding of the best conditions to burn agriculture fields. COMACO has provided sensitization about the potential effects of late season fires through traditional leaders, but there is the need for consistent, widespread sensitization efforts. Community Resource Boards (CRBs) exist in each of the protected areas, which provide a natural conduit for future sensitization efforts spearheaded by ZAWA and Forestry Department personnel. COMACO currently engages the CRBs to educate the surrounding communities on prudent management of natural resources.

Challenges

- There are few firebreaks within the district on any lands, with the exception of some firebreaks surrounding agriculture fields (specifically areas managed in agroforestry). Protected areas have few firebreaks as the agencies lack manpower and equipment to install and maintain them. In the 1980s, firebreaks existed in many national parks and GMAs in the district and the officers would burn these areas early in the season (May and June). There was also formal training in fire management. At this time, there was only one

agency; since then, however, forestry, wildlife, and fisheries have been split into separate agencies.

- There are no boundary markers designating lands in protected areas, so encroachment is a continual problem. This has also led to increased fire occurrence in these areas.
- The officers felt that local community members do not really understand the effects of their burning, which can lead to uncontrolled and damaging fires. They do not often properly manage their fire, but instead tend to light it and move on.
- The officers respond to escaped fires within the district, but often the fire is too big for successful suppression efforts. They feel they do not have enough personnel or adequate training and equipment. In open areas, fire suppression is the responsibility of the Forestry Department.
- Fire management is well enshrined in both the Wildlife Act and Forests Acts, but they both lack implementation and enforcement. Both ZAWA and the Forestry Department would benefit from formal fire management training and more available equipment.

Minga Stop Village

The team met with Haggai Banda, a community leader.

Uses and Seasonality of Fire

1. The first people burning every year are generally hunting mice (Figure 24). This occurs in July following harvest and people of all ages participate.
2. Hunters scouting for rabbits and other game will burn the bush to improve hunting conditions.
3. Crop residues are often left in the field and then the fields are grazed by cattle. The fields may then be burned to prepare for planting after the cattle have grazed the residues.
4. Some communities will blackline around their village to help defend against unwanted fire. This will often be accomplished at dusk as they are very cognizant of weather and wind; therefore they wait until conditions are right to light a low intensity backing fire. They will use beaters (green branches) to manage or herd the fire when they burn around the village for protection.
5. Uncontrolled fires approaching the village are a common problem. As flame lengths and fire intensities are often such that villagers cannot directly fight these fires, village members will generally light a fire around the village to create a burned buffer.
6. Fire is used for cooking.
7. Some people will light fires while collecting honey and occasionally these fires will escape.
8. Some people light fires just to watch them burn.
9. Fires sometimes escape during charcoal production.



Figure 24. Mice hunters in Petauke District. Photo by C. Ferguson

Observations

- Mr. Banda noted that fires are destroying many small trees, as well as animals that get trapped by fire. He stated that most people who start fires do not manage them but let them burn indiscriminately. He also noted that fires burn during the entire dry season; it often dries out very quickly in this area following the wet season.
- Firebreaks are often installed with hoes around personal vegetable gardens. Most of the gardens lie along rivers and streams.
- Usually fields are not blacklined as they are often too close together.
- Many will burn wet leaves when they collect honey, as they produce copious smoke but minimize chances of fire escape.

Sensitization and Education

There are some formal rules in place that dictate punishments when fires cause damage, of which local communities are aware. For example, if a fire damages a house, the individual responsible for the fire will be arrested and taken to the police. For a lesser crime such as burning a garden, that individual may be banished or ordered to make a payment of a goat or chicken to the field owner as directed by the headman or chief.

There has been little interaction with Forestry Department extension officers, but Mr. Banda felt that any sensitization efforts would be well received within the community. While there is currently no community nursery, there was interest in establishing one.

Challenges

- Grass for thatch is often collected in March and April before it has fully matured. However, if the community members wait to harvest the grass when it is taller they risk losing this resource to fire.
- The village is running out of available wood from the forest, such as the long roof poles needed to reroof houses. Most of the available trees are too short to span the length of the roof.
- Many trees are lost to charcoal production. (Mr. Banda suggested that there are intriguing alternatives available, such as charcoal produced from corn cobs.)

Sinda District

Sinda District is a new district created in February 2012 by the President. An official boundary map has not been created yet. This district is located between Petauke and Katete Districts and has been carved from a portion of each of these districts. Its capital is the town of Sinda.

In Sinda District, the team met with forestry officers at Sinda National Forest and stakeholders at Munendwe village (Figure 25).



Figure 25. Locations of Sinda National Forest and Munendwe Village and previous boundary (light red line) of Petauke District.

Chimtengo Forest Station

Chimtengo is the headquarters for the Sinda National Forest (approximately 3,534 ha). There is a mill at Chimtengo to process logs cut from plantations on the national forest; nearby plantations are planted with eucalyptus (*Eucalyptus grandis*) and pine (*Pinus kesiya*). The majority of the area within the Sinda National Forest is managed as miombo woodlands dominated by *Brachystegia speciformis* and *Julbemardia globiflora*. The Sinda National Forest is surrounded by both private and community lands.

The team met with Lydia Luatula, District Forestry Officer for Sinda District.

Uses and Seasonality of Fire

1. Early burning occurs on the national forest from May through July in the indigenous forest and mature plantations. The main goal is to reduce fire intensities later in the summer when the community members most frequently burn the bush (August through October). National forest personnel work hard to control fire intensity by burning in the morning or evening when the temperature is lower and relative humidity is higher. They use beaters (green branches) to help manage the fire. The burn units are compartmentalized with firebreaks to allow for effective control.
2. Many villagers burn their own lands early in the dry season.
3. Local people burn to make it easier to see burrows while hunting mice. This practice occurs inside and outside the national forest boundary.
4. Villagers burn to keep footpaths through the national forest clear of vegetation and provide easier access for cattle.
5. Fire is used for traditional bee keeping. Smoke produced from burning wet leaves is used to sedate the bees allowing for the collection of wild honey.
6. Fires spread onto the national forest from surrounding agriculture fields.
7. Children will sometimes light fires on their way to school for entertainment.
8. Some community members' burn portions of the national forest including the plantations as an act of revenge. This has been noted in cases when trees that were illegally harvested, such as mukula (*Pterocarpus chrysothrix*), have been confiscated by the authorities.

Observations

- Precipitation during the wet season can be highly variable which affects the timing of early burning. Forestry Department personnel carefully observe fuel moisture to determine the best time to burn.

- Firebreaks are used within and around the plantations to create compartments. They are annually installed with hoes (scuffed). A strip of *Gmelina aborea* has been planted between the firebreak and plantation. This hardwood species produces minimal litter.
- Portions of the national forest boundary are blacklined to create a buffered strip with lighter fuels to halt or slow the spread of fires moving onto the national forest. This method is less expensive than installing firebreaks.
- The team noticed recently burned areas in the forest and plantations (Figure 26). We learned these fires were set by adults and children from local communities.
- Plantations with young trees are annually weeded to reduce surface fuels.
- Poaching has not been an issue here.



Figure 26. This recent fire within the Chimtengo plantation on the Sinda National Forest was caused by an arsonist. About 10.2 ha of newly planted trees were scorched. Photo by L. Hollingsworth

Sensitization and Education

Community members are included in early burning activities and are offered incentives including grazing and water access on the national forest for their livestock. Villagers are allowed to collect NTFPs such as fruit, wild honey, and mushrooms from the national forest for free. The Forestry Department is promoting the use of beehives to minimize the risk of escaped fire in the forest. Community members may be permitted free lumber for funerals or building outhouses and “off-cuts” from the mill for building structures and other uses.

Forestry Department personnel have engaged in the past in sensitization of local community members with respect to responsible fire management. Recently 17 headmen participated in a meeting learning about the dangers of fire. These education and outreach efforts typically occur in April prior to commencement of the early season burning.

Ms. Luatula felt that formal fire management training would benefit Forestry Department staff and community members that work as casual hires on the national forest.

Challenges

- Adequate fuel for transport of Forestry Department staff can be an issue.
- The Forestry Department suppresses easily accessible fires but lacks the resources (equipment, training, manpower, and transportation) to manage more remote fires that occur on the national forest. Lack of personnel is considered to be a major issue with respect to fire management. The national forest heavily relies on neighboring communities to help manage fires.
- Locals are not well educated or informed when it comes to the negative effects of uncontrolled fires. As a result, fire is often used indiscriminately and strategies for management or control are not given much thought.

Munendwe Village

This meeting was held at Kafunde Community School and attended by the village headman, Mr. Frackson Phiri, the village secretary, Mr. Febiano Banda, and approximately ten villagers including members of the Health Post Committee and male and female farmers. There are about 1000 people in the village. Community members farm maize and cotton and raise cattle, pigs, and goats. Fire has been used for hundreds of years by local inhabitants.

Uses and Seasonality of Fire

1. Fire is used for burning piled crop residues in October and November, but villagers are often not concerned for where the fire spreads.
2. Hunters will set fires when hunting small game such as rabbits in July and August to improve hunting conditions.
3. Fire is used to expose holes in the ground (burrows) while hunting mice.
4. Community members will burn to promote new grass growth for livestock in July; fire intensity is moderate at this time, as the herbaceous fuels are only partially cured.

Observations

- The grass is generally too moist to burn in April through June.
- Village representatives have noticed that fire can be harmful to natural resources, wildlife, and livestock.
- There is very little game in this area, so they are not concerned with stimulating grass growth for wildlife but will light fires to stimulate grass growth for livestock as indicated above.

Sensitization and Education

The Headman has instructed each household to clear burnable debris from around their houses during the dry season (Figure 27). Many communities create firebreaks around their homes to protect their property; homes are quite susceptible as most have thatch roofs and fences of wood or grass.

Fire is generally discouraged in the community; rules have been developed around its use and penalties established for its misuse. These traditional rules discourage burning the bush and an offender may be taken before the chief or banished. It was stated that most community members are very respectful and would not set fire to the bush or next to an agricultural field.

