ECOLOGICAL ROLE OF FIRE

Compiled by: Bongani Finiza

1 INTRODUCTION

Natural or anthropogenic fires have a significant role in maintaining the biodiversity and functionality of ecosystems. Improper use of prescribed fires can be very destructive leading to a threat of property, human life and the environment. Fire has an altering effect on the distribution and arrangement of fauna and flora resulting in the restoration or disturbance of the ecological balance in an area.

In its natural regime cycle, fire has a fundamental management role in diverse vegetation types, fire managers have to prevent inappropriate application thereof that can cause severe damage to plant community structure and composition and worst of all; possible extinction of fire intolerant species. To conserve and maintain biomes, fires should be applied as an effective ecological tool to the fire dependent species.

According to Unwin (1989) and Chapman et al. (1997), unscientific application of fire to fire-adapted vegetation types, can alter the natural state of these communities permanently.

2 FIRE FOR SUSTAINABLE LAND USE

The use of fire in different types of land use has an important role in maintaining habitats, resource management and conservation, reducing fire threats and maintaining cultural values. Over time a system of integrated fire management has

developed in most communities which includes a variety of important uses of fire that sustain and maintain ecosystems and maximize the benefits brought about by sustainable use of fire. Integrated fire management focuses on challenging fire problems which are not properly addressed in the way modern society applies fire. It also facilitates decision-making with an understanding of the fire ecology and cultural aspects of affected ecosystems while keeping the needs of the people living within these ecosystems in mind (Myers, 2006). Figure 1 demonstrates integrated fire management structure.

Figure 1: Integrated fire management aim, an aid to decision-making pertaining to fire use, preservation and influence (Myers, 2006)

2.1 The need / necessity for using fire

Fire is a cheap and effective tool for managing, shaping and removing vegetation and its structure. Maintenance of habitats can be achieved through the practice of mosaic burning, which also has the natural ability of occurring in the wild lands (Rose et al., 1999; McCaw, 2000). Fire application also plays a role in pest and insect management (Komarek, 1971). The application of fire affects the soil nutrient level in the following ways (Seubert, 1974):

- The amount of bases in the soil increases markedly

- The amount of exchangeable ions such as calcium, magnesium, and potassium triples after burning
- There is a dramatical increase in the supply of available phosphorus
- There is no decrease in organic matter content

2.2 Fires as an ecological tool

The fire can be a very effective tool for different land use systems, management purposes and of ecological benefit for plants. Burning will enhance flower and fruit germination of a plant (Brown et al., 1989; Uchytil, 1992). Fires can be used to control bush encroachment to improve wildlife habitat (Wright et al., 1982). Fires can be applied in the environment in different ways for various intensions that may result in different effects (FOA, 2006):

- Natural fires in forests and wild-lands
- Burning with the intention of converting forest and fields for agricultural practices
- Agricultural burns to improve pastures as well as for the management of sugarcane lands
- Prescribed burns as a forest management tool
- Improving the environment for wildlife and flora especially on fire dependent ecosystems by implementing prescribed burns

3 ROLE OF FIRE IN ECOLOGICAL SUCCESSION

Fire can be very effective in influencing the natural cycle in ecological succession. It plays a significant role in breaking the seed dormancy and triggers the seed germination process. The plant community is subjected to change in structure, dominance and ground cover composition after the incidence of a fire occurring, for

instance re-sprouters are the first species to occur after a fire. Adequate soil moisture, abundant available soil and other factors will influence plant growth. Figure 2 illustrates the stages of plant ecological succession.

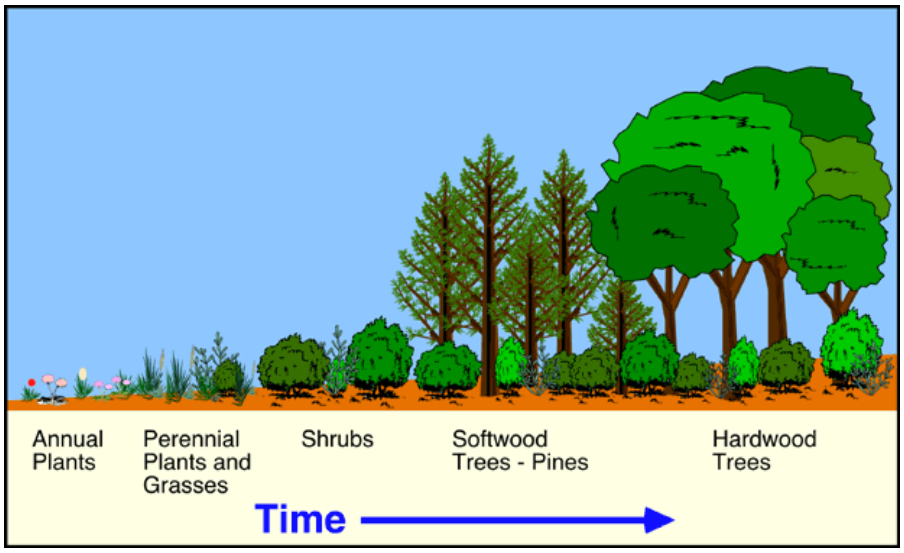

Figure 2: Plant succession progress taking place (Thomas et al., 1979)

