

Fire Situation in Namibia

Fire Environment, Fire Regime and Ecological Role

(will be published in IFFN No. 25)

Introduction

Namibia lies in the west of Southern Africa, bordering Botswana and South Africa to the east and the Atlantic Ocean to the west, and covers an area of approximately 824 000 km.

Large areas burn each year, with more than 3 million hectares estimated to have burned in 1997 alone. Frequent, indiscriminate burning is having highly negative effects on some ecosystems, while in other

Excessive, indiscriminate burning is having highly negative effects on some ecosystems, while in other areas fire frequencies are more in equilibrium with requirements for long-term stability of existing vegetation communities (Goldammer 1998).

Fires burn during Namibia's severe dry season from April to October. The vast majority occurs as surface fires that spread in the grass and shrub layer. Crown fires and ground fires occur over only limited geographical areas. The amount and connectivity of the predominant grass and shrub fuel is highly variable spatially and temporally, controlled by a severe rainfall gradient oriented in an approximately SW to NE direction. This means that the most frequent, intense and extensive fires occur in the north and particularly in the Northeast, while in the south and west fires rarely occur. Figure 1 shows a burned area map of the fire-prone areas of Namibia (derived from remote sensing) and demonstrates how the size and extent of burned areas increases from SW to NE.

Lightning fire is the most significant natural cause, but accounts for a small percentage of all fires. The majority of fires are ignited by people, either deliberately or accidentally.

Table 1 describes the broad fire environment and fire regimes for six different zones (Figure 1). The zoning into different fire regime areas in Figure 2 is based on the GIS-based analysis of different maps of land use, rainfall, vegetation and maps of burned areas (e.g. Figure 2).

Ecological Roles of fire in the six zones

In Zone 1, the desert fringe of western Namibia, fire is so infrequent that its ecological role can be discounted.

In Zone 2, the fuel load is so low and fires are so infrequent that fire plays a limited but positive role in removing material.

In Zone 3, fires are generally not desired as the resulting loss of fodder may constrain pastoralism. Therefore, in cases where fires occur, coordinated efforts are made to put them out quickly. This means fires rarely spread over very large areas. However, decades of fire exclusion have contributed to severe bush encroachment over extensive areas.

In Zone 4, the Etosha National Park, fire is managed according to a block burning strategy designed to promote the maintenance and, in special cases, to increase the biotic diversity. Fires prescribed by management result in reduction of moribund material, regeneration of palatable grasses, control of bush encroachment and prevention of severe fire hazard by reducing the fuel load (Du Plessis 1997).

In Zone 5, fires are perceived negatively, although few coordinated efforts are made to put them out. In years with sufficient fuel load and continuity, fires can spread over very large areas. High livestock density and grazing pressure maintain the fuel load at relatively low levels that limit fire intensity. Ecological impacts are therefore small and tend to do little more than prevent moribund material from accumulating in the herbaceous layer. Fire does not pose a serious threat to forested or wooded areas within this zone.

In Zone 6, high fire frequency and high shrub/grass biomass pose a serious threat to the large areas of wooded land and forest present by converting important areas of forest and wooded land into shrubland with very few mature trees. Succession of the shrubland to mature wooded land and the survival of many seedlings is prevented by subsequent high frequency fire. In Mopane/*Terminalia* woodland, fire tends to prevent bush encroachment. In areas of Other Land, fire plays an important role in the regeneration of grasslands.

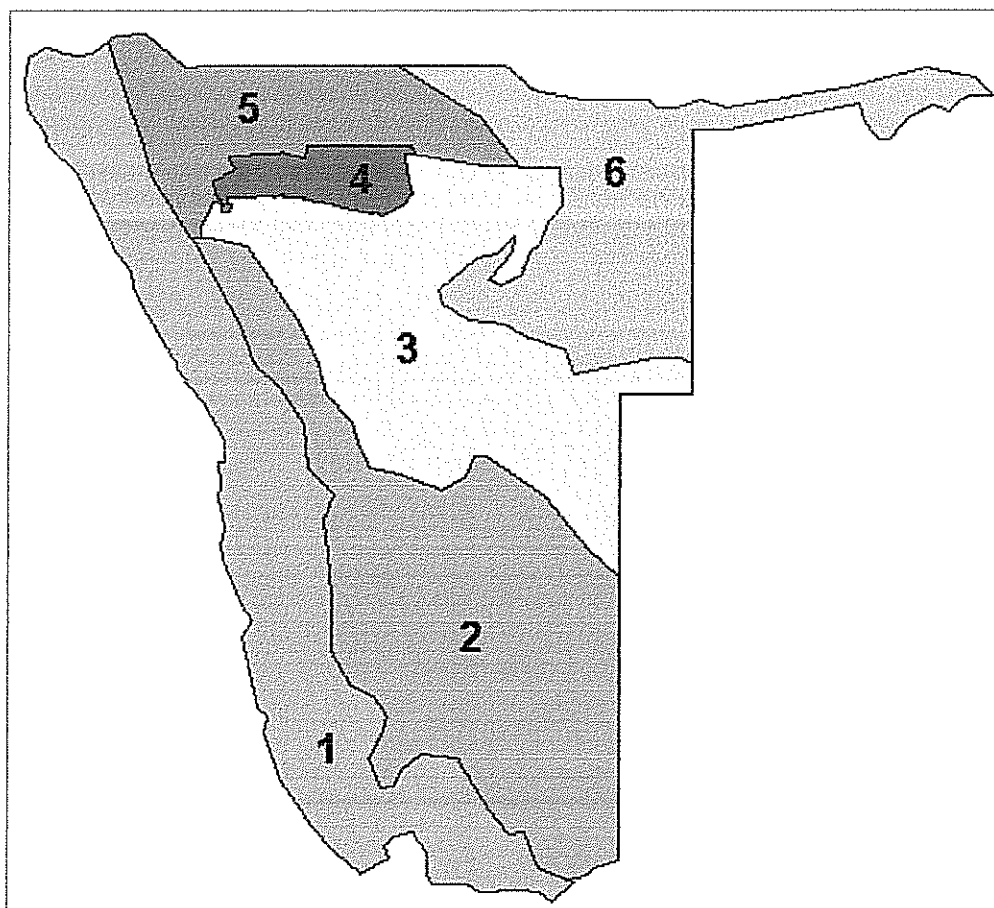


Figure 1. The six Zones used to describe the different fire regimes of Namibia.

Wildfire impacts

Important impacts occur mainly in zones three to six. In Zone 6, large areas of wooded and forested land have been damaged by high frequency fire, with a significant reduction in areas of commercial and non-commercial timber resources, loss of habitat, reduction in woodland biodiversity, and losses of wood resources for domestic use. The high fire frequencies also promote the establishment of fire-resistant, but often less useful woody species, such as *Dichrostachys cinerea*. Fires have also killed large mammals, with peat ground fires in the Malangalenga area of Caprivi killing 170 buffalo in 1996 alone. (Mendelsohn and Roberts 1997). During the height of the dry season, large smoke plumes and high levels of background smoke are present, although any effects of reduced air quality upon public health are yet to be quantified. In Zones 3 and 5, the removal of pasture by fire is a highly undesired impact that can threaten survival of livestock. This situation is compounded during years when rains fail after burning. In Zone 4, the active management of fire aims to promote beneficial impacts, and adverse impacts are rare.

In exceptional cases, people are trapped and receive fatal burns. Centralised figures on the different impacts are unavailable.

Fire Database

Fire statistics are not yet compiled or aggregated to the national level, and resources for obtaining fire statistics in the field are limited. By far the most comprehensive surveys of active fires and areas burned have been made using image data from the Advanced Very High Resolution Radiometer (AVHRR) sensor onboard the U.S. NOAA (National Oceanic and Atmospheric Administration) satellite series (Cracknell 1997). Maps and statistics have been compiled for north-central and northeast Namibia (primarily Zones 4, 5 and much of Zone 6), with the whole of Namibia mapped for just 1997 (Trigg 1997, 1998; Le Roux *pers. com.*). Based on AVHRR data, fire frequency maps have been prepared for much of Zones 5 and 6 and all of Zone 4.

