

## WILD FIRES IN FOREST TREE PLANTATIONS IN NIGERIAN SAVANNAS

Plantations forestières et feux de brousse  
dans les Savannes du Nigéria.

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### RESUME

*Les plantations forestières de Nimbia, Mongu et Mokwa sont installées dans des régions de savane du Nigeria. Elles ont été sévèrement endommagées par les feux de brousse au début de l'année 1983. 85 % de la surface totale ont été affectés. Des quatre espèces dont on a suivi le comportement en pareille circonstance, les pins de deux ans se sont avérés les plus vulnérables. G m e l i n i a a r b o r e a est l'espèce la plus résistante tandis que E u c a l y p t u s d e g l u p t a est la plus fragile dans les plantations les plus anciennes.*

### ABSTRACT

*Forest tree plantations in Nimbia, Mongu and Mokwa in Derived Savanna, Jos Plateau and Southern Guinea Savanna zones respectively were severely burnt by wild fires between January and April 1983. About 82 % percent, 100 percent and 85.6 percent of the plantations respectively were affected by the wild fire. Of the four species studied, 2 year old pines were most vulnerable to fire. G m e l i n i a a r b o r e a was observed to be the least fire tender species while E u c a l y p t u s d e g l u p t a proved to be the most fire tender of the four older species affected.*

### INTRODUCTION

Wild fire has been defined as any uncontrolled and freely spreading combustion not prescribed for the area by any authorized plan (OGUNTALA, 1980). It is one of the most serious dangers to which forest tree plantations and woodlands may be exposed especially in savanna areas where

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grass ground vegetation and litter deposits become dry and inflammable. This is accentuated by the fact that the savanna areas have peculiar dry climate giving rise to periodic widespread droughts and periods of high temperatures, low humidities that last 6 to 9 months and strong harmattan winds.

It is reasonable to assume that the Nigerian woodlands have been subjected to widespread and frequent, in fact, annual burning for many decades hence the savanna vegetation is often referred to as a fire climax (LANCASTER, 1957). JACKSON (1964) indicates that annual or periodic burning of grass is a feature of savanna vegetation. Satellite and aircraft pictures of the Nigerian savannas, which occupy about 88 percent of the total land areas, have supported the view that up to 70 percent of the Nigerian land is set ablaze every year.

In order to increase the woodland area in Nigeria savannas, new forests (plantations) are being planted, but these are usually situated, for economic reasons, on marginal lands where soil and climatic factors restrict the number of tree species that can be grown successfully. Under these conditions, relatively few indigenous tree species are suitable for commercial forestry and foresters are relying more and more upon exotics for afforestation. Within the last decade, the areas of land planted with exotic species have increased steadily. Unfortunately, these plantation stands are now being attacked by wild fires as they are planted adjacent to the native vegetation.

Most wild fires are caused by human carelessness, negligence or ignorance and some of them are incendiary. The pastoral Fulanis burn the vegetation late in the dry season in the bid to get good flushes of grass for their cattle. Farmers also engage in bush burning during their land preparation for farming. The population pressure has now increased the demand for "bush meat" and thus increased the frequency of bush burning by individual or group hunters in search of wild life even where hunting is prohibited. KAVALLE (1970) expressed deep concern about animal habitat continuously being destroyed by man with fire through hunting.

Careless smokers are responsible for most of the wild fires. Many of these are started when cigarette butts or matches are tossed from automobiles. Others are caused by hikers, hunters and those working in plantations or by fire wood harvesters who are careless in disposing of their smoking materials. Electrical sparks along the power lines also start such wild fires.

The only important natural cause of fire is lightning but this is not so prominent in the savanna areas of Nigeria.

The practice of bush burning has resulted in the destruction of the leaf litter, forest floor and the vegetation and led to the exposure of the land surface to intensive insolation and rainfall impact. The effect of burning in increasing erosion has been demonstrated in many instances in some countries (LOWDERMILK, 1930; KITTREDGE, 1936). OGUNTOYINBO & OGUNTALA (1978) indicate that apart from the wild fires direct effect on the biology of the area, wild fires change drastically the microclimate of the affected areas. According to them, the savanna zone of Nigeria that are burnt annually have higher radiation reflection coefficient (albedo) than the unburnt forest area.

The object of this paper is to survey the wild fire incidents at Nimbia, Mongu and Mokwa in Derived Savanna, Jos Plateau and Southern Guinea Savanna zones respectively and to determine the effects of such wild fire in the plantations.