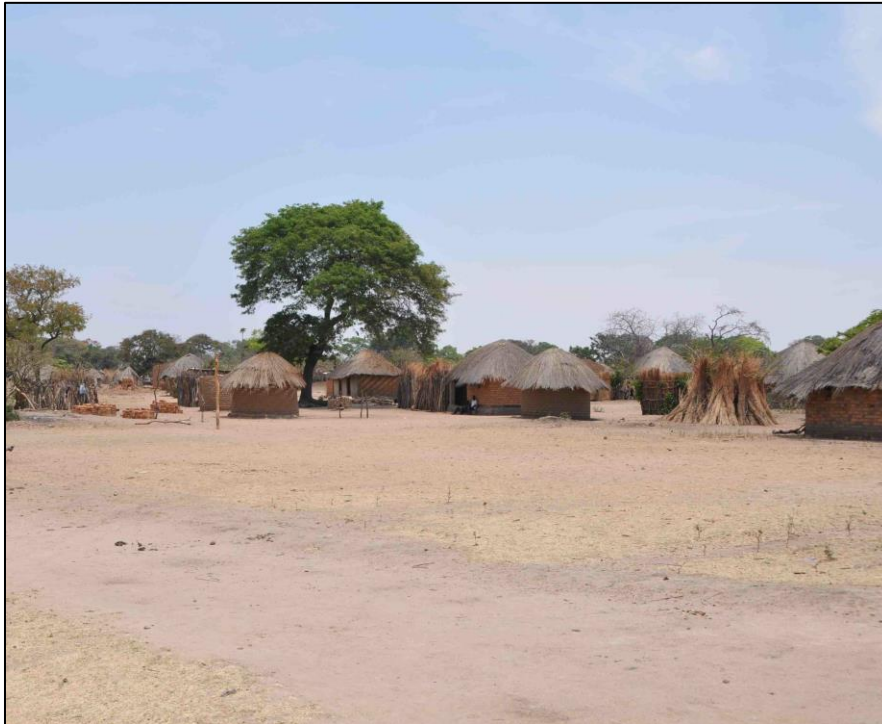


Figure 27. Some defensible space surrounding Munendwe village and the traditional thatch roofs prevalent through much of Eastern Province. Photo by D. Johnson

Challenges

- Fire can burn the grass before it can be harvested to use as thatch for roofs.
- Occasionally a fire will sweep through the fields prior to harvest from outside the village. The entire village will work to suppress this fire using beaters (green branches).
- Some people do not obey the traditional rules and will start a fire, especially children hunting mice.

Katete District

Katete District occupies a total area of 3,989 km² and has a population of 243,849 people (2010 estimate), of which 91% live in rural areas. The district is predominantly occupied by the Chewa People under the Paramount Chief Kalonga Gawa Undi with a number of sub-chiefs that manage various clans in the district.

The main economic activity is agriculture including cotton, maize, beans, groundnuts, and sweet potatoes. Cotton is grown as a cash crop while groundnuts, sweet potatoes, and beans are generally grown for household sustenance. Maize is grown as both a cash crop and for household sustenance.

Livestock production is also a common economic activity including raising goats, cows, chickens, and pigs.

In addition to Katete National Forest, there are seven local forests (Chindindendi, Mulodzela, Matanda, Mpangwe Hills, Chiulukire East, Chilukire West, and Lunga Hills) totaling approximately 17,500 ha in the district. Due to staffing shortages, the local forests are not often visited by Forestry Department personnel. Due to this failure to visit the local forests, the local forests face various forms of degradation including encroachment, illegal harvesting of wood forest products, charcoal production, and uncontrolled fires. There are no national parks or GMAs in this district.

In Katete District, the team met with multiple stakeholders at Katete District Forestry Office and Mindola Forest Station (Figure 28).

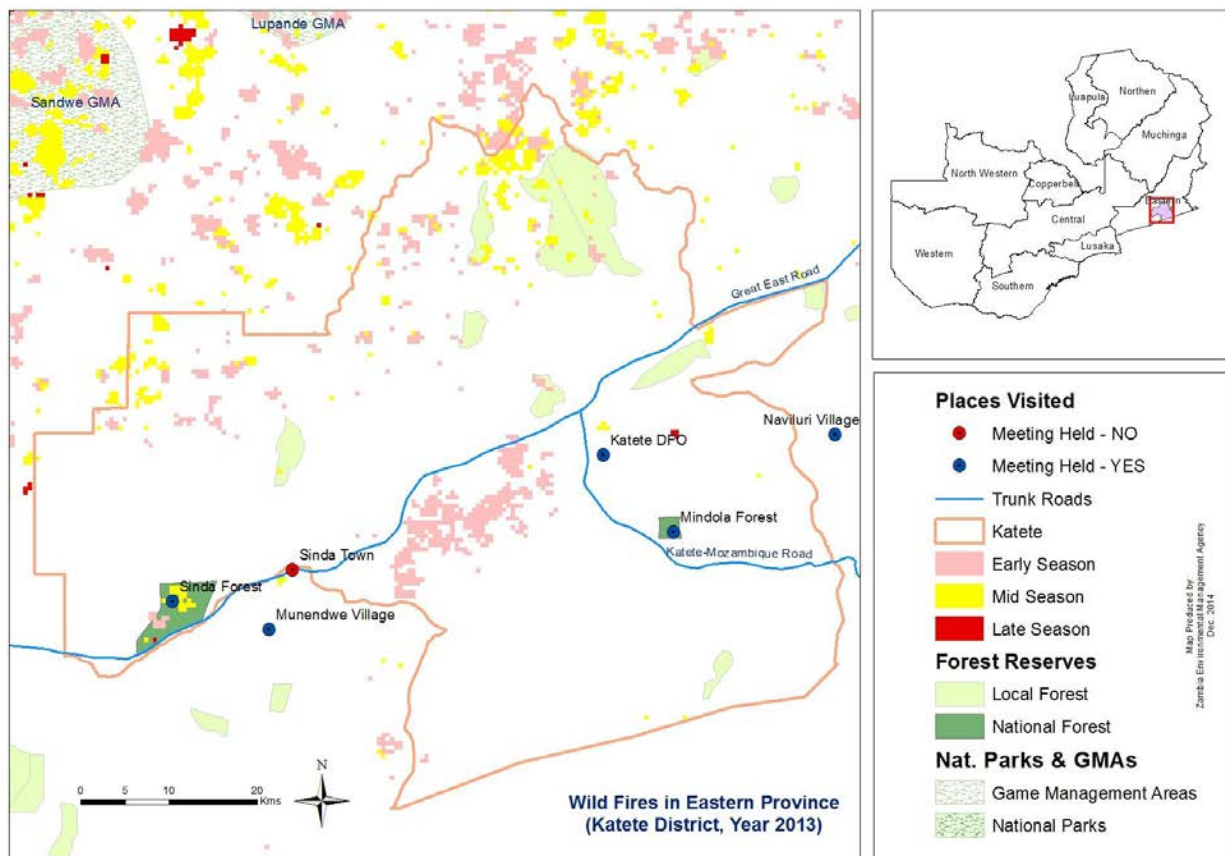


Figure 28. Meeting locations in Katete District

Katete District Forestry Office

The Katete National Forest is approximately 567 ha and includes the Mindola Plantation which covers an area of 84.2 ha (Figure 29). The plantation is planted with eucalyptus which grows better in this soil type than pine.



Figure 29. Managed eucalyptus plantation on the Katete National Forest. Photo by L. Hollingsworth

Stakeholders: Zebron Chitotobwe, District Forestry Officer (Zambia Forestry Department)
Gift Nyawali, Forestry Technician (Zambia Forestry Department)

Uses and Seasonality of Fire

1. Early burning is conducted on the national forest from May through July. Forestry Department burns patches of vegetation in hopes this will reduce future fire intensities should a late season fire burn onto the national forest.
2. Fire is used to promote new grass for cattle. This is generally done in July although some small patches are burned early in the dry season
3. Villagers set fires to expose burrows while hunting mice, this occurs throughout the dry season. For the most part this activity is focused in the agriculture fields, but the fires are typically not managed and therefore spread to adjacent indigenous forest or plantations.
4. Fire is used to burn crop residues to prepare fields for planting.
5. Poachers use fire for hunting small game. This is especially true for those hunting with dogs rather than rifles; the dogs chase the game that run from the spreading fire.

Observations

- The indigenous forest is most often affected by fire as the plantation is surrounded by firebreaks which offer some protection. From the description by Forestry Department personnel, late season fires can best be described as mixed severity fires, often having small patches of complete tree mortality.
- Most community members rely on grass for thatching their roofs.
- Community members will also work to suppress any uncontrolled fires outside of the national forest using beaters.

Sensitization and Education

There have been efforts in the past looking at potential for joint forest management involving both the Forestry Department and local communities. Most felt there were tangible benefits to both parties. While these were considered successful ventures, some community members felt they should have been compensated for their participation; this remains an issue for consideration when planning future activities in collaboration with communities.

The Forestry Department used to engage in fire management sensitization in local communities; however this is no longer being done extensively due to lack of funding, shortage of personnel, and lack of vehicle transport for forestry employees. While active, the sensitization was very effective. Despite the more recent cut in resources, there is still effort under way to engage chiefs and headmen on matters related to fire management; consequently there has been a reduction in the number of fires that affect villages and food storage facilities. Sensitization efforts should continue and must include the chiefs and village headman, as they are the foundation of the traditional social hierarchy. Of note, even with sensitization efforts, there have been many accidents, such as uncontrolled fire burning homes or crops, as people are not properly informed about how and when to start and control fires. Forestry Department personnel feel that most community members respond well to outreach efforts.

Challenges

- The Forestry Department is tasked with fire management in the district but they lack capacity to adequately fulfill this mandate (not enough vehicles, fuel, or personnel). Thus they are not able to engage local communities in sensitization efforts about how and when to use managed fire.
- Forestry Department personnel acknowledged that late season fires in September and October often affect the national forest. These fires often kill trees.
- Fires have burned maize storage areas in communities.

Mindola Forest Station

The team met with Paul Zulu (Figure 30) who works as a forest guard.

Uses and Seasonality of Fire

- Crop residues in adjacent agriculture fields are burned in September and October; these fires occasionally burn by accident onto the national forest.
- Sometimes fire spreads onto the forest from crop fields where community members hunt mice by burning to expose the burrows. There is not a lot of mouse hunting on the Katete National Forest.



Figure 30. Team member Sylvester Siame (in red) with Zebron Chitotobwe (next to Sylvester) and Paul Zulu (behind, with ax). Photo by L. Hollingsworth

Observations

- Approximately 14.2 km of firebreaks are annually maintained in April within the plantation by scuffing with hoes. This breaks the plantation into compartments and has been quite successful in protecting the plantations from uncontrolled fire.
- Competing vegetation (shrubs and understory species) within the plantation is slashed, some of which is used to heat local prisons. Local villagers are also allowed to collect this slashed vegetation as fuelwood and poles for construction. They either pay a fee or exchange labor in the form of firebreak maintenance and provide their own tools. By having villagers collect competing vegetation within the plantation, this reduces the impacts to the indigenous forest.
- Villagers also participate in conducting early burning and creating a firebreak around the national forest, and in turn, they are allowed to collect NTFPs.
- There are two technicians that work on the national forest. Their mode of travel is either bicycle or foot. They routinely patrol the national forest about two to three days per week looking for fires or illegal activities and generally drive intruders away with slingshots. If a fire is found burning within the national forest they use beaters to suppress it.

Sensitization and Education

The Forestry Department would like to conduct early burning in the plantation rather than slashing, as they feel it would be a more effective means to moderate fire intensity later in the dry season should a fire spread into the plantation. Also, the District Forestry Officer commented that non-native eucalyptus becomes tolerant to fire over time if routinely exposed to fire. The team suggested they work with the local community to gather the slashed fuel prior to early prescribed burning. This allows fuelwood for the villagers and reduces surface fuels within the plantation which would decrease fire intensity during prescribed burning. This could be accomplished in April when the firebreaks are maintained.