Fire numbers

Due to difficulties in determining independent ignitions from active fires detected using AVHRR, there are no reliable statistics on fire numbers.

Area burned

AVHRR-based burned area maps are available for five consecutive burning seasons (1994-1998 inclusive) for all of Zone 4 area and for the majority of the most fire prone area of Zone 5. They are also available for the most fire-prone part of Zone 6, for four consecutive burning seasons (1996-1999 inclusive). Figures three to six are all based on these remotely sensed data.

Figure 3 shows the areas that burned each year in the different zones. Zones 4 and 5 are characterised by high variability between years. In zone 6, fire is much less variable, with large areas burned every year.

Figure 4 shows that in zones four and five, only a small percentage of the land burned during the years under consideration, whereas in zone six, some 40 to 60 percent of the land has burned every year.

Examination of an image showing how many times Zone 6 burned during the four year period 1996-1999 (Figure 5), reveals that some 10 percent of the land area burns every year, and that most of the area burned between two and four times. The small unburned areas are coincident with areas of high population pressures and high livestock numbers, and consequently little combustible biomass. As mentioned, the high return period of fire poses a serious threat to the survival of the large areas of wooded land and forest remaining in Caprivi.

It is evident from figure 6 that the vast majority of Zones 4 and 5 did not burn in the five year period under consideration, with a distribution skewed towards relatively low fire frequency. The more normal distributions in the two sub-areas of zone 6 illustrate that fires occur much more frequently, with more than 10 percent of the area to the east of 21°E having burned every year (Figure 6D).

Causes of fire

In Zone 6, people light the majority of fires for many reasons. Those reasons include: to stimulate the growth of fresh grass for cattle, to attract game, to flush out game that can then be hunted, to clear vegetation around waterholes and honey-gathering areas, to clear land for cultivation, or to promote the regeneration of grasses used for thatching. Arson also occurs. As most fires occur at times with no convective thunderstorm activity, it is clear that lightning plays a relatively minor role (Mendelsohn and Roberts 1997).

In Zones 3 and 5, fires originate either as a result of lightning strikes during convective storms at the beginning or the end of the burning season, or are started accidentally during charcoal making or from inadequately supervised camp fires, or careless use of cigarettes. In zone five, large areas are sometimes burned accidentally as the uncontrolled extension of fires deliberately lit to clear new fields.

In Zone 4, fires are ignited mainly by lightning and park management and occasionally by accident.

In Zones 1 and 2, the rare fires that occur are started mainly by accidental ignition and lightning.

Operational fire management systems and/or organisations

Fire is managed over the full extent of Zone 4 (Etosha National Park) by the Directorate of Resource

Management of the Ministry of Environment and Tourism. Part of East Caprivi within Zone 6 is managed by local communities mobilised by the Directorate of Forestry. In Zones 2 and 3, farmers' associations are concerned with fire suppression, although their links to central government is yet to be formalised.

Fire prevention

Large scale fire prevention occurs only in Zones 4 and 6. In Zone 4, Park management actively prevents fires from entering the Park from neighbouring areas. The Park itself is divided into fire management blocks separated by well-maintained fire breaks. Fires naturally occurring within any block are actively contained within that block. In Zone 6, communities mobilised by the Directorate of Forestry, with support from the Finnish government, make a network of fire lines to prevent the spread of fire into important forest reserves. This contribution has resulted in a reduction in areas burned.

Fire early warning, detection and monitoring

Staff at the Etosha Ecological Institute (within Zone 4) collect NOAA AVHRR satellite data at approximately 12 hour intervals every day. These data are used operationally to provide early warning of approaching fires, to detect and monitor the progress of active fires within the zone and to map burned areas. AVHRR data are also used to map fires operationally in Zone 5 and in part of Zone 6.

Suppression

Undesired wildfires are suppressed where possible in most of zone 2, all of zone 3 and 4 and in some areas of Zones 5 and 6. In Zones 2 and 3, fires are suppressed by members of the farmers' association. In Zone 4, Park management staff from the Directorate of Resource management suppresses wildfires. In parts of Zone 5, local officials from the Ministry of Agriculture assist community members in combating certain fires. In part of East Caprivi in Zone 6, the communities mobilised by Directorate of Forestry have also been equipped and trained to suppress wildfires. Table 2 summarises the main organisations involved in the different fire-related activities.

Main research issues

In eastern Caprivi (Zone 6), research has developed simplified techniques for assessing range condition for controlling burning. This will provide a practical means of applying ecologically acceptable controlled burning for different systems of land use in East Caprivi. It is intended that the simple criteria developed can be used by non-rangeland specialists as an objective basis for deciding whether rangeland needs to be burned or not (Trollope et al. 2000).

Research is also being conducted with the primary aim of improving the accuracy with which burned areas can be mapped using remote sensing. This involves consideration of potential improvements from new satellite sensors such as MODIS (Moderate Resolution Imaging Spectroradiometer), launched December 1999 (Trigg and Flasse 2000), as well as the development of techniques to improve the accuracy assessment of resultant burned area maps. The latter step is seen as an important step in improving the reliability and accuracy of techniques for the remote sensing of burned areas.

Use of prescribed fire in the region to achieve management objectives

Trollope and Trollope (1999) state that the main land-use types relevant to prescribed burning in East Caprivi (within Zone 6) are:

- Livestock farming
- Nature Conservation
- Forestry in the State Forest
- Production of thatching material in communal lands

By considering the reasons for burning within each land use type and by understanding the effects of different fire regimes, they have formulated guidelines for prescribed burning in each land use category. The techniques for range condition assessment (described briefly above) are a more detailed extension of

this work. The guidelines also reflect the need to continue measures to prevent and exclude fires from the forest and wooded land that is currently under threat from excessively frequent fire. These studies will form the basis for fire management that is adapted to and specifically focused on the promotion or maintenance of land for specific uses.

Prescribed fire is used to achieve management objectives in the Etosha National Park (Zone 4) as described above. In Zone 6, small fires are prescribed to prepare land for agriculture.

Sustainable land-use practices employed to reduce wildfire hazards and wildfire risks

In Zone 6, communities mobilised by the Directorate of Forestry, with support from the Finnish government, have been trained and equipped to cut firebreaks to prevent the spread of fire in important forest reserves. This contribution has resulted in a reduction in areas burned.

Public policies concerning fire

The formulation of policy and regulations concerning fire is an ongoing process. The Directorate of Forestry has prepared a document on the Development of a National Fire Policy and Guidelines on Fire Management in Namibia (Goldammer 1998). This builds on the Namibia Forestry Strategic Plan, which provided the basis for fire policy and management planning. The Strategic plan recognises many of the complexities of fire, including; the need to reduce the occurrence and severity of uncontrolled and accidental forest fire, while still allowing controlled fire under specific circumstances; that community participation is desirable in the protection of forest resources; and that different policies could, in theory, be adopted in different parts of Namibia as necessary.

A Round Table Meeting on Fire was held in Windhoek on 10-11 October 1999 (Goldammer 1999) towards further definition of fire policy and the coordination of responsibility for fire management (Goldammer 1999). Draft proposals for regulations on bush fire management have been prepared recently (Piepmeyer 2000).

Namibia has ratified the UN convention on Climate Change, and is consequently required to provide quantitative assessments of free-burning vegetation fires (Goldammer 1998).

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 NAMIBIA

Table 1. Fire environment and fire regimes for six major zones of Namibia.