#### MATERIALS AND METHODS

The States' and Forestry Research Institute of Nigeria (FRIN) plantations at Nimbia, Mongu and Mokwa were visited over the years during the dry season. The three Forest Reserves belonging to three vegetation zones are shown in table I below :

Forest Reserve	Latitude °N	Rainfall (mm)	Max. Temp. (°C)	Period of Dry season (months)	Vegetation zone
Nimbia F.R.	9°20'-9°31'	1350-1820	25.6-37.8	3-4	Derived savanna
Mongu F.R.	9°31'-9°33'	1170-1430	31	4-5	Jos Plateau
Mokwa F.R.	9°12'-9°30'	1170-1430	33.3-37.2	3-4	S.G. Savanna

Tab. I : Groupings of forest reserves by climate and vegetation zones.

#### Nimbia F.R.

Nimbia Forest Reserve is located in the Derived Savanna zone in the southern escarpment of Jos Plateau (Fig. 1). The rainfall in this area ranges from 1350 mm to 1820 mm per annum with only 3 to 4 months

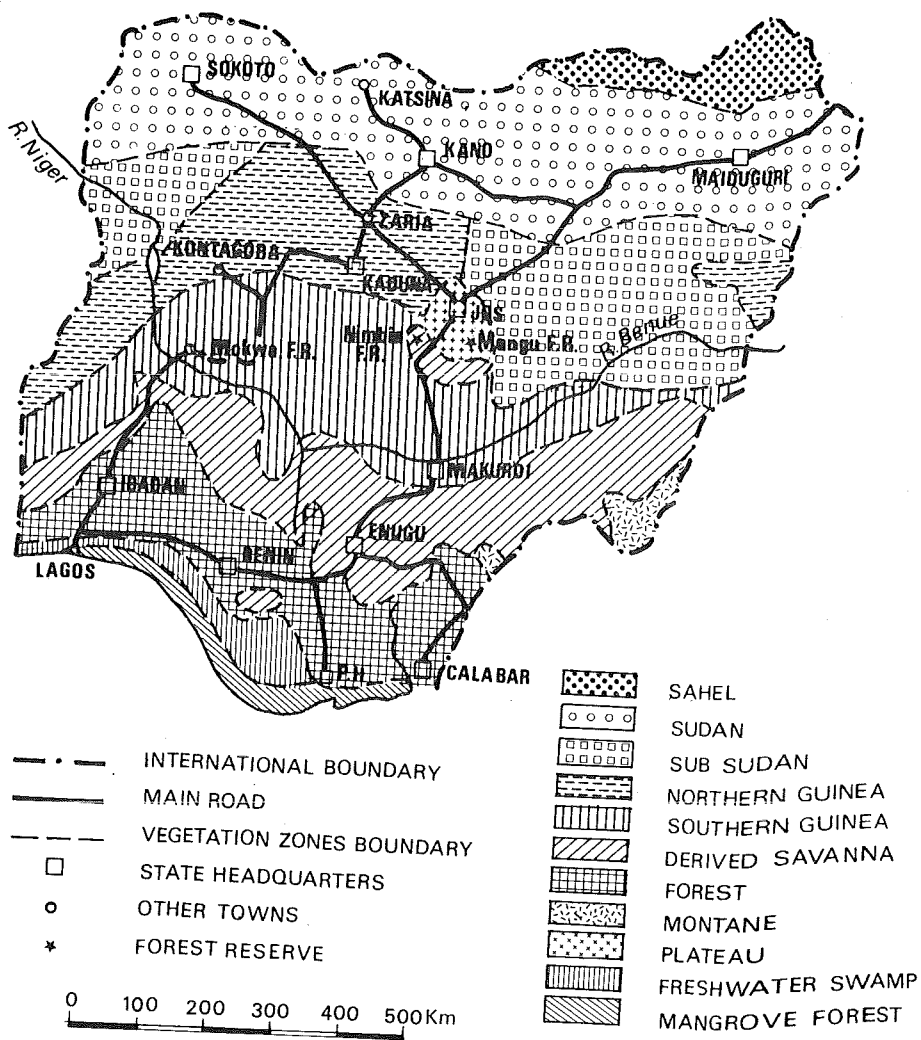


Fig. 1 : Map of Nigeria showing vegetation zones and the three forest reserves affected by 1983 wild fire.

of less than 26 mm of rain. The maximum temperature ranges from 25.6° C in August to 37.8° C in February. The minimum temperature is about 12.8° C in December. The relative humidity ranges from 50 percent in February to 84 percent in August (CLEYTON, 1957). The soil units found in the reserve are mainly eutrophic brown soils and few ferruginous tropical soils.

The forest reserve is characterized by forest species such as *Kaya senegalensis*, *K. grandifoliola*, *Chlorophora exelsa*, *Sterculia tragacantha*, *Napoleona vogelii*, *Millettia thonningii*, *Malacanthus alnifolia* and *Cola gigantea*; savanna woodland species such as *Daniellia oliveri*, *Erythrophleum guineense*, *Sterculia tragacantha*, *Uapaca togoensis*, *Entada abyssinica* and *Vitex doniana*; and grassland species such as *Terminalia laxiflora*, *Combretum hypoleinum*, *Nauclea latifolia* and *Hyparrhenia* sp.