Challenges

- There is a critical lack of transport, fuel, and manpower for Forestry Department personnel.

Chadiza District

Chadiza has a population of 107,327 people. Approximately 97% live in rural areas. Chadiza had an area covering 2,574km², but part of this has been delineated to form Vubwi District. Chadiza District is mainly an agricultural district growing maize and tobacco, which is mainly a cash crop.

Chadiza District has four local forests (Kazimuli, Kadamnuzu, Chikanga, and Chamchenga East) covering a combined area of 9,181 hectares. When district lines were redrawn, Nzewe South National Forest (approximately 21,092 ha) became part of Vubwi District. However, neither the national forest nor the local forests have a Forestry Department presence on the ground. Thus there has been rampant illegal harvesting of mukula trees that are smuggled out of the country through the Malawi and Mozambique borders.

There is an “out-grower scheme” that tobacco companies use to provide farmers with the seed, chemicals, and training required to produce a tobacco crop. The farmer is responsible for preparing the site/nursery and growing the seedlings, transplanting the seedlings, and growing the actual crop. Fire is used to sterilize the soils before planting tobacco and then later used in the kilns to dry tobacco after harvesting. Kadamnuzu Local Forest has been almost completely depleted of trees as it is surrounded by tobacco farms. However, Forestry Department personnel have commenced sensitization programs for tobacco growers including tree planting and nursery preparation skills to ensure they will have wood for their tobacco kilns and help reestablish the degraded forests.

Though fire is used for hunting mice, people in the district also catch mice using traps. They use a torch and containers to catch the mice, but do not set fire to the landscape. While these methods are less effective for hunting mice, they are not as destructive to the environment.

Charcoal is commonly produced in the district. This has not been a major source of uncontrolled fire and exacerbates deforestation. The top soil around the charcoal kilns is used to cover the kiln, and the cleared area acts as a firebreak. The adjacent forests have closed canopies and very little undergrowth for fires to effectively spread.

In Chadiza District, the team met with officials at Chadiza District Forestry Office and stakeholders at Chitsadzi village in the Naviluri area (Figure 31).

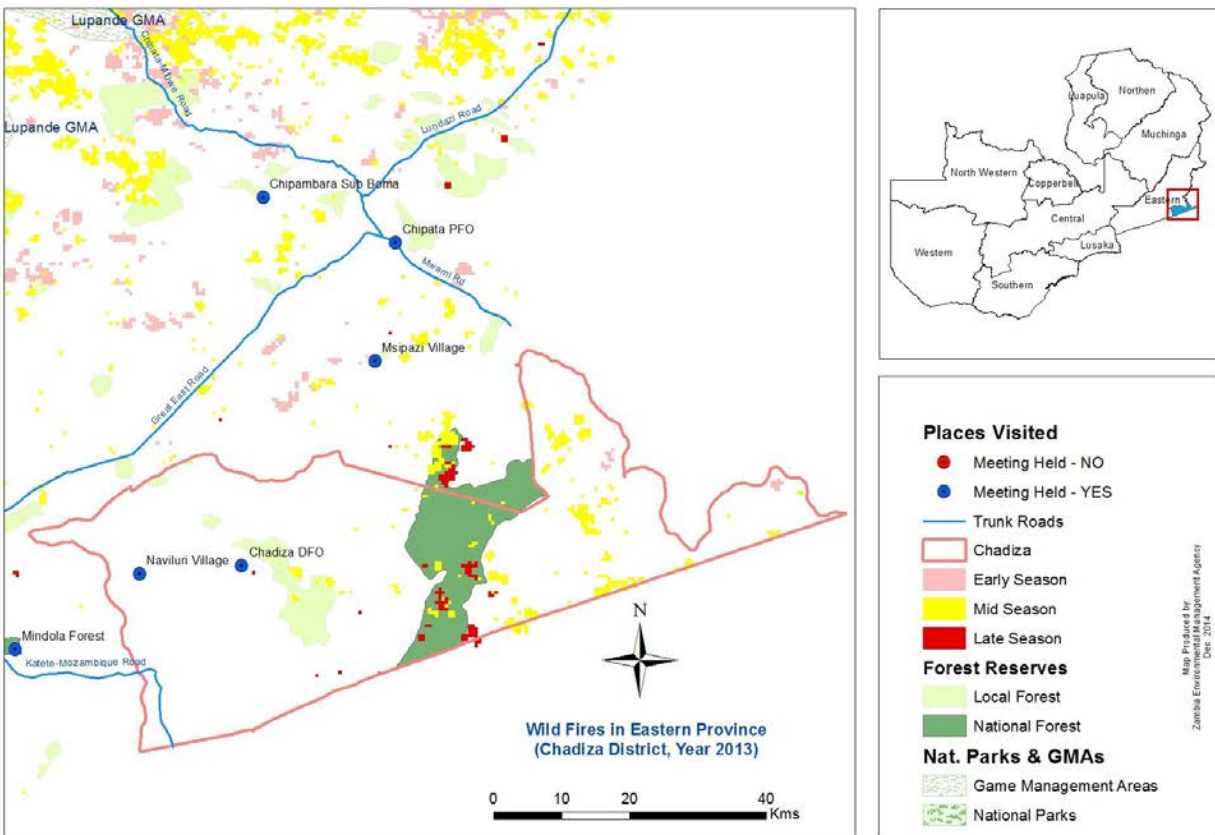


Figure 31. Locations of meetings in Chadiza District

Chadiza District Forestry Office

The team met with Charles Banda Mchotsa, District Forestry Officer.

Uses and Seasonality of Fire

1. There is a lot of early season burning in May and June to provide accessibility the rest of the dry season. Evidence of early season burning has been observed in the forest reserves.
2. Villagers will use fire to expose mice burrows when hunting. Villagers typically burn a large section of the bush to be able to chase the mice and hit them when they run. This is typically early in the dry season and traps, racquets, or digging are methods commonly used following harvest in July.
3. Villagers also use fire when hunting other small game, typically with dogs that are used to chase the animals fleeing the spreading fire.
4. Local communities burn crop residues in the agriculture fields.
5. Fires are also set by locals in conjunction with gathering wild foods.

Observations

- Many areas are burned every year so there is very little fuel accumulation.
- Villages cut wood from within the forest reserves, particularly tobacco farmers.
- In some areas the forest reserves have been heavily affected by cutting trees for charcoal production.

Sensitization and Education

Villages keep the area surrounding their houses clean of burnable debris.

There has been sensitization within the district by extension officers, including fire and forest management training, which has proven to be very effective.

Challenges

- Efforts to promote tree planting by farmers on their land has thus far proven unsuccessful.
- The largest challenge for the Forestry Department on the district is the lack of resources including transport, fuel, equipment, and personnel. More personnel and transportation would enable greater focus on sensitizing the local communities on when and how to use fire. The comment was also made that formal fire management training would benefit Forestry Department personnel and local villages.
- There is one plantation in the district managed by the Forestry Department. It is a mix of non-native species including pine (*Pinus kesiya*) and closed canopy eucalyptus (*Eucalyptus grandis*) with some indigenous species. Very few understory species grow under the eucalyptus. The plantation has had little management over the last five years due to lack of transportation.
- Illegal harvesting has been an issue on the district and 200 to 300 illegally harvested mukula logs were recently found, but they were moved by the offenders before the authorities could effectively confiscate them. The authorities lacked access to a truck to

confiscate the logs. There are also challenges with illegal harvesting within forest reserves in conjunction with building roads. Proper permissions often do not occur.

Chitsadzi Village (Naviluri area)

The team met with more than 13 villagers led by Marianna Banda, the Vice Chairperson for the Chadiza District Women's Association (DWA) and sister to the village headman (Figure 32). Also present was Ivis Banda, chairperson for the local section that includes a plantation. There are about five villages in the immediate area with a population of 1,500 people.



Figure 32. Meeting with community members in Chitsadzi village as Ms. Banda (standing) greets team members. Photo by L. Hollingsworth

Uses and Seasonality of Fire

1. Fires are lit by children clearing the vegetation for cattle or burning residues in the fields to smoke the mice out of their burrows. This is typically following the harvest in June. Sometimes the children are just being mischievous.
2. Hunters will light fires year round in both fields and forests while hunting mice and other small animals. These fires are typically not managed and are allowed to burn indiscriminately often resulting in escaped fires.
3. Some people will light fire within the village's plantation or woodlot.
4. Crop residues are burned in the field, any time during the dry season from June through November. Firebreaks may surround the field.
5. Fire is used for cooking.
6. Fire is used for burning refuse.
7. Fire is used for making bricks.

Observations

- The village manages a eucalyptus plantation from which they harvest timber to sell, as well as construction materials for their houses. Villagers maintain firebreaks to protect this resource from wildfires. They also rake within the plantation to remove surface fuels.
- Firebreaks (roads and trails) are maintained around village gardens and homes, which are generally kept clear of all debris. Whenever there is a fire, communities work together to fight the fire using beaters and water if available. Villagers also use tactics such as burning out around the village if there is an approaching fire; this practice creates a burned buffer devoid of fuels between the village and the main fire.
- The community has a woodlot planted with *Gmelina* spp. facilitated by the Lutheran World Federation (LWF).
- Most community members understand they should be cognizant of time of year and weather conditions when they start a fire. They are cautious when burning so the fire does not spread to unintended areas. Many also choose not to burn in the heat of the day.
- The villagers theorize that continually burning the agriculture fields may decrease soil productivity.

Sensitization and Education

Bush fires have destroyed property, including homes. There are also some instances of human and animal lives having been lost due to bush fires. With this in mind, fires are taken seriously. Though people who start fires are sometimes not discovered, serious punishment before the village headman is given to people who are apprehended, and children who start fires are disciplined. If a home is burned, the individual responsible for starting the fire is taken to the police.

Most houses in the district use grass thatching. Collection of this grass usually begins in June when it has matured and the seeds have fallen. All villagers are therefore aware that fires should not be started before grass is harvested. The village headman has established a bylaw that prohibits people from burning the bush until after people have harvested their crops and grass for thatching houses.

There have been trainings by the Forestry Department on building firebreaks, and sometimes they will blackline their fields. The villagers commented they would benefit from sensitization efforts to better understand the best time of year to burn and different ignition patterns. Ms. Banda was intrigued about the effects of fire on the local environment including biodiversity, wildlife, and specific natural resources. There is a need to educate community members to further their understanding of some of the benefits of fire to natural resources, as well as the negative consequences.

Challenges

- Many fires are set at night when most people are sleeping; but often these fires are not managed or monitored. People burn at night to minimize fire intensity, as they were taught this practice by the Forestry Department.

- Late season fires are most likely to impact other villages; often the person responsible for setting late season fires runs away if they realize they cannot control the fire they have set. Escaped fires occur frequently during the months of September and October. There have been fatalities as a result of these uncontrolled late season fires.
- Destructive fire often results in people having to harvest trees in order to rebuild fences, huts and other structures. This contributes to local deforestation.