Area	Fire Environment				
	Land use	Vegetation	Rainfall	Biomass	Return period
1.	State land, tourism, mining	Sparse grass and shrubs, trees confined to water courses, occasional succulents	Extremely arid below 100 mm rainfall	Very low	Ten years or more
2.	Commercial and communal farmland	Karoo shrub, grass, trees	100 to 300 mm	low	Five to ten years
3.	Commercial and communal farmland	Mixed tree and shrub savanna, wooded land	150 to 550	Medium to high	Two to ten years
4.	National Park, wildlife and Tourism	Mixed tree and shrub savanna	250-500 mm, increasing from west to east	Low to medium, increasing along the rainfall gradient	One to five years
5.	Communal farmland	Mixed grassland, savanna and wooded land.	250-500 mm, increasing from west to east	Low to high, increasing along the rainfall gradient	Two to five years
6.	Communal farmland, National Parks, State forest	Mixed grassland, savanna, wooded land and forest	500-750 mm, increasing from west to east	Medium to very high	One to three years over majority of area.

Table 2. Main organisations involved in fire suppression activities.

Zone	Fire Prevention	Early warning, detection and monitoring	Suppression
1	None	None	None
2	None	None	Farmer's associations
3	None	Directorate of Resource Management, on ad hoc basis.	Farmer's associations
4	Directorate of Resource Management.	Directorate of Resource Management.	Directorate of Resource Management.
5	None	Directorate of Resource Management	Ministry of Agriculture
6	Directorate of Forestry	Directorate of Resource Management, Directorate of Forestry (National Remote Sensing Centre)	Directorate of Forestry

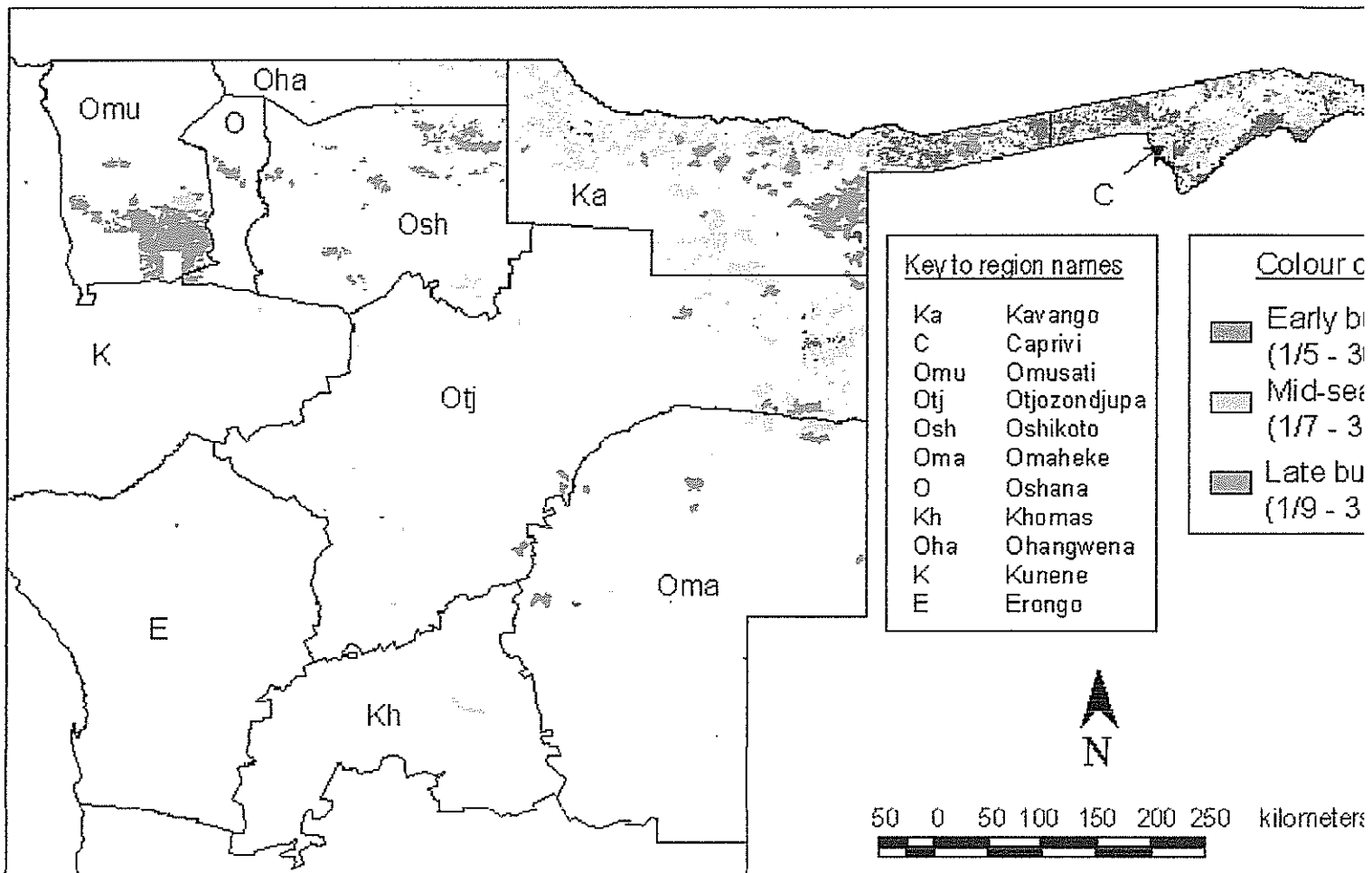


Figure 2. Fires in Northern Namibia for the 1997 burning season, colour coded according to approximate date of burn.

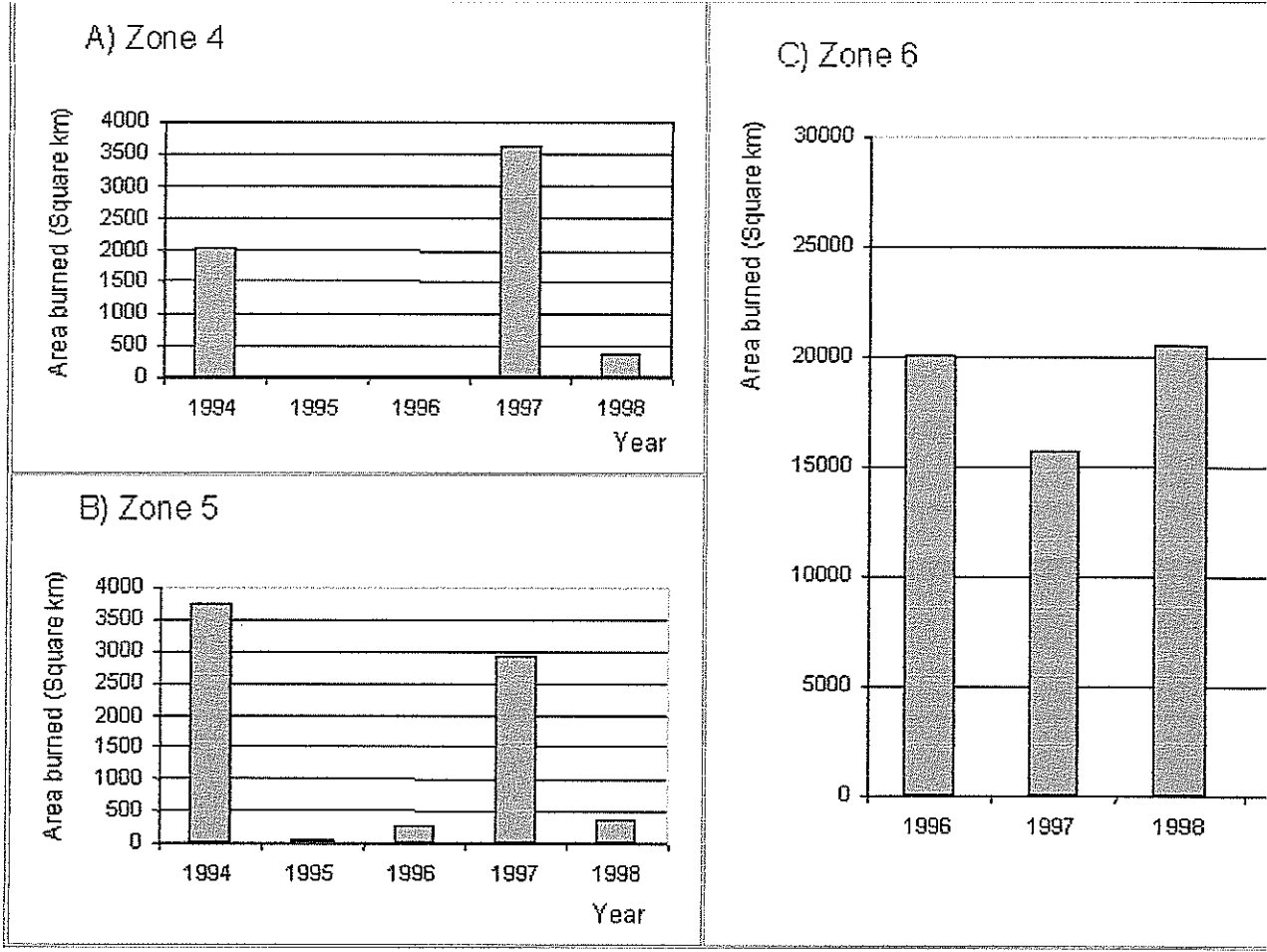
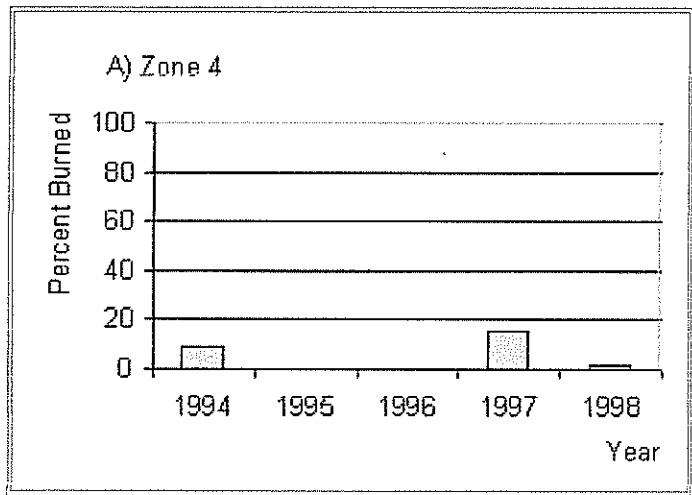