The old vegetation has been cut over by the Kaduna State Government and planted up with mainly Teak (*Tectona grandis*) and a few *Gmelina arborea* stands. Forestry Research Institute of Nigeria (F.R.I.N.) has few pines, *Tectona grandis*, *Gmelina arborea*, *Eucalyptus deglupta* and *Chlorophora* experimental plots in the reserve. The remnants of the original vegetation are found along the sides of the rivers and in patches all over the reserve.

#### Mongu Forest Reserve

Mongu Forest Reserve is located in Jos Plateau vegetation zone (Tab. I) where the rainfall ranges from 1170 mm to 1430 mm and the dry season lasts from 4 to 5 months. The elevation on the Plateau varies from 1,000 to 1,333 meters above sea level and this has a profound effect on its local temperature. The maximum temperature is about 31° C in January. The relative humidity at 12.00 hours G.M.T. varies from 14 percent in January to 76 percent in August (BUCHANAN & PUGH, 1966).

The two important soils in this area are eutrophic brown soils and ferruginous tropical soils.

The reserve is covered by savanna woodland and tree savanna species such as *Anogeissus leiocarpus*, *Butyrospermum paradoxum*, *Syzygium* sp. and *Monotes kerstingi*.

The Plateau State Government has cleared part of the reserve and planted it up with eucalyptus while Forestry Research Institute of

Nigeria (F.R.I.N.) planted mainly pines - the last plot of which was planted in 1981.

### Mokwa Forest Reserve

Mokwa Forest Reserve is located in the Southern Guinea Savanna zone. This zone has an annual rainfall of between 1170 mm and 1430 mm with a 3 to 4 months dry season. The minimum temperature from November to January ranges from 16.7° C to 37.2° C. The relative humidity at 12.00 hours G.M.T. from November to March has a monthly mean of 29 per cent (BARRERA, 1971). The principal soil units in this reserve are red ferrallitic soils on loose sandy sediments.

The forest reserve is covered by savanna woodland, tree savanna and shrub savanna vegetation classes (HOWARD, 1965). In all except the shrub savanna, *Azelia africana*, *Burkea africana*, *Daniellia oliveri*, *Butyrospermum paradoxum* and *Adansonia laxiflora* are among the dominant species, with *Pterocarpus erinaceus* in the savanna woodland and *Lophira lanceolata* in the tree savanna. The shrub savanna contains lower storey species of the other formations, such as *Detarium microcarpum*, *Combretum mole*, *Strychnos spinosa* and *Grewia mollis*. The commonest grasses include *Andropogon gayanus* and *Ctenium newtonii*.

About 40 percent of the reserve was cleared and planted up with mainly *Gmelina arborea* by Niger State Government. The Forestry Research Institute of Nigeria has few *Gmelina arborea*, *Tectona grandis* eucalyptus and pine plots in the reserve. The remaining portion of the reserve was either cleared but not yet planted or still under woodland cover. The cleared portion was over grown by grass and few coppices of woodland species.

In all the three forest reserves described above, the areas burnt by the wild fires were investigated. The effects of the wild fires on tree species and soils were visually studied. Further information was also obtained from field workers and relevant maps of the plantations were collected where available and studied.

### RESULTS AND DISCUSSIONS

Table II shows the summary of the extent of burnt areas in the three forest reserves.

At Nimbia, of 1,805 hectares planted to *Tectona grandis*, few

*Gmelina arborea*, pines and eucalyptus, a total of 1,479.9 hectares (81.99 %) were burnt. It was observed that the fire was mainly ground fire which started from the adjacent farmland. The fire occurred in February 1983.

Forest Reserve	Total Area (ha)	Area planted	Area of plantation burnt	Percentage of the plantation effected by wild fire
Nimbia F.R.	2,201.5	1,805	1,479.9	81.99
Mongu F.R.	539.1	Not determined	Not determined	100.0
Mokwa F.R.	6,120.2	2,448	2,095.5	85.6

Tab. II : Summary of the extent of burnt areas in the three forest reserves.

At Mongu, all the compartments of eucalyptus belonging to the Plateau State Government and the Forestry Research Institute of Nigeria pine experimental plots were burnt. The fire was mainly ground fire which was started by an unknown person in February 1983.

At Mokwa, of 2,448 hectares planted to mainly *Gmelina arborea* and few *Tectona grandis*, eucalyptus and pines, a total of 2,095.5 hectares (85.6 %) were burnt. Only the States *Gmelina* stand were affected. The fire was set in March by hunters. The Forestry Research Institute of Nigeria plots escaped the incident but the effect of the previous fires were still observed as most of the eucalyptus and pines were killed.