Chipata District

Chipata District hosts the provincial capital and most of the government offices. It has a population of 455,783 (2010 estimate), the highest in the province, and covers an area of 6,693 km². Approximately 74% of the people in the district live in rural areas and are dependent on agriculture activities including growing maize, cotton, and sorghum.

Chipata District has 27 forest reserves including two national forests and 25 local forests; the total area in forest reserves is 48,900 ha. Many of the forests near towns are highly degraded due to farming and charcoal production. ZAWA has no protected areas within Chipata District.

In Chipata District, the team met with officers at the District Forestry Office and traditional authorities at Msipazi plantation and Kasosa village (Figure 33).

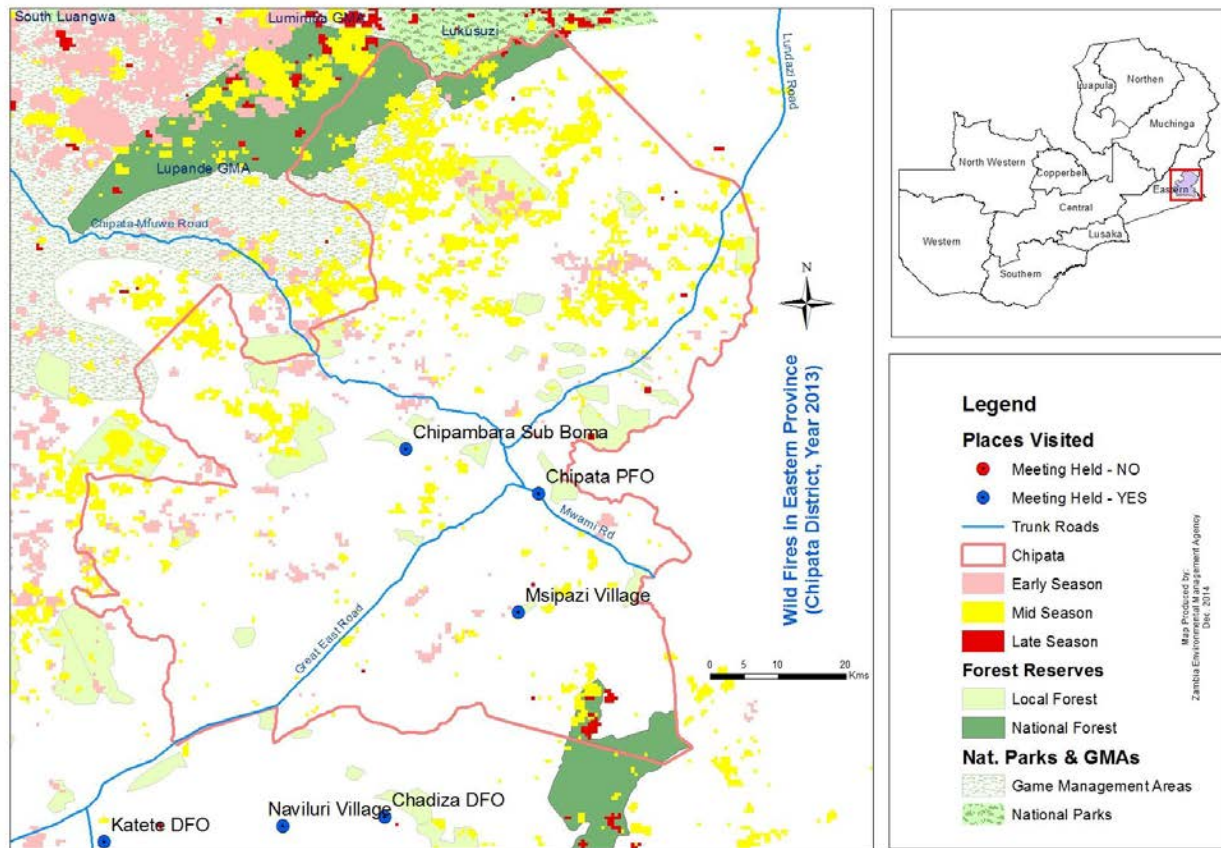


Figure 33. Meeting locations in Chipata District.

Chipata District Forestry Office

Stakeholders: Lamek Zulu, Ranger (Zambia Wildlife Authority)
Emma Sakala, Acting District Forestry Officer (Zambia Forestry Department)
Foster Phiri, Regional Coordinator (Community Markets for Conservation)

Uses and Seasonality of Fire

1. The Forestry Department conducts early burning in two local forests that have plantations once the trees are a few years old. They usually include local communities in these burns. The grass often recovers sufficiently by September to carry fire again.
2. Traditional honey harvesting using leaves and grass to produce smoke occasionally start uncontrolled fires.
3. There are many late season fires in some of the local forests, usually set by people hunting mice or poaching. Many people who hunt with dogs light fires so the dogs can catch the animals fleeing from the flames.
4. Communities living adjacent to forest reserves light fires that spread to the forest reserves with very little or no control. These are mostly started in the late season (September to November) and often damage newly planted seedlings in the plantations.
5. Arson is another cause of fire in Chipata District.

Observations

- Plantations are a mix of pine (*Pinus kesiya*), eucalyptus (*Eucalyptus grandis*), and a few other species such as *Gmelina aborea*. Firebreaks separate the plantations into compartments. Weeding takes place when the trees are first planted.
- Masupe and Msipazi Local Forests have fire management plans.
- Schools have been provided with wood products from the forest reserves as a community benefit.

Sensitization and Education

There are many benefits to the local communities from the forest reserves, including hunting, gathering mushrooms, and honey production. COMACO has developed sensitization programs focusing on small groups of 15 to 20 people and educating them on the numerous benefits they may receive from the forest reserves. COMACO's use of nitrogen fixing tree species in agro-forestry practices mean that fire is no longer used to clear and prepare fields.

Many local people grow groundnuts and collect honey and sell these products to COMACO. COMACO provides modern beehives and tree seeds along with the necessary education working through Community Resource Boards (CRBs). The locals have an investment in helping to protect the forest and provide information on poachers. A decrease in fire activity has been noted, which can perhaps be correlated to the fact that COMACO pays higher prices for honey and groundnuts in areas with low fire activity but lower prices in areas with high fire activity. This approach has been successful as it gives the village ownership.

COMACO provides incentives for villagers who turn in their guns or snares typically used for poaching animals. They are rewarded by being appointed a special position, such as lead forester, or being able to attend trainings. The more guns or snares they hand over, the greater the benefits received. They also can be denied access to market for honey or groundnuts if they are caught poaching, producing charcoal, or engaging in other illegal activities.

An MOU (memorandum of understanding) is being developed between COMACO and the Forestry Department in the Mphomwa Forest Reserve, called the Joint Forest Management Program. This is in part a result of the Forestry Department's recognition that there needs to be a stronger link with communities with respect to sustainable forest management, conservation, and fire management. This MOU includes an initiative to relocate people who are either currently living in unproductive areas or and/or who are heavily involved in charcoal production to other areas that are more productive, so that they can earn a living in a way that is not so destructive to the environment.

Communities benefit from NTFPs found in the indigenous forests. People often focus on obtaining food in the short term; as a consequence, they do not always completely understand the negative implications that uncontrolled/unmanaged fire can have on these NTFP resources. The Forestry Department feels that sustained and long-term fire management sensitization in communities would be very helpful in addressing this and other fire related issues.

Challenges

- COMACO indicated a lack of personnel in the field as a critical problem in successfully implementing programs.
- Lack of funding, transportation, and equipment were cited as constant issues within the Forestry Department and ZAWA. There is also no formal training in fire management beyond the limited classroom training received in the university program.
- Late season fires often heavily impact wildlife.
- Within ZAWA, there is one member of staff (in Mfuwe, shared between Chipata and Lundazi Districts) who is responsible for fire management in the GMAs and national parks.
- The Forestry Department engages in fire management in two forest reserves, but the remaining 25 are virtually unstaffed.

Meeting with Traditional Authorities at Msipazi Plantation

The Msipazi plantation is located within Msipazi Local Forest. The team met with numerous local leaders, farmers, and teachers (Figure 34).

Stakeholders: Fidelis Chileshe Musonda, Officer in Charge at Msipazi plantation
Alikangelo Zulu, Headman (Yonke Village)
Friday Jere, Headman (Mshawa Village)
Ignatio Banda, Headman (Kempala Village)
Raphael Banda, Headman (Soko Chimwala Village)
Michael Mbewe, Representative (Kunkuli Village)
Peter Zulu, Nduna (Yonke Village)
Rodgers Moyo, Head Teacher (Msingo Primary School)

Lyson Zulu, Headman (Chiundama Village)
John Phiri, Nduna (Chiundama Village)
Brother Alfonso Zulu, Farm Manager (St Mary's Catholic Mission)



Figure 34. Meeting with local headmen, farmers, and teachers at Msipazi plantation. Photo by L. Hollingsworth

Uses and Seasonality of Fire

1. Fires are started in agriculture fields following harvest from August through October when hunting mice to expose the burrows, especially by children. These fires often spread to forests.
2. In the early part of the season, fires are started while hunting mice to better expose the burrows.
3. Hunters burn the bush while hunting small animals (especially rabbits) to facilitate greater visibility, generally from August through October. Using fire in this way is a tradition among the Ngoni people.
4. Crop residues are piled following harvest in July and burned in October to prepare the fields for planting.

Observations

- Most fires are started between July and August.
- Occasionally they plow or blackline a 2-meter swath around fields to protect crops. Fields that lack a firebreak are most often the source for uncontrolled fires while people are hunting mice.
- A firebreak is maintained around the Msipazi plantation using hoes.

- If an uncontrolled fire is spotted, the whole village responds. They use beaters and water if available.
- While there is not much burning in the early portion of the dry season, many have noticed that when the grass is burned early (often while hunting small game) the grass responds very quickly and provides better forage. However, early burning can destroy grasses traditionally gathered for thatch. These grasses are collected in June and July. Cattle are often grazed in the same areas used for collection of grass for thatch.
- The farm for St Mary's Catholic Mission allows crop residues to remain in the fields but does not burn the residues. There are two primary reasons for this: 1) the residue provides food for the livestock during the dry season (September and October) and 2) the residue acts as manure when plowed back into the soil during what is referred to as "winter plowing".
- It was noted that burning residue piles during the dry season may affect the guinea fowl, as residue piles can serve as a source of insects and worms for these ground-nesting birds.

Sensitization and Education

Most community members wait to burn until fields have been harvested. If there are any infractions (burning conducted before harvest,) that individual is brought before a community and educated about the effects of uncontrolled fire. If an individual has multiple infractions, that person is taken before the chief. Most often a payment will be negotiated to be given to the owner of the burned field.

It was mentioned that not burning in the forest would result in more forage being available for livestock and wildlife during the dry season months (September and October). In addition, crop residues could be used to feed livestock and then plowed back into the soil rather than burning. The caveat to this approach is that a plow and animals must be available.