Figure 3. Areas burned in Etosha National Park (Zone 4), and the areas of Zones 5 and 6 for which burned area maps are already available. Note that A and B are for the years 1994 to 1998, whereas C is for 1996-1999 (note the very different scale of A and B compared to C).



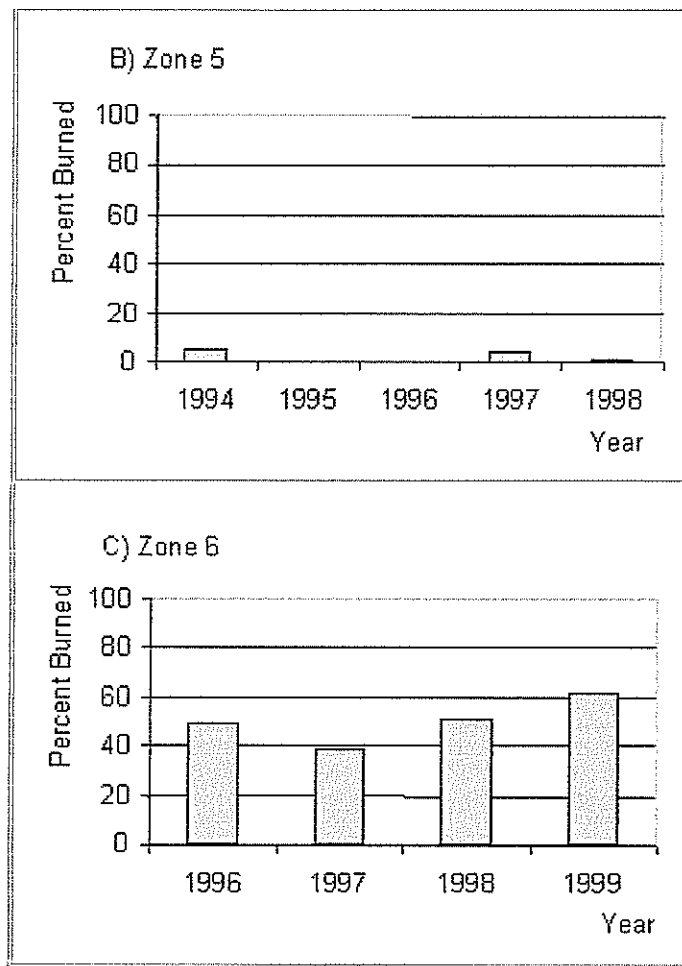


Figure 4. Percentage area burned in Etosha National Park (Zone 4), and the areas of Zones 5 and 6 for which burned area maps are already available. Note that A and B are

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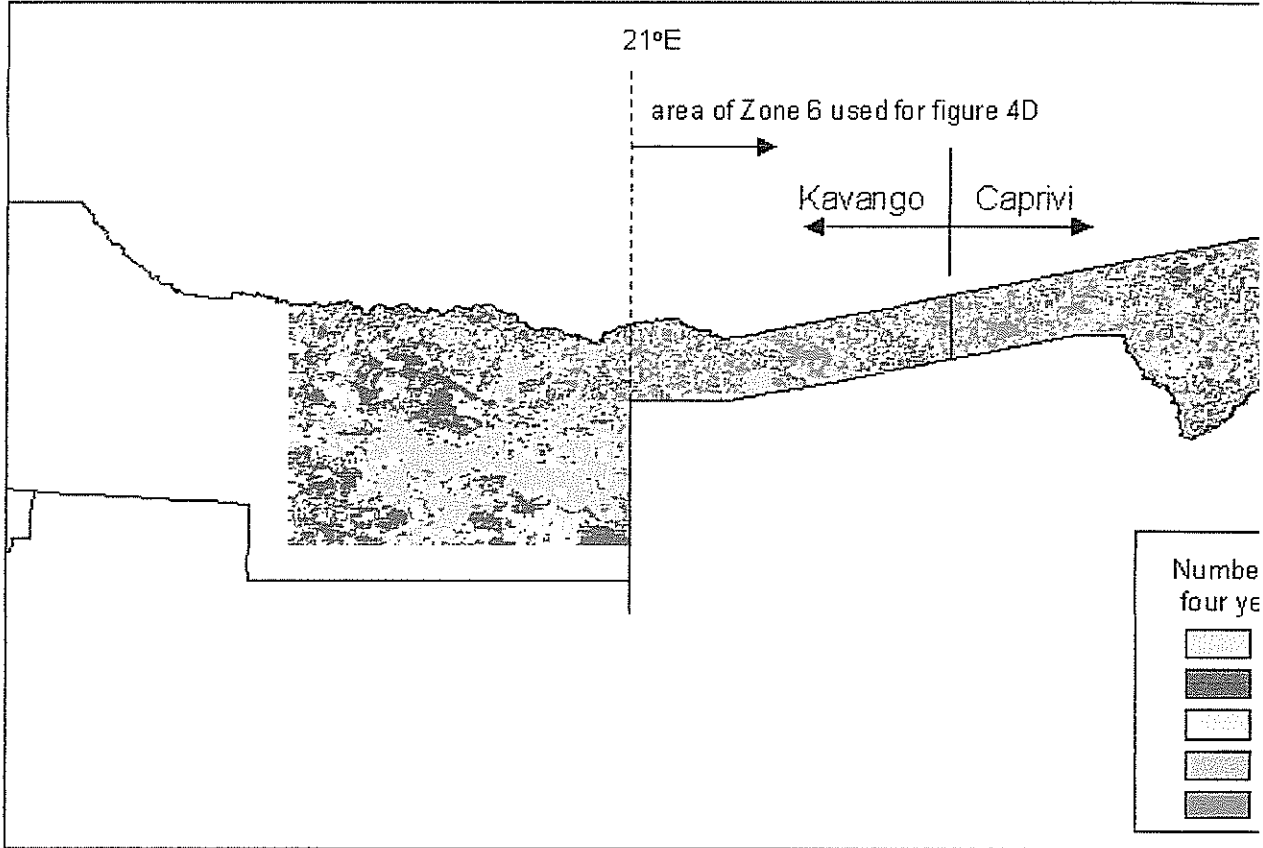
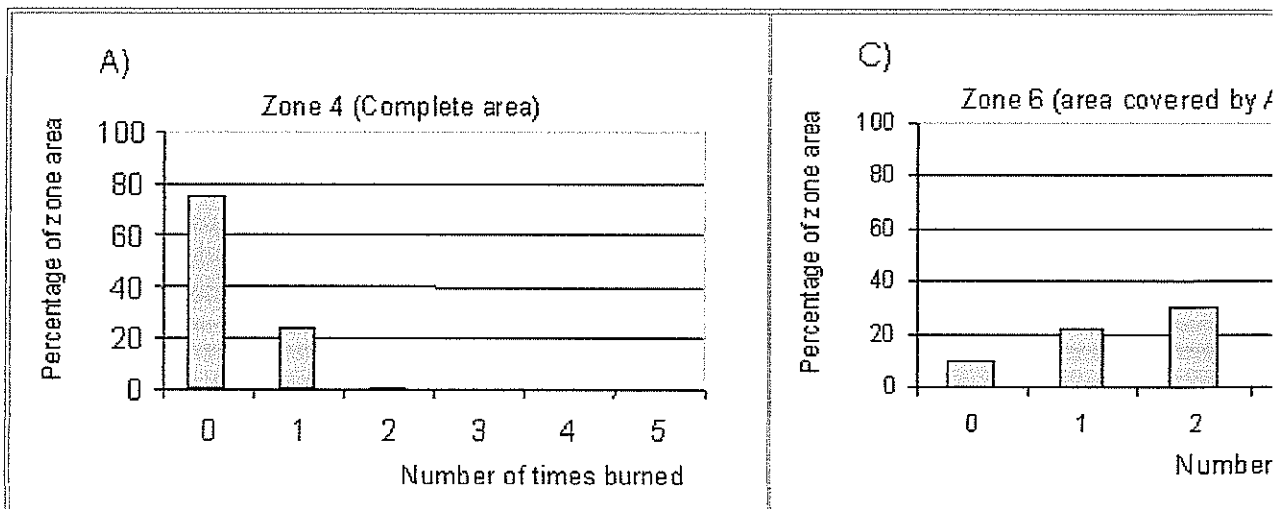