It was observed that fire incidents occurred in the plantations during the hottest and driest parts of the year in the three locations when all the deciduous plantation trees had shed their leaves. The fires were ground fires but were very intense as there was a lot of fuel on the floor as a result of accumulation of lop and top in plantations after thinning, especially at Nimbia where heavy thinnings have been done.

At Mongu, the 2 - year old pine plot showed high mortality. This is similar to the effect on 3 - year old pine plots at Afaka Experimental area which were burnt accidentally in February 1982 by the nomadic cattle Fulanis. On the contrary, the 6 - year old F.R.I.N. pines at Mongu and Nimbia did not suffer death or severe damage. Only few pines

lost some scorched needles as a result of the intense heat that emanated from the ground litter fire. This observation points out the fact that pines are most vulnerable at tender age. This supports JACKSON's (1964) remark that some tropical pines are resistant to fire after the age of four years.

At Nimbia, stem mortality was rare in both *Tectona grandis* and *Gmelina arborea* plantation stands except trees with less than 9 cm d.b.h. and those that had scars caused by previous fires or insect or fungal attack with exposed dry parts. This might be due to the fact that most of the stands in this reserve were over six years old.

At Mokwa, higher mortality of *Gmelina arborea*, especially in younger stands, was observed. Some trees with double or triple leaders either lost some leaders of lower diameters or the entire leaders.

On the whole, in plantations of both teak and *Gmelina arborea* of the same age, the stems of teak appeared more scorched by fire than those of *Gmelina arborea*.

It was observed that a stand of *Eucalyptus deglupta* at Nimbia was severely damaged. This is attributable to the fact that this species has very thin bark and can suffer cambial damage very readily (ROSS, 1976). Secondly the species sheds large quantities of bark, branches and leaves annually resulting in an accumulation of fuel on the floor. ROSS (1976) has recorded a rate of up to one metric ton per hectare per year and corresponding increase in fire suppression difficulty in a mature stand of eucalyptus forest.

It should be noted that although severely scorched, some tree species appeared to recover well, there will be a drop in diameter increment. A drop of about 12.5 mm was recorded over the next six months of growth after fire damage by the Australian Forest and Timber Bureau (1972).

The entire litter on the floors in the three locations were burnt off thereby exposing the surface of soil to intense insolation and rainfall impact. It should be noted that a lot of gaps were created in these stands owing to the fire incidents that occurred when the stands were young. A lot of burnt worm casts were seen on the surface indicating that most of the earthworms and other organisms including nitrifying bacteria were killed. It should not be surprising that the nitrifying bacteria must have been seriously affected as MEIKLEJOHN (1955) has



found that changes in bacterial population occurred when the soil temperature was significantly increased.

He also found that the ammonia - oxidizing bacteria were killed by temperatures exceeding 100°C. MEYER (1959) noted that nitrification did not occur above a temperature of 41-42° C but ammonification proceeded, but RAMSEY & INNES (1963) indicated that only the temperature of the top inch of soil was affected by fire. At Olokemeji in Nigeria temperatures in excess of 150° C were recorded at about 1.9 cm depth, though at 3.4 cm, little effect was observed when the natural savanna/grass were burnt in mid-March (JENKINS, 1964). At Afaka (Nigeria), it was observed that a late burn resulted in the nitrate nitrogen content of the surface soil remaining low until about a month after burning when it started to rise, achieving its maximum level some 6 to 8 weeks after burning. This delay in attaining the maximum level was ascribed to the disturbance of the bacterial balance of the soil by the fire (KEMP, 1963).

From the extent of the wildfire effect, especially in both Nimbria and Mokwa, one can not but imagine that a lot of wildlife got trapped in the ensuing inferno and consequently got killed in the process.

A lot of dead snails and tortoises were seen on the floor of Mokwa plantation stands during the survey. As we are all aware, it takes years for those animals to mature and reproduce.

It is not easy to estimate the extent of damage done to the atmosphere when the air got polluted by the resultant inferno in our forest plantations and woodlands. EZENWA (1982) has enumerated causes and effects of air pollution in relation to growth of forest trees.

The 1982-1983 dry season recorded as the most severe for the past 30 years with its attendant desiccation on vegetation generally resulted in wide spread fire outburst which extended southwards beyond the Southern Guinea vegetation zone. It is fair knowledge that plantations and other farms were badly affected in the southern parts of the country.

Considering the implications of repeated forest fires on forestry development in the country, it should be noted that such wild fires will generally retard the progress of forestry development in the country in that :

- a) there will be a short fall in targeted productivity levels of plantations and
- b) it will result in financial loss in forestry investments of the country.

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