The local leaders were very excited for future sensitization efforts. There are some success stories of successful fire management, which need to be more widely shared.

Challenges

- Sometimes fields are burned prior to harvest, often while villagers are hunting mice.
- Some community members' burn their own land without managing the fire and it spreads to neighboring properties, affecting those that rely on the grass to graze their cattle.
- There is also some communal land that people burn without controlling the fire.

Chiparamba, Kasosa Village

The team met with many local leaders from the surrounding villages, as well as David Likokelo, Block Officer for Chiparamba Agricultural Block (Figure 35).



Figure 35. Stakeholder meeting at Kasosa Village, Chipata District. Photo by L. Hollingsworth

Uses and Seasonality of Fire

1. There is some early burning while live herbaceous fuel moistures are high in order to reduce fire intensity and area burned from April through June. This is often to promote new grass for cattle forage. Hoes are generally used to construct firebreaks to contain these burns.
2. Firebreaks are burned early in the dry season.
3. Fire is used for blacklining agriculture fields to protect against unwanted fire.
4. Fire is used for clearing thickets in order to increase visibility.
5. Fire is used while hunting mice to be able to see the burrows. These fires are often uncontrolled and burn far into the bush. Many times, people secretly burn others' property at night under the cover of darkness while hunting mice.
6. When hunting small game, both fields and forests are burned; this is generally when dogs are used to chase the fleeing animals.
7. Fire is used to scare dangerous animals away, such as lions and snakes.
8. Fire is used for burning crop residues following harvest in July, often by blacklining the perimeter first and then burning the interior to warrant against escapes. These fires occur at any time following harvest.
9. Uncontrolled fires can burn into the villages from the surrounding areas. These fires are often damaging and burn crops and dwellings.
10. Fire is used for cooking.
11. Fire is used for warmth (such as during a funeral).
12. Fire is used for making bricks.

Observations

- Recently a fire burned a garden and killed all the trees.
- Beaters are used to suppress fires and water is used if available.
- Grass is collected for thatch in April through June prior to harvest so it will not be burned when the crop residues are burned.
- Sometimes the crop residues are stored to feed livestock, a practice referred to as conservation agriculture (CA); they are not left in the field as there is a high probability they would be burned by mouse hunters.
- Areas to be grazed are often protected from fire.
- Beehives at the local school are protected with firebreaks.
- A firebreak surrounds most villages in the form of roads and trails.
- The community seems aware of the fact that fire can negatively affect NTFPs but are not proactive on this issue.

Sensitization and Education

The villages sensitize early in the season while crops are still in the field. These efforts are especially directed towards children, who are forbidden to burn in the forest. Starting in July, there are also regulations within the villages that debris must be cleared away prior to any burning and that the area around each house must be kept clean in order to provide a defensible space.

Villagers have received some sensitization from Forestry Department extension officers and radio programs in the past. Agriculture and livestock extension agents have cautioned against burning crop residues due to the cumulative effect of adding pollutants to the air that may affect climate change.

If a fire someone has set is known to have damaged another's property, the damages will be assessed and the guilty party will make payment (money or an in-kind payment such as a goat or a cow). Occasionally the police are involved. Often the culprit is not caught.

The group asked whether they were using fire appropriately. The team answered that there is always room for improvement as we would like to diminish the negative effects of fire such as burning crops, houses, or livelihoods being affected. There is need for additional education and training in this area regarding appropriate fire management.

Challenges

- While many fires are appropriately managed, others are not which can cause destruction such as the loss of homes, crops, and gardens.

Mambwe District

Mambwe District has a population of 68,918 (2010 estimate) and covers an area of 5,294 km². About 62,589 (91%) reside in rural areas, and their livelihood is highly dependent on agricultural activities.

South Luangwa National Park, Lupande GMA, and Lumimbe GMA lie within the Mambwe District and cover nearly 70% of the district. Much of the district is managed by ZAWA. Communities are allowed to reside within the GMAs, so there are high levels of animal-human conflict. For instance, elephants have destroyed homes and killed people; conversely, many elephants have been killed, mostly as a result of poaching.

Mambwe District has one national forest (Machinje Hills) covering approximately 68,281 ha and five local forests (Lupande, Mpomwa, Nkanga, Mpoto, and Katakoli East) covering a total area of approximately 22,776 ha. All the forest reserves except Mpomwa and Katakoli East fall within the Lupande GMA.

Mambwe District has very high fire activity early in the early from April through June as shown by satellite data (MODIS fire detection data), though there are also numerous mid-season fires in July and August. Late season fires are also quite common, especially in the southwestern portion of Lupande GMA.

In Mambwe District, the team met with officers at South Luangwa Area Management Unit (Figure 36).

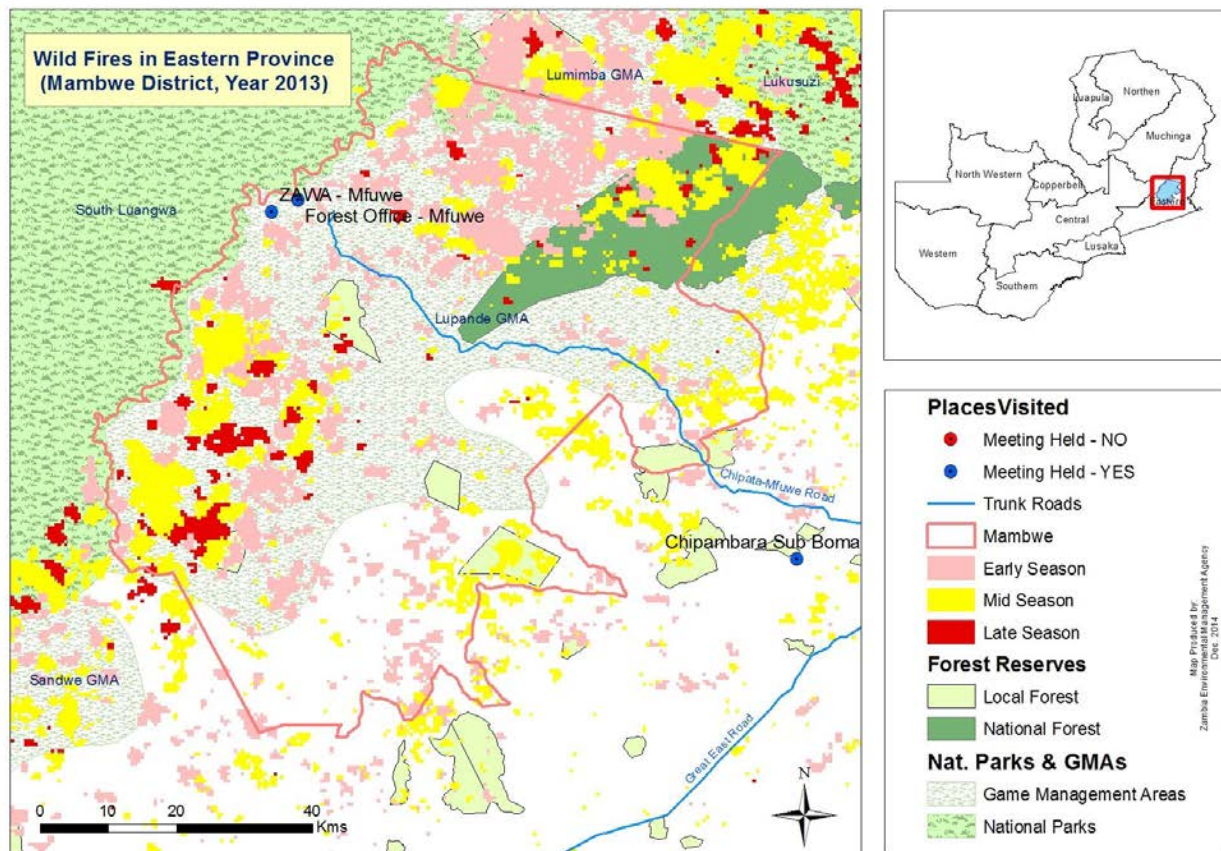


Figure 36. Meeting location in Mambwe District.

ZAWA Regional Offices, South Luangwa Area Management Unit

ZAWA's regional offices in Mfuwe are responsible for game reserves in the Northern, Muchinga, Eastern, and part of the Central Provinces.

Stakeholders: Harry Alfred Phiri, Assistant Manager for South Luangwa National Park
(Zambia Wildlife Authority)
Christopher Gondwe, District Forestry Officer (Zambia Forestry Department)

Uses and Seasonality of Fire

1. ZAWA conducts early burning starting in May, mostly to promote grasses for wildlife browse. They also find that early burning does not affect shrubs needed as cover for animals to give birth. The officers observe fuel moisture to determine the right time to burn, but these activities generally occur from May through July. Late season burns are sometimes conducted by ZAWA to eliminate diseases or pests in the national park, such as anthrax; the late season fires typically are in the dambo vegetation type. Almost all prescribed burning occurs in South Luangwa National Park and very little in the GMAs.
2. Poachers set fires within South Luangwa National Park and the GMAs. Some of these fires occur early in the dry season to attract animals to that area with new grass growth. Late season fires are a strategy used to cover poachers' footprints and catch wildlife.
3. Fires often originate from villages within and adjacent to GMAs. GMAs have the highest fire activity, as they serve as a buffer between villages and South Luangwa National Park. The Luangwa River runs between the GMAs and the national park and serves as a firebreak; as a result unmanaged or escaped fire rarely enters the park.
4. Fires are often lit within the GMA while people are hunting mice to expose burrows or while hunting other animals with dogs.
5. Lodge workers disgruntled with management sometimes start illicit fires. These are generally reported and suppressed quickly.
6. Burning coals left during charcoal production start fires in adjacent vegetation, often in the late season.
7. Fire will spread into adjacent protected areas when crop residues are burned in the fields. People burn the residues to kill termites.
8. When honey is harvested, the tree with the hive will be set on fire to smoke the bees out and this fire is left uncontrolled.

Observations

- South Luangwa National Park has a fire management plan. The plan includes strategies for promoting habitat beneficial to wildlife within the park as a source of forage and refugia. The fire management plan contains detailed information that outlines where burning should occur on an annual basis.
- The ZAWA research department suppresses fires using beaters from September through October.
- Firebreaks compartmentalize units within the national park, and officers wait 15 to 30 days to burn the adjacent unit. The firebreaks are very useful in fire suppression efforts.

- ZAWA does not control noxious weeds within the national parks or GMAs but allows nature take its course. They will control weeds in waterways.
- Lodge owners often report wildfires. This area is a popular location for safaris and therefore tourism remains important to the local economy.

Sensitization and Education

Officers receive some basic classroom training in fire management but no refresher or advanced training. ZAWA felt the officers would benefit from formal training on different strategies and tactics such as installing fireline and lighting fire off this established fireline. Mr. Phiri suggested looking at the curriculum developed by the Nyamaluma Training School in Mambwe that includes training in fire management.

Most people only think about the immediate benefits in the short term when starting a fire. Greater community involvement is needed so that people better understand the effects of fire at different times of the year and develop greater ownership in conserving resources.