Figure 5. The number of times the areas of Zone 6 (routinely monitored by AVHRR) burned over a four year period (1996-1999).



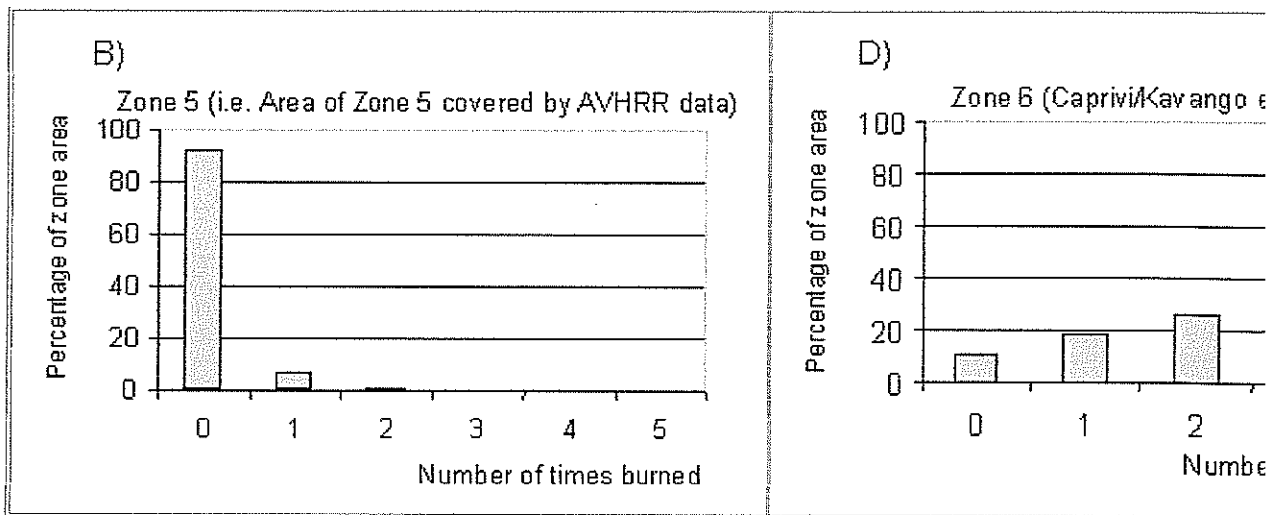


Figure 6. Percentage of land having burned different numbers of times within a set number of years. A and B show the percentage of Zones 4 and 5 that burned between 0 and five times during a five year period (1994-1998). C and D show the percentage of Zone 6 and the Caprivi-Kavango extension of Zone 6 (see Figure 5) that burned between 0 and four times within a four year period (1996-1999).

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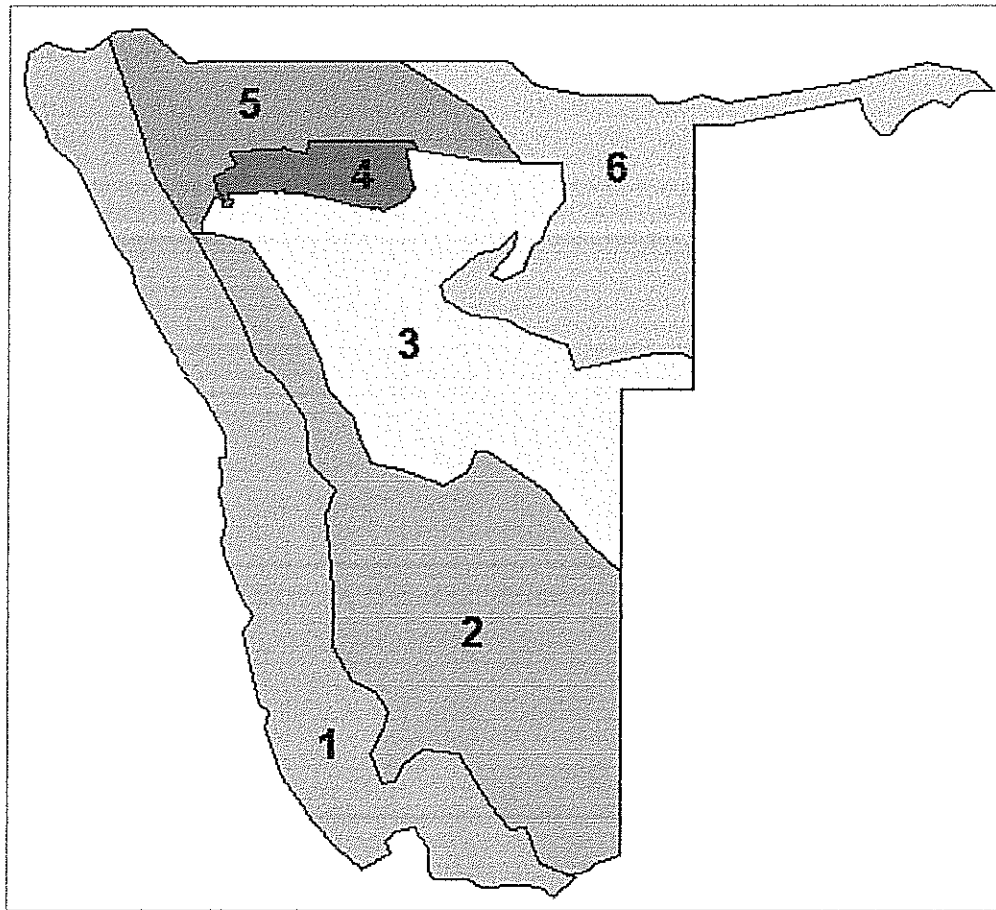


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- Production of thatching material in communal lands

By considering the reasons for burning within each land use type and by understanding the effects of different fire regimes, they have formulated guidelines for prescribed burning in each land use category. The techniques for range condition assessment (described briefly above) are a more detailed extension of

this work. The guidelines also reflect the need to continue measures to prevent and exclude fires from the forest and wooded land that is currently under threat from excessively frequent fire. These studies will form the basis for fire management that is adapted to and specifically focused on the promotion or maintenance of land for specific uses.

Prescribed fire is used to achieve management objectives in the Etosha National Park (Zone 4) as described above. In Zone 6, small fires are prescribed to prepare land for agriculture.

Sustainable land-use practices employed to reduce wildfire hazards and wildfire risks

In Zone 6, communities mobilised by the Directorate of Forestry, with support from the Finnish government, have been trained and equipped to cut firebreaks to prevent the spread of fire in important forest reserves. This contribution has resulted in a reduction in areas burned.

Public policies concerning fire

The formulation of policy and regulations concerning fire is an ongoing process. The Directorate of Forestry has prepared a document on the Development of a National Fire Policy and Guidelines on Fire Management in Namibia (Goldammer 1998). This builds on the Namibia Forestry Strategic Plan, which provided the basis for fire policy and management planning. The Strategic plan recognises many of the complexities of fire, including; the need to reduce the occurrence and severity of uncontrolled and accidental forest fire, while still allowing controlled fire under specific circumstances; that community participation is desirable in the protection of forest resources; and that different policies could, in theory, be adopted in different parts of Namibia as necessary.

A Round Table Meeting on Fire was held in Windhoek on 10-11 October 1999 (Goldammer 1999) towards further definition of fire policy and the coordination of responsibility for fire management (Goldammer 1999). Draft proposals for regulations on bush fire management have been prepared recently (Piepmeyer 2000).

Namibia has ratified the UN convention on Climate Change, and is consequently required to provide quantitative assessments of free-burning vegetation fires (Goldammer 1998).

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Table 1. Fire environment and fire regimes for six major zones of Namibia.

Area	Fire Environment				Return period
	Land use	Vegetation	Rainfall	Biomass	
1.	State land, tourism, mining	Sparse grass and shrubs, trees confined to water courses, occasional succulents	Extremely arid below 100 mm rainfall	Very low	Ten years or more
2.	Commercial and communal farmland	Karoo shrub, grass, trees	100 to 300 mm	low	Five to ten years
3.	Commercial and communal farmland	Mixed tree and shrub savanna, wooded land	150 to 550	Medium to high	Two to ten years
4.	National Park, wildlife and Tourism	Mixed tree and shrub savanna	250-500 mm, increasing from west to east	Low to medium, increasing along the rainfall gradient	One to five years
5.	Communal farmland	Mixed grassland, savanna and wooded land.	250-500 mm, increasing from west to east	Low to high, increasing along the rainfall gradient	Two to five years
6.	Communal farmland, National Parks, State forest	Mixed grassland, savanna, wooded land and forest	500-750 mm, increasing from west to east	Medium to very high	One to three years over majority of area.

Table 2. Main organisations involved in fire suppression activities.

Zone	Fire Prevention	Early warning, detection and monitoring	Suppression
1	None	None	None
2	None	None	Farmer's associations
3	None	Directorate of Resource Management, on ad hoc basis.	Farmer's associations
4	Directorate of Resource Management.	Directorate of Resource Management.	Directorate of Resource Management.
5	None	Directorate of Resource Management	Ministry of Agriculture
6	Directorate of Forestry	Directorate of Resource Management, Directorate of Forestry (National Remote Sensing Centre)	Directorate of Forestry

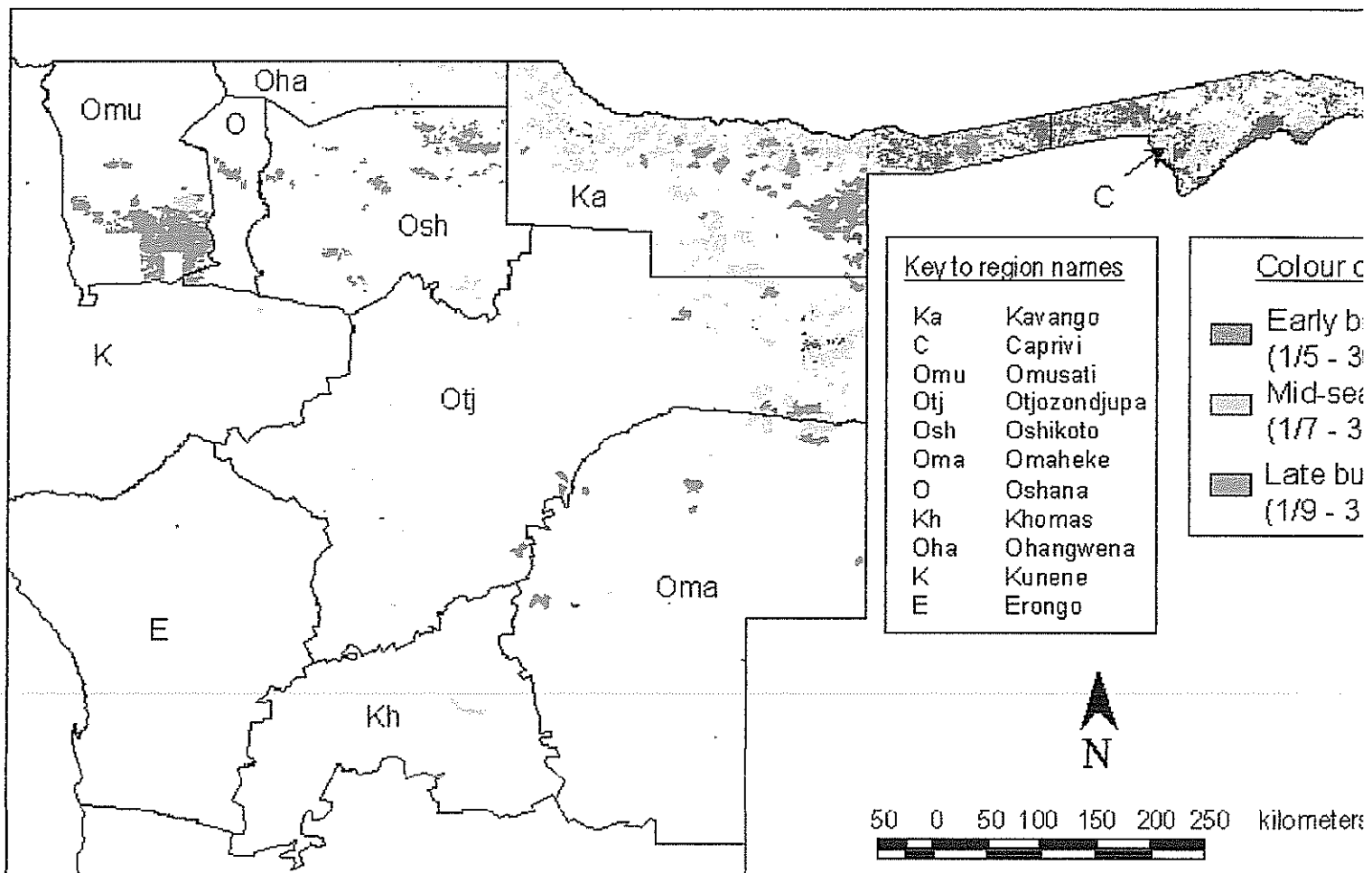


Figure 2. Fires in Northern Namibia for the 1997 burning season, colour coded according to approximate date of burn.