Challenges

- While ZAWA does have transportation, they lack equipment such as tools and protective clothing. The Forestry Department lacks adequate transportation. Both are in need of more personnel to be more effective. The protected areas within this district cover a large area.
- Previous sensitization efforts involving chiefs and headmen have had little success.
- Fires often cause destruction of wildlife habitat and breeding areas, especially in the GMAs.

Lundazi District

Lundazi District has a total population of 323,870 people of which 95% live in rural areas (2010 estimates). Lundazi is the largest district in the province covering an area of 14,058 km² with a population density of 23 people per square kilometer. Nearly all people living in rural areas are heavily reliant on natural resources in support of their livelihoods; maize, groundnuts, sorghum, tobacco, and cotton are cultivated. Local people also raise cattle, goats, and chickens. Small scale mining for gemstones is very common among many villagers, though not officially reported in most cases.

The district has five local forests (Lumimba, Lundazi Dam, Chimaliro, Kaluwe, and Ndjovu) covering a total area of 34,598 ha. A portion of the Lundazi National Forest stretches into Chama District. Lumimba GMA and Lukusuzi and Lwambe National Parks fall entirely within Lundazi District as well as portions of Musalangu GMA and South Luangwa National Park. In total, game reserves cover nearly 40% of Lundazi District, predominantly as mopane forests.

Satellite data show evidence of early burning in Lumimba GMA and Lwambe National Parks, but very little occurrence in Lukusuzi National Park. Mid-season and late season fires are rampant in most GMAs and national parks. There is very little fire detected in the eastern part of the district where most of the agricultural activities are centered.

Deforestation is of utmost concern as this district has few intact forests (Figure 37). Forests have been harvested for conversion to agriculture and fuelwood for households, producing charcoal, and firing tobacco kilns. There are Malawian NGOs active in the district that provide tree seeds of multiple species, nursery materials, and education free of charge; these programs seem most effective when there is an individual in the community spearheading these efforts, such as Peace Corps volunteers. The NGOs often include incentives to the village to improve quality of life based on the number of trees planted; more trees planted correspond to greater incentives.



Figure 37. Deforestation is a major issue in most of Lundazi District. Photo taken from Chapulama Village. Photo by L. Hollingsworth

In Lundazi District, the team met with officers at the district forestry office and stakeholders at Vwenku village and Chapulama village (Figure 38).

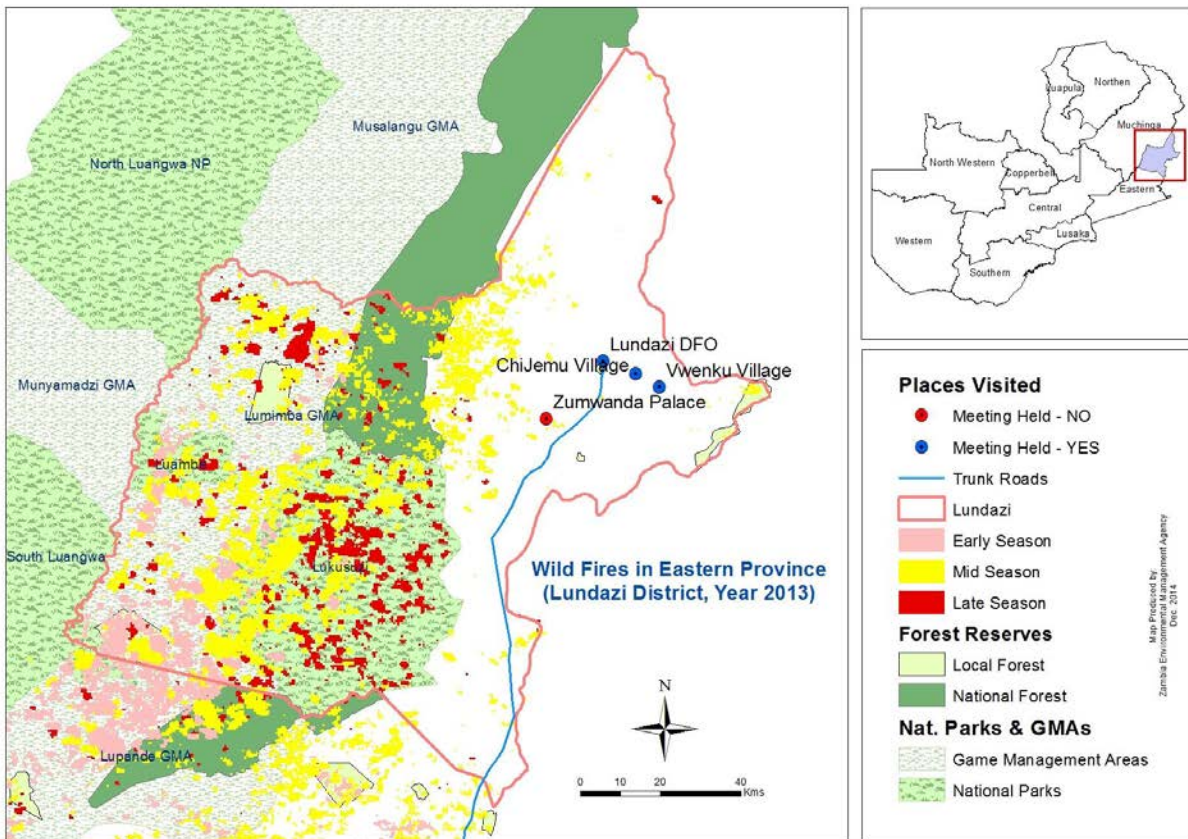


Figure 38. Meeting locations in Lundazi District.

Lundazi District Forestry Office

Stakeholders: Amikena N. Musiwa, District Forestry Officer (Zambia Forestry Department)
Patrick Sakanga, Ranger (Zambia Wildlife Authority)

Uses and Seasonality of Fire

1. The Forestry Department conducts early burning on forest reserves located in close proximity to the town of Lundazi. Their objectives include reducing surface fuels to modify fire behavior of wildfires later in the dry season and promoting regeneration by splitting dormant seeds of *Ricidendron rautenaii* and *Colophospermum mopani*. Since the miombo vegetation tends to have higher canopy cover and is found at higher elevations than mopane, the surface fuels do not cure as quickly so these burns are conducted in June and July.
2. ZAWA scouts conduct burns early in the dry season from April through June. They often burn in a mosaic pattern. Their objective usually focuses on improving forage for wildlife. They do not use firebreaks due to a shortage of personnel but use beaters to stop the spread of fire when necessary.
3. Local communities burn to expose burrows when hunting mice and other small animals. These fires are generally not managed.
4. People burn the bush for personal safety to see wildlife and ZAWA officers. These fires are generally not managed.
5. Fire is used to clear indigenous vegetation to cultivate crops.

Observations

- The mopane vegetation is found in valley bottoms with clay soils and is browsed heavily by elephants. There is not as much grass in this system but surface fuels are adequate to spread fire.
- Late season fires are often linked to the need to procure food for local communities. While it is rare for prescribed fire to spread from a protected area, it is common for uncontrolled fires to spread into protected areas.
- There is one plantation of approximately 20 ha planted with eucalyptus. Firebreaks are maintained annually by scuffing with hoes using casual workers. There is no burning while the trees are young but they will weed surface fuels. Early burning is conducted when the trees are older.

Sensitization and Education

There are Community Resource Boards (CRBs) active in the district and ZAWA provides education on different aspects of fire management. These programs would be more effective if they had more resources. COMACO has also led sensitization efforts in communities. The Forestry Department, ZAWA, and COMACO work collaboratively.

Many villagers burn because of tradition but do not think about the potential consequences. Awareness-based training needs to be conducted, as well as access provided to alternatives to current conventions, including energy saving cookstoves.

Challenges

- The Forestry Department lacks transportation which especially complicates any management activities far from Lundazi. Both ZAWA and Forestry Department have staff shortages and a lack of formal training in different aspects of fire management.
- While fire is important in the regeneration of some indigenous tree species in mopane vegetation (for example, it opens the seed pods of mkusu, *Ricinodendron rautanenii*) there is currently no prescribed burning being conducted. Burning should be conducted earlier (May and June) in the mopane systems, as these tend to dry out before miombo woodlands.
- Encroachment into protected areas has been a problem, especially near Lukusuzi National Park where 150 people illegally inhabit the area. This has also been an issue in Lundazi National Park and in many local forests. People cut trees for fuelwood and to clear fields for cultivation, which exacerbates deforestation. These fields are often productive for a short period of three to four years.
- Officers are concerned about the loss of mopane forests. Mopane are not fire tolerant and are important for wildlife habitat. Some late season fires have burned the stumps so severely the trees fail to coppice. These effects can completely alter the ecosystem. An example was given of a fire that burned within Nsefu Park in Mambwe District; that area is now grassland.

Vwenkhu Village

In Vwenkhu village the team met with 13 headman and leaders from nearby villages, and three women from the Vwenkhu village (Figure 39).



Figure 39. Local headmen from surrounding villages meeting at Vwenkhu village. Photo by D. Johnson

Uses and Seasonality of Fire

1. Fire is used for clearing thickets for better visibility, ingress, and egress.
2. The bush is burned while hunting mice to expose burrows and allow for easier digging; this practice is only allowed after harvest.
3. The bush is burned following harvest while hunting small animals such as rabbits.
4. Fire is used for burning crop residues following harvest which typically occurs in June and July.
5. Fire is used for burning piles of trees to prepare new agriculture fields.
6. Fire is used for burning refuse in pits in the ground.
7. Campfires are used for warmth and safety (i.e. to scare away such animals as lions).
8. Fire is used for collecting wild honey.
9. Fire is used for cooking.
10. Fire is used for bathing.

Observations

- Burning is typically conducted from June through October, following the harvest.
- The local villagers use beaters when an uncontrolled fire approaches their village or agriculture fields.
- Bush paths serve to protect villages from fire. Villages also rely on agricultural fields that surround many villages to help protect against a fire spreading into the interior of the village. No other firebreaks are installed.
- Grass for thatch is generally collected in May and June prior to the agriculture harvest to reduce the chances the grass will be burned.
- Mouse hunting begins at the onset of the dry season in May, but only by manually clearing around the hole and digging. Fires can be used while hunting mice after crops have been harvested.
- Graveyards are considered protected areas that prohibit burning, collecting fuelwood, and hunting. Due to widespread deforestation in the Lundazi District, trees are sometimes secretly harvested from these areas and/or fuelwood is gathered. Transgressors are called before the village headman for punishment if caught.
- Most of the indigenous forests have been harvested for conversion to agricultural fields.
- There is not a lot of charcoal production in the area, as there are few trees. Most of the remaining trees are fruit trees. While the fruit trees in the agricultural fields are protected while burning, they are not protected elsewhere. The team noticed multiple fruit trees outside of fields that had recent fire damage. Villagers consulted indicated it is not worth their effort to protect fruit trees from fire, as the fruit is often stolen.
- There is a young village woodlot around which the vegetation is manually cleared to create a firebreak.
- The villagers wondered about the potential effects to the soil from repeated burning.

Sensitization and Education

There are rules within the villages that the area around each house must be kept clean during the dry season.

The villagers commented that they do not understand how to plant and grow trees. A program has recently been initiated to start a tree nursery within the village which includes necessary education and training. The villagers were intrigued with the idea of planting trees and questioned the team on the best locations to plant trees. Agroforestry has thus far not been embraced. There is one individual in the area focusing on regenerating orange and lemon trees.

There has been little sensitization in the area about how to properly manage fire or the best time of year to burn.

Challenges

- Many fires are not managed and consequently crops and houses may be destroyed. Many houses are burned because refuse is burned in close proximity to houses. Compensation for damages to crops or houses is generally decided within the village but occasionally the police are involved.
- Local people do not readily acknowledge land ownership and will start fires anywhere.

Chapulama Village

The team met with four community leaders (Figure 40).



Figure 40. Meeting in Chapulama Village, Lundazi District. Photo by L. Hollingsworth

Uses and Seasonality of Fire

1. Grass is burned to promote new grass growth, generally from July (following harvest) until the start of the rainy season. If burning prior to harvest, they are generally quite careful and only burn a small section at a time. These early season fires appear to be carefully managed.

2. Fire is used for burning vegetation while hunting mice to better expose the burrows (often by children).
3. Fire is used while hunting small animals, such as rabbits.
4. Fire is used for burning crop residues, generally starting in August.
5. Fire is used for burning refuse, typically at night.
6. Fire is used to heat kilns when making bricks.

Observations

- September and October are typically active burning months. Local villagers often burn in the afternoon when burning conditions allow fires to spread easily and therefore require minimal effort, as the grass is too moist to effectively carry fire in the morning. Community members will often burn regardless of wind and weather conditions and will even stomp fires out in the shrubs if it is not carrying fast enough for their liking; they feel fires burning with quick spread rates are more effective for hunting mice.
- Grass is cut for roof thatch when metal sheeting is not available. This is typically done from May through July once the grass is mature and the seeds have fallen off. Community members are careful not to be late in collecting grass as they risk losing this resource to fire and the grass would then have to be purchased.
- Community members are cognizant not to burn crop residues on another farmer's field, as it is unknown why these residues are being saved. Often these residues are left in the fields to allow cattle to graze on them late in the dry season when grass may be scarce. There have been occasional instances where fields were burned but this is generally considered to be a bad practice.
- Trees (often eucalyptus) are sometimes planted as windbreaks.
- Wood is used for granary foundations (for the storage of maize). Thin strips of wood are woven to form the sides of the granary.
- Some charcoal is made in the local villages.
- It is felt that adults are more careful while hunting mice and will often manually clear an area rather than burning.
- Farmers typically do not have firebreaks surrounding their fields. A bank used to give loans to install firebreaks to those farmers managing areas greater than 12 ha, but this bank is no longer in business.
- If an uncontrolled fire is observed approaching the agriculture fields or houses, the entire village will respond. They will work to suppress the fire using beaters and water if available. Occasionally someone may be injured, but people take care to protect themselves by wearing sacks soaked in water. There has not been a field accidentally burned in more than five years.

Sensitization and Education

Total Land Care, a Malawian NGO, recently provided trees seeds, nursery materials, and education to allow for a tree nursery to be established in the village. About 2,000 tree seeds have been planted in the nursery and if these seedlings can be successfully transferred to create a woodlot of 2,000 trees, the village will benefit with a new ventilated pit latrine installed by the NGO.

Challenges

- Damage to crops and houses has occurred when fire whirls have spread embers outside of the intended area to be burned (this is a whirlwind that occurs in the fire area that allows for embers or firebrands to be blown outside of the area on fire, thus starting spot fires).
- Trees have been stolen by those involved in charcoal production.
- The villagers have noticed that fires occurring late in the dry season often kill regeneration.

Meetings in Lusaka with Ministry Officials and Stakeholders

The team met with various government officials and other stakeholders in Lusaka following meetings in Eastern Province.

Ministry of Chiefs and Traditional Affairs

The team met with Mr. Michael B. Pwete, Clerk for the House of Chiefs.

The House of Chiefs is an assembly of chiefs represented by three elected chiefs per province that meet twice per year to discuss and debate bills that would affect customary or traditional affairs before they are introduced into the National Assembly. The mission of the House of Chiefs is to administer and promote traditional and customary governance systems and preserve Zambia's heritage and culture.

Prior to Zambia's independence in 1964, bylaws stated it was a punishable offense to start fires without official authorization, although early burning was generally considered an acceptable practice. Since these bylaws that regulated affairs at the village level are no longer implemented, the central government remains responsible for regulating fire management. Village development committees used to manage local resources using the bylaws. The government has struggled to take over this role and as a result local resources such as wildlife and forestry are poorly managed. In effect there is very little local ownership in the management of these resources and thus very little incentive to manage them sustainably. Mr. Pwete feels it would be advantageous to reinstate bylaws and enforce them at the community level.

The House of Chiefs recognizes and has raised the issue of uncontrolled burning. Mr. Pwete commented on the need for sensitization in the communities, as villagers often burn for no apparent reason. He commented that no one is actively managing the open areas, but the communities need to embrace ownership. Mr. Pwete indicated that the issue should be discussed again at the next meeting of the House of Chiefs.

The Nature Conservancy (TNC), Zambia Program Office

The team met with Mr. Jeremy Pope, Conservation Manager, and Dr. Patricia Mupeta Muyamwa, Community Conservation Program Manager.

TNC has been working in Zambia since 2010, focusing on enhancing biodiversity and conserving wildlife in Kafue National Park (KNP). The TNC program in KNP encourages early burning. TNC has included ZAWA, local communities, and other stakeholders in developing fire management policies for KNP, and the local communities actively participate in implementation.

Mr. Pope remarked it would be advantageous to collect data on the ecological effects of burning at different times during the dry season and compare these results to data available in other locations in Zambia.

Both Mr. Pope and Dr. Muyamwa agreed that uncontrolled burning is a significant problem in Zambia that will require changes in people's behavior. National legislation passed in 2011 does not address fire management, but the issues at the forefront in Eastern Province are shared across the country as a whole. TNC is currently developing some land use plans for villages that include fire management policies and enforce penalties for infractions. It would be effective to incorporate fire management policies into land use plans that are tied to the way in which a particular tract of land is managed and that tract's management objectives.

There are currently different entities in place that may serve to disseminate information, including community resource boards (CRB). Since most Zambians are religious, Mr. Pope and Dr. Muyamwa suggested reaching out to church leaders to assist in sensitizing citizens on the importance of judicious fire management and the consequences of not properly managing fires. Funds from carbon sequestration programs may be available for community awareness campaigns. Both Mr. Pope and Dr. Muyamwa commented on the importance of sensitizing the headmen.

Ministry of Lands, Natural Resources, and Environmental Protection

REDD+ Coordinating Unit, Forestry Department, Lusaka Headquarters

The team met with Mr. Moses Kaumba, Project Officer.

In 1996, the Forestry Department was restructured. Many forest guards and field-based positions were lost; not only did the forest guards help protect the natural resources but they were a natural conduit for outreach within the local communities. Communities were more responsible for their actions and safeguarding natural resources at this time as sensitization efforts were ongoing. The Ministry of Finance has recently approved a pilot project to recruit up to 1,000 new extension officers/forest guards.

A fire management plan is required for all forest reserves as part of the forest management plan, but many reserves still lack a forest management plan due to funding and personnel constraints.

While the Forestry Department is conducting early burning within some forest reserves, their capacity for all aspects of fire management is still quite low. However, there have been notable successes in some provinces. An Italian NGO, CELIM, is working to improve prescribed burning and fire suppression activities in the Western Province which may serve as a starting template for other provinces. The contact is Gianclaudio Bizotto, Country Representative (g.bizzotto@celim.org.zm).

Uncontrolled fires have been a consistent problem in the forest reserves and often damage plantations and require trees to be replanted. There have also been some escaped prescribed fires. While the Forestry Department formerly mobilized communities to assist with fire suppression, this no longer occurs. Current capacity to manage fire is very limited, and the Forestry Department responds to less than 10% of fire incidents. In the past there was also heavy investment in reforestation programs, but most of the young trees have been destroyed by fires. ZAFICO formerly manned towers within their plantations but no longer does so.

Uncontrolled fires are potential threats to UN-REDD projects as they can damage an entire forest. Mr. Kaumba emphasized the key to success is sensitizing citizens so they understand they have a responsibility to manage fires and help protect natural resources.

Environmental Department

The team met with Mr. Richard Mfumu Lungu, Chief Environmental Protection Officer.

The Forestry Department is mandated by law to suppress wildfires, but the agency lacks resources, equipment, and personnel to effectively do so. Before the Forestry Department was restructured, the agency focused on forest management including forest and fire management sensitization efforts within communities, but now the focus is extension. Sensitization efforts are not occurring on the scale they did previously and few Forestry Department personnel are in the field mobilizing communities to assist in fire suppression. The forest guards to be hired will focus on forest management of reserves and extension activities including how to light fires, time of day and season, monitoring fires, and identifying boundaries.

Bylaws used to be enforced prescribing the time of year burning could take place. Mr. Lungu feels the bylaws should be updated and reinstated and national policies should be strengthened and gaps identified. Uncontrolled fires have far-reaching effects in Zambia, affecting wildlife habitat, crops, villages, plantations, forest reserves, REDD+ projects, deforestation, and even potentially leading to a loss of genetic diversity.

Most communities in Zambia do not consider themselves as partial owners of the forest reserves, and therefore do not feel a sense of responsibility in helping to manage these resources. A key approach should focus on changing these opinions. Many fires that cause damage to forest resources are started deliberately, but they are not reported to authorities, nor do community members do anything to stop these fires unless their property is at risk. Population increases in Zambia has contributed to increased occurrence of fires as well as demand for agricultural land; thus encroachment has become an escalating problem in many forest reserves.

Technology has changed over time as fire towers are no longer manned; rather, satellite technologies such as MODIS allow for detection of fires nowadays. However, for this system to be effective adequate communication needs to allow these messages to reach people on the ground.

Fire management should be promoted as a key tool in the management of forests in Zambia. Many of the tree species have adapted to fire and need fire for regeneration. Fire has not been prioritized in the UN-REDD report.

Zambia Wildlife Authority (ZAWA), Lusaka Headquarters

The team met with Mr. Chuma Simukonda, Head of Research for ZAWA.

The ZAWA Research group is drafting a set of fire management guidelines for ZAWA focusing on fire prevention, protection, and prescribed fire including early versus late season burning. It is hoped that these guidelines will help to strike a balance between community needs and the needs of wildlife. Interviews from community members are in fire-prone areas such as Eastern Province and Kafue National Park. Kafue National Park had a fire management plan created in 2010 as a pilot project; this plan will be revised to include the surrounding GMAs and collaboration from the local communities.