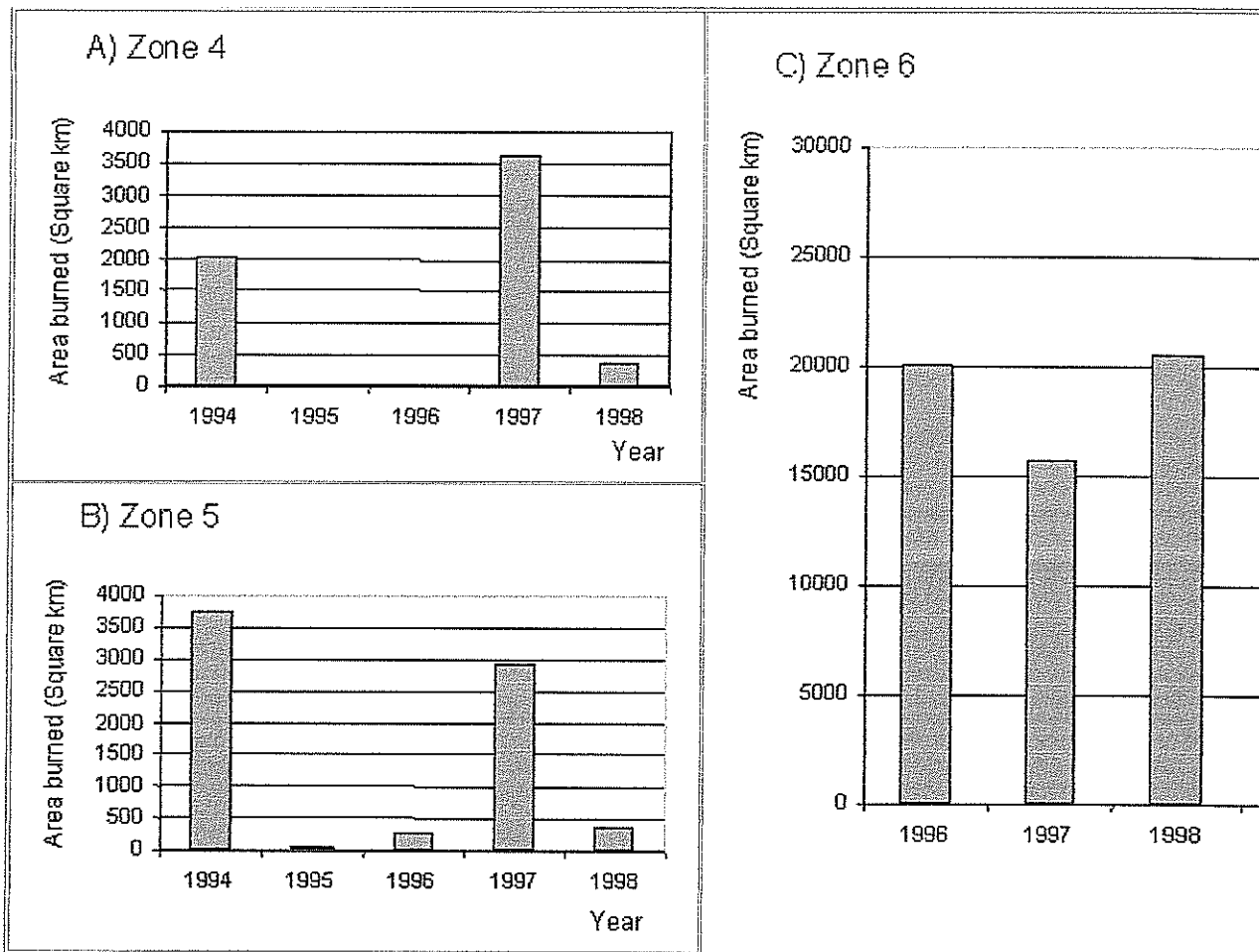
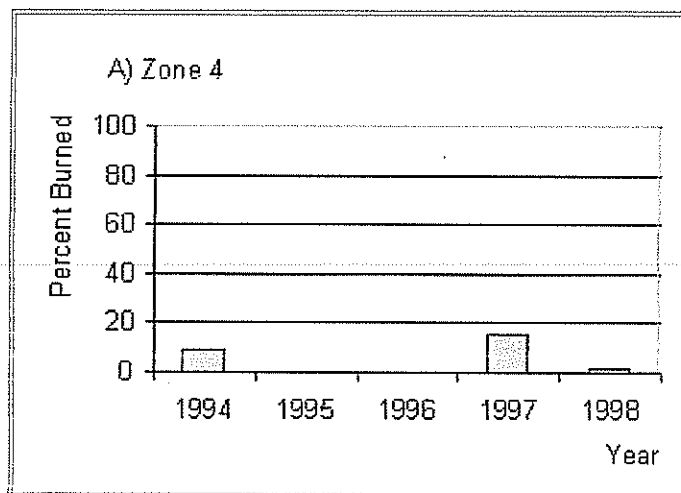


Figure 3. Areas burned in Etosha National Park (Zone 4), and the areas of Zones 5 and 6 for which burned area maps are already available. Note that A and B are for the years 1994 to 1998, whereas C is for 1996-1999 (note the very different scale of A and B compared to C).



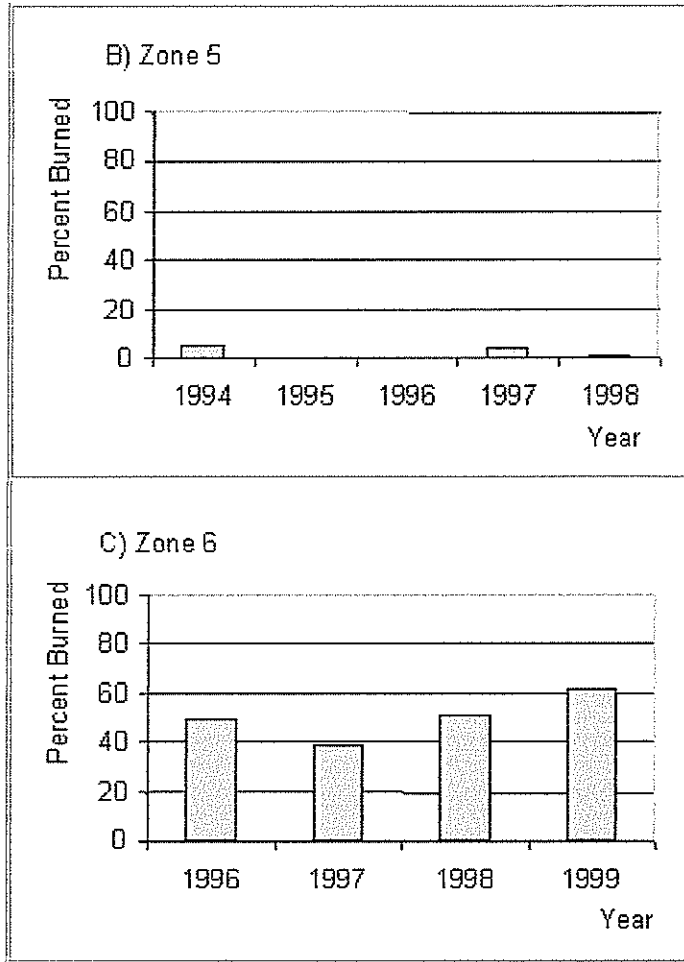


Figure 4. Percentage area burned in Etosha National Park (Zone 4), and the areas of Zones 5 and 6 for which burned area maps are already available. Note that A and B are