ZAWA Research is also developing fire management plans (through consultants) for all protected areas they manage that will include a discussion of the dominant vegetation types, common economic activities, fire occurrence, and establishing firebreaks. Mr. Simukonda indicated implementing the fire management plan may be challenging due to lack of resources.

ZAWA is also interfacing with communities and traditional leaders to have better communication and understanding of the potential effects of uncontrolled fires. Some chiefs have already ordered their people not to burn the bush beyond August. Protected areas often interface with communities and therefore are exposed to fires from these communities. ZAWA realized that without community involvement, fires will continue to be a challenge in protected areas. In some areas the fire frequency is so high the vegetation is changing. There may also be effects to wildlife habitat and soils which affect wildlife population and distribution.

Ministry of Local Government and Housing

The team met with Mr. Nkumbu Siame (Assistant Director), Mr. Peter Ngoma (Senior Inspector), and Ms. Manda Daka (Principal Community Development Officer).

The Ministry is responsible for fire and rescue services in each of the districts via local authority fire brigades and establishing policies on fire issues. The Ministry is ultimately responsible for all fires including structural and wildland fires; however, they primarily focus on structural fires due to capacity restraints and poor coordination between stakeholders. They are currently developing a policy to improve coordination between all stakeholders responsible for wildland fire.

Members of the fire brigades are dedicated firefighters (100% of their time) and receive training from a full time fire training school located in Kabwe. The training school offers up to six firefighting and rescue courses each year depending on availability of funding and is open to local authority fire brigades, Forestry Department, ZAWA, the private sector (mining companies, etc.), and others. Currently there are fire brigades in Petauke, Katete, Lundazi, Chipata, Chadiza, and Mambwe Districts in Eastern Province; Nyimba District recently submitted a proposal for a fire brigade.

The Ministry coordinates with the Zambia Air Force and Civil Aviation Authority in severe situations. The Air Force and Civil Aviation Authority provide equipment and personnel normally used in response to incidents at airports (airplane crashes, fires, rescue operations, etc.).

District Coordinating Committees (DCC) are located in each district and work to direct the developmental activities for that district by acting as a conduit to decentralize policies to each district. These committees usually convene on a monthly basis to discuss a wide array of district level issues and include representation from most Government agencies and ministries, donors, and NGOs. The DCCs address fire related issues in accordance with Act 281: The Local Government Administration Fire Service Regulations (1991). Refer to Volume 16, Chapter 281 (Local Government Act) of the Act which states the functions of a council as being *“To establish and maintain firefighting and prevention services, and to take and require the taking of measures for the protection of life, property and natural resources from damage by fire”* (Section 61, No. 22, p. 69).

Recommendations

There are a number of activities that should be undertaken in order to ensure the successful use and management of fire in Eastern Province and across Zambia. Specific recommendations are below. Given the lack of available resources at the disposal of Government Ministries, Authorities, and Departments, we strongly recommend Zambian Government partners explore partnership opportunities. US Forest Service can provide short term technical assistance training to Forestry Department and ZAWA on targeted technical needs. Peace Corps Volunteers can serve as invaluable resources living in and working with communities on a daily basis for a prolonged period (two years). Potential to further partnerships with other stakeholders (such as COMACO) that are engaged in Zambia should also be explored. An itemized list of recommended areas of intervention and improvement follows:

- **Policy and Legislation** – Existing policy and legislation applicable to fire management in Zambia should be reviewed and—where necessary—revised in order to determine gaps and address areas of weakness.
- **Formal Fire Management Training** – Opportunities for formal training in various aspects of fire management should be developed for Forestry Department, ZAWA, and local fire brigade personnel. We recommend modified versions of S-190 (Introduction to Wildland Fire Behavior), S-290 (Intermediate Fire Behavior), S-219 (Firing Operations), and relevant

excerpts from RX-301 (Prescribed Fire Implementation) and RX-341 (Prescribed Fire Plan Preparation) courses be taught at least once per year by qualified US Forest Service personnel at ZAWA headquarters in Mambwe (South Luangwa National Park) and/or the fire training center in Kabwe. Formal classroom training shall be supplemented by field training exercises in South Luangwa National Park and other appropriate sites.

- **Education & Outreach** – Increase sensitization efforts with a focus on fire management in rural communities through prevention programs and increased awareness. To support this process it will be strategic to explore the use of existing structures such as the District Coordinating Committees (DCCs) and/or Community Resource Boards (CRBs) to assist in identifying fire management issues within each district and to develop relevant education and training materials. Forestry Department, ZAWA, and local fire brigade personnel should take the lead on sensitization activities and be responsible for disseminating relevant information to communities. Approaches should also be developed to improve dialogue amongst stakeholder groups in order to share success stories at district, provincial, and national levels. We recommend that opportunities to partner with Peace Corps on these education and outreach efforts be explored.
- **Community Based Fire Management Plans** – Development of local fire management plans should be created through community collaboration with direct support from the Forestry Department and ZAWA. Including local communities in forest and fire management planning activities may lead to an increase in responsible fire use by those groups. In addition, this more inclusive approach to fire management will likely have a positive impact on the sustainable management of forests and other natural resources, and aid in identifying capacity needs with respect to managing prescribed fires and suppressing wildfires. At a minimum, these fire management plans should include prescribed fire objectives and other relevant information to allow for safe and effective use of fire. The inclusion of criteria that define the condition of fuels for early burning will be essential (for instance, a range of live herbaceous fuel moisture content, soil moisture, foliar moisture content, etc.) as the end of the wet season varies every year. Community-based fire management plans can be tiered or incorporated into more comprehensive community/district level natural resource management plans that also include forest, carbon, and other resource management guidance and strategies. To support this process it will be strategic to explore the use of existing structures such as the District Coordinating Committees (DRCs) and/or Community Resource Boards (CRBs). Developing and implementing a fire danger rating system, similar to the National Fire Danger Rating System used in the United States, may provide an important outreach tool so local communities understand if the current fire danger is low or high.
- **Project Level Fire Management Plans** – Natural Resource Management (NRM) projects, specifically those with a focus on sustainable forest management, community based resource management, and REDD+, should develop and implement fire management plans. The primary objectives of these plans should be to mitigate the threat of damaging wildfire and promote the judicious and strategic use of planned fire. Project-level fire management plans can be tiered or incorporated into more comprehensive community/district level

natural resource management plans that also include forest, carbon and other resource management guidance and strategies.

- **Fire Detection** – Development of an automated system is needed, which will allow the dissemination of real time fire detection information (MODIS) by ZEMA to district-level Forestry Department, ZAWA, and local fire brigade personnel using the Internet and mobile SMS technology. There are limitations with a satellite-based fire detection system including: many fires are not detected due to coarse data resolution (MODIS data is 1 km by 1 km), small smoldering fires may not be detected, or fires not actively burning during the satellite overpass may not be detected. An automated detection system afforded by MODIS does not replace a fire occurrence database providing information including: location of the fire origin, discovery date and time, specific human cause, fuels or vegetation burned, fire size, suppression resources used, date and time the fire was declared out, fire effects, and fire intensity.
- **Tree Nurseries** – Support the development of community-based tree nurseries. This should be supplemented with a training and education component to ensure maximum success of reforestation efforts. We recommend that a partnership with Peace Corps be established to help realize this goal.
- **Dissemination Workshop** – Organization and facilitation of a Fire Regime Assessment Report dissemination workshop. The intent of the workshop would be to discuss the findings and recommendations of this report, and solicit input from stakeholders on future training objectives. The workshop should include but not be limited to participants from relevant GRZ (Government of the Republic of Zambia) ministries, agencies, and departments; donors; donor-funded project leaders; private sector stakeholders; and NGOs.

Conclusion

This technical report summarizes discussions with representatives from a multitude of Zambian stakeholder groups ranging from ministry officials, chiefs, headmen, community leaders, community members, and government agency personnel. These groups shared their views on fire, how they use and manage fire, the effects fire has on their villages and surrounding environment, and local rules regarding the use of fire. Fire is used by rural populations in Eastern Province for a variety of activities as it is a cheap and readily available tool. The primary uses of fire include hunting, clearing land for agriculture, improving herbaceous growth for grazing livestock and wildlife, and clearing vegetation around dwellings, structures, gardens, and fields to create defensible space.

Although fire is a tool that has long been used by rural populations in Eastern Province, there is strong evidence to suggest that its current management is inadequate resulting in fires that may damage the environment, resources, property, or threaten lives. Currently fires burn more than one million hectares in Eastern Province annually, which accounts for approximately 20% of the total land base in the province. In terms of average annual area burned, mid-season fires from July

through August burn the greatest area (507,502 ha), followed by late-season fires (September through November, 354,290 ha) and then early-season fires (April thru June, 143,632 ha). Over a 14 year period from 2000 to 2013, 28% burned with a frequency or mean fire return interval of 1.6 years, 37% of the area experienced fire every 3.5 years, and 35% of the area burned had a fire return interval of 7 to 14 years in Eastern Province.

It is important to note that lengthening the mean fire return interval in an area and/or shifting prescribed fire towards the early part of the dry season may have unknown ecological effects. For example, fuel loads may shift as more herbaceous and woody fuel loads exist, there may be greater potential for higher severity fires that burn in the latter part of the dry season as there is potentially more biomass available to burn, and possibly changes in area burned if fires burn larger areas due to more available fuel.

An increase in capacity within those government agencies mandated to manage fire, namely the Forestry Department and Zambian Wildlife Authority, is imperative to implement successful policies and strategies for sustainable fire management in Eastern Province that must include opportunities for formal fire management training. In addition to improving capacity within the management agencies, there needs to be consistent, timely, and tangible education and outreach efforts to local communities. Increasing sensitization within rural communities will not only result in a greater awareness of the benefits of well managed fire, but also the potential negative consequences of poorly managed fires.

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Appendix A. Acronyms

CDM	Clean Development Mechanism
CBNRM	Community Based Natural Resource Management
CIFOR	Center for International Forestry Research
COMACO	Community Markets for Conservation
CRB	Community Resource Board
DCC	District Coordinating Committee
EIA	Environmental Investigation Agency
FCPF	Forest Carbon Partnership Facility
FD	Zambia Forestry Department
FIP	Forest Investment Program
GHG	greenhouse gases
GMA	game management area
GRZ	Government of the Republic of Zambia
IPCC	Intergovernmental Panel on Climate Change
KNP	Kafue National Park
LWF	Lutheran World Federation
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	memorandum of understanding
MRV	monitoring, reporting, and verification
NGO	non-governmental organization
NRM	Natural Resource Management
NTFP	non-timber forest products
NTPP	National Tree Planting Programme
REDD	Reducing Emissions from Deforestation and Forest Degradation
TNC	The Nature Conservancy
UNEP	United Nations Environment Programme

UN-REDD	United Nations Reducing Emissions from Deforestation and Forest Degradation
USAID	United States Agency for International Development
WMO	World Meteorological Organization
WWF	World Wildlife Fund
ZAWA	Zambia Wildlife Authority