for
the
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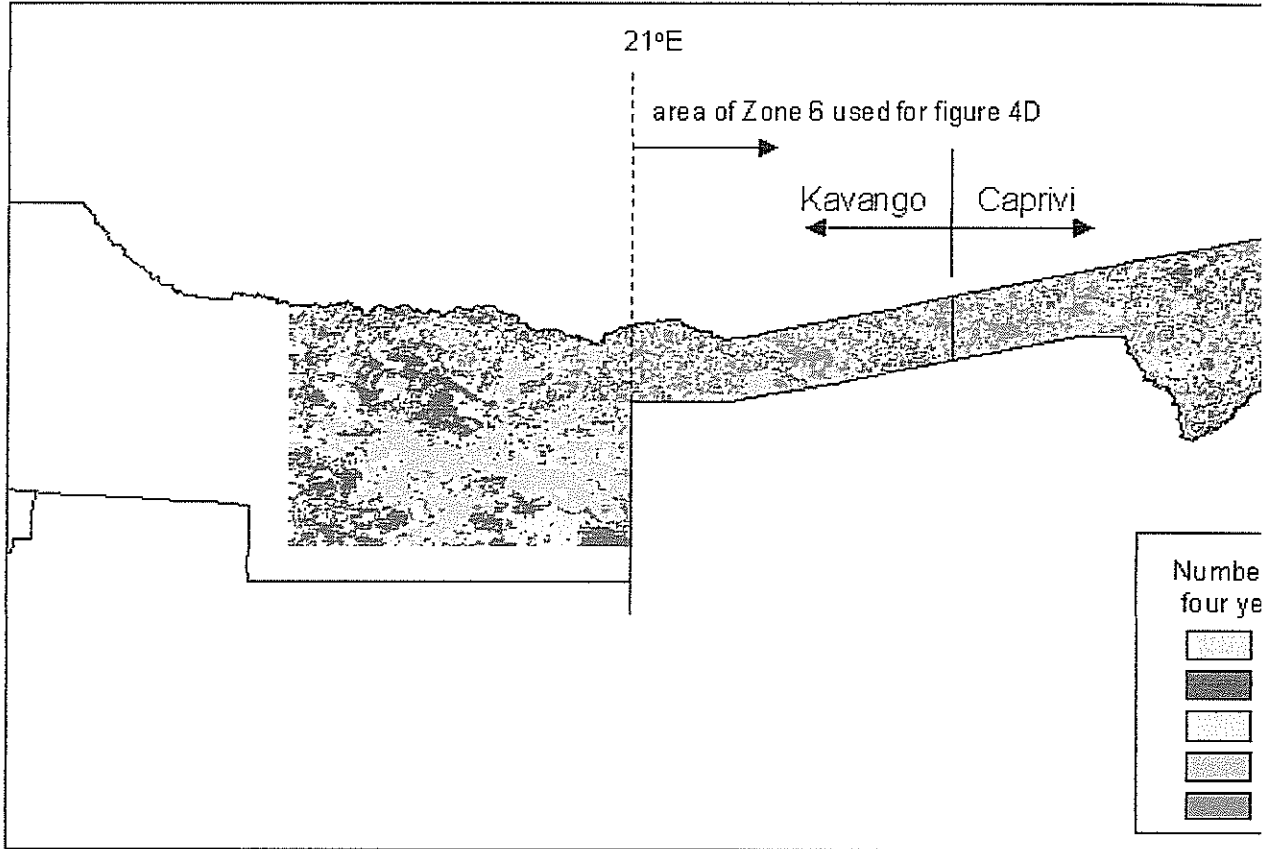
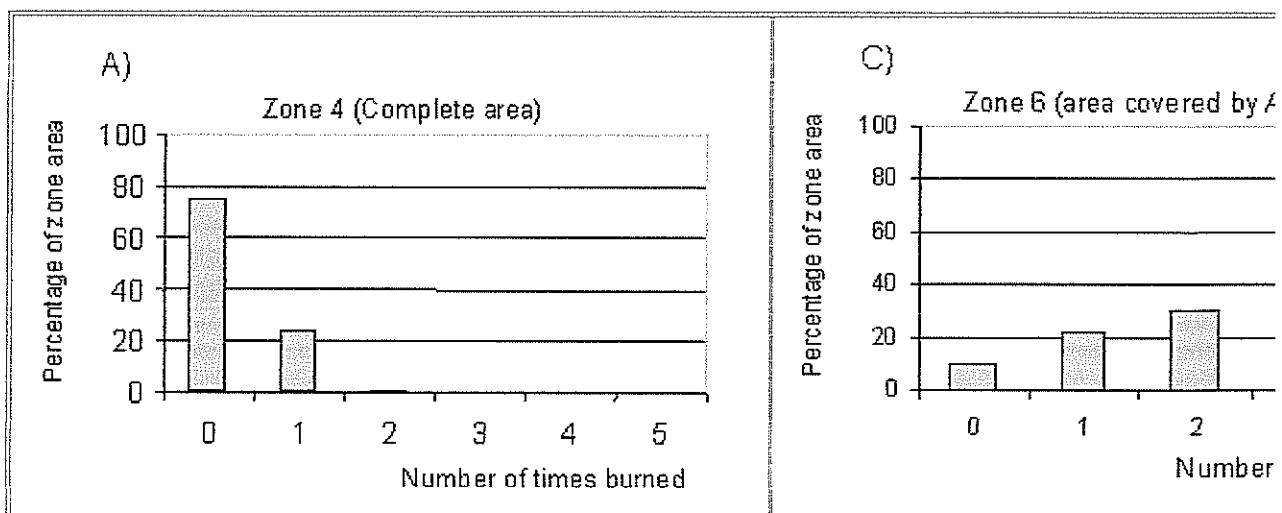


Figure 5. The number of times the areas of Zone 6 (routinely monitored by AVHRR) burned over a four year period (1996-1999).



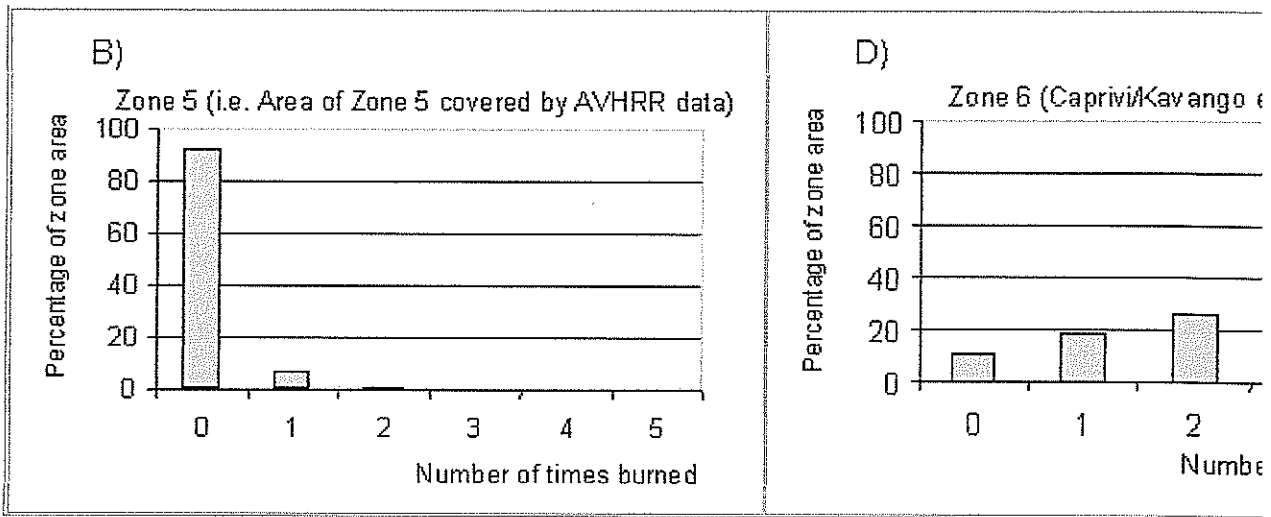


Figure 6. Percentage of land having burned different numbers of times within a set number of years. A and B show the percentage of Zones 4 and 5 that burned between 0 and five times during a five year period (1994-1998). C and D show the percentage of Zone 6 and the Caprivi-Kavango extension of Zone 6 (see Figure 5) that burned between 0 and four times within a four year period (1996-1999).