3.1 Fire influence on fauna

Fires can be very destructive when it comes to fauna, but they are also beneficial in ensuring the natural migration and prevention of invading of exotic animal species from other ecosystems. Fire also has a potential of keeping the habitat for many animals and bird species under favourable conditions, since most of them prefer fresh blooming vegetation (Fox, 1983; Tasker et al., 1999).

Amphibians are more vulnerable to be killed by fire, since they are less mobile. Animals such as reptiles usually retreat to rocks and moist vegetation to seek refuge from the fire (Nichols et al., 1984). The response of birds from fire differs due to different behaviour patterns among them, for example some birds are attracted to the smoke where insects are abundant and driven away by fire to evade the harsh conditions of the area (Lyon et al., 1978; Nichols et al., 1984).

3.2 Influence of fire on biodiversity

Fire has the ability of altering the biodiversity in different ways as well as impacting the ecosystems structure (Duchesne, 1994). Fires create an opportunity for new vegetation to be naturally established in cleared sites. Annual burning ecosystems may be threatened by fire, if it occurs before mature plants can produce seeds (Chandler et al., 1983). Research evidence has revealed that in order to maintain biodiversity in grass ecosystems, fires must be applied in different intervals during a year to obtain a successful seedling establishment and productivity of different range of plants (Bragg, 1991). Fire frequency is of utmost importance for survival of some plants species and migration of certain animal species within the ecosystem.

3.3 Site nudation

Clearing should be applied after enough seed has been produced and are waiting for fire to trigger germination during mature vegetation removal. The following reasons can aid the application of fire in areas where fires are supposed to occur naturally, to knock-out the mature vegetation, were due to certain circumstances did not occur (Turner, 1998):

- To control bush encroachment
- To manage areas which could be a threat
- To remove old, unpalatable moribund material, this in turn has negative implications to the herbivores and the entire food chain
- To maintain plant and animal species biodiversity

3.4 Forage management and growth enhancement

Fire use in rangelands and savannas enhance growth of new and palatable foliage. Research has revealed that application of fire does not only help in maintaining the ecosystem but also helps in ensuring the availability of quality forage (Trollope et al.,

1999; Archibald et al., 2005). In South Africa and Namibia it was found that freshly burnt savannas have managed to produce new plant growth which provides palatable forage compared to unburnt savannah with mature grasses. A freshly burnt area attracts even large herbivores to the site and gives rest to other grazing so that they can recover (Trollope et al., 1999).

3.5 Vegetation disturbance

Climax community disturbance is needed to reduce and eliminate plant cover and to increase resource availability (Sousa, 1984). It is of utmost importance to understand the distinct vegetation disturbance events. Disturbance regimes can be categorized as the following (Turner, 1998):

- *Area or size* – area to be can described as area per event or area per time period
- *Distribution* – special distribution
- *Frequency* – means number of disturbance events per time period
- *Magnitude* – is expressed as intensity or severity
- *Return interval* – the average time interval between successive disturbance events

4 TYPES OF FIRE ECOSYSTEMS

As a result of fire, ecosystems have been categorized into four categories. They behave or respond differently to fire (Booysen et al., 1984; DeBano et al., 1998). Figure 3 gives an indication of the fire ecosystems which are found in South Africa:

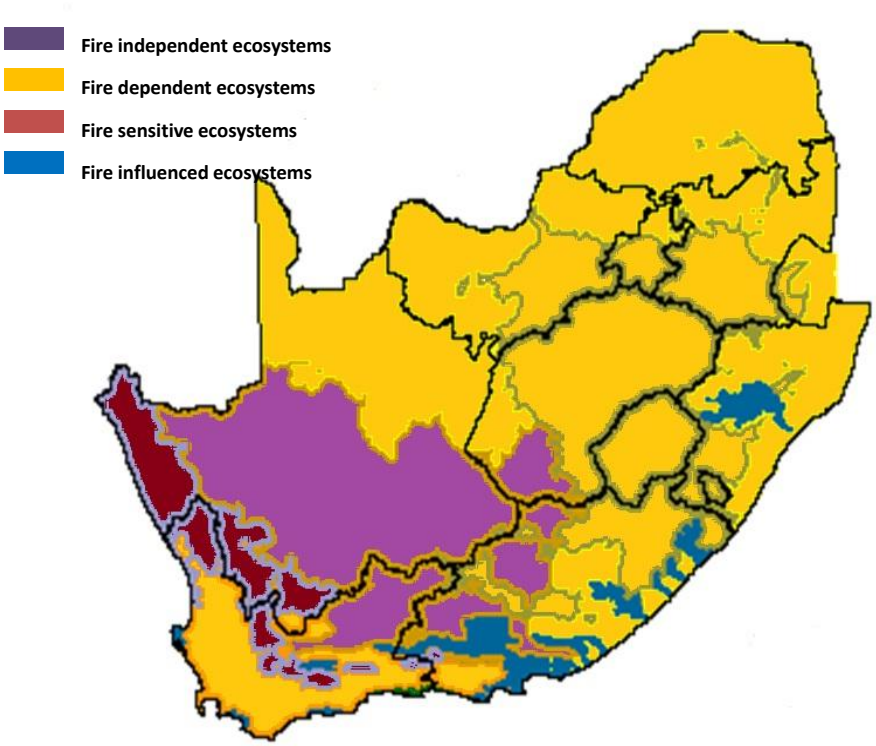

Figure 3: South African fire ecosystems types (adapted from S.A. Biomes) Low et al., 1998.

4.1 Independent ecosystems

Fire has little influence on areas such as these since they are too wet, too cold and are too dry to support fire and spread. Fire can only be a threat to these areas due to land use activities, invasion of species which do support fires and facilitate spread, and the influence of climate change (Booysen et al., 1984; DeBano et al., 1998).

4.2 Dependent ecosystems

Fire is essential to this ecosystem; these species are entirely depending on fire for their development and growth, also known as the fire-maintained ecosystems. The vegetation type is evolving to respond to fire regimes. Fire absence can lead to extinction of certain species and the ecosystem can change (Booysen et al., 1984;

DeBano et al., 1998). For example savanna, fynbos and temperate coniferous forests.

4.3 Sensitive ecosystems

Vegetation cover does not respond well to fire and if fires do occur there will be a high rate of mortality. This type of ecosystem is not flammable and vegetation structure and composition tends to hinder ignition and fire spread. If fires become more frequent in these types of ecosystems they will shift to a more fire prone vegetation. Sensitive ecosystems include tropical and subtropical broadleaved forests which are mostly found in the moisture and temperature zones (Booysen et al., 1984; DeBano et al., 1998).

4.4 Influenced ecosystems

They are mostly found in the transitional zones between fire dependent and fire sensitive or fire independent ecosystems. They are commonly sensitive ecosystems and may have some species which can respond to fire and facilitate the spread. Fires usually originate from adjacent fire dependent vegetation types and the spread properties will determine the spread rate and damage (Booysen et al., 1984; DeBano et al., 1998).

5 OTHER ECOLOGICAL BENEFITS OF FIRE

Fires are calculated to be beneficial in terms of environmental, social and economical. Fire can be used for land clearing. Soil fertility can be enhanced by the application of fire. There are some species which can be regenerated by the application of fire, such as *Acacia mearnsii*, this method is seen to be cost effective.

5.1 Economical and Social benefit

The use of fires across the world has a significant role in both the economy and in the social aspect. The application of fire can provide a variety of benefits, socially and economically, which is influenced to a large degree by the land-users objectives. Table 1 shows the benefits which can be obtained using fire as a tool especially by the agriculture and forestry industry (Guyon, et al., 2002).

Table 1: Benefits obtained from using fire both in the short and long-term (Guyon, et al., 2002)

	Immediate/Short-Term	Medium/Long-Term
Cost	Fire use is cheap for land-clearing	Lower maintenance cost
		Returns over crop performance
		Reduction of crop loss through pest and disease
Soil	Easy access for planting operations	
	Some tree species require ash beds	
Crop Protection	Less pest and diseases	
	Less competition for crops	
	Less fire hazard	

5.2 Nutrient recycler

Fire plays a role of quickly decomposing organic matter and influences nutrient availability which will lead to soil enrichment and promoting conditions that will be suitable for plant growth (Williams et al., 1994; Cheal, 1996;). Application of fire in

forest ecosystems help to release locked up nutrients in the slow decomposing layers of litter. Biological decomposition in cold and dry environmental condition is limiting and influencing the accumulation of plant debris.

6 CONCLUSION

The fire-dependent ecosystems are entirely reliant on fire for the survival of their biodiversity. Fire application has a number of direct and indirect benefits, and thus it is of utmost importance to manage and by all means to maintain fire regimes especially in fire-dependent ecosystems. Most of the ecosystems and biodiversity across the world are dependent on fire for their existence and survival. Fires also have a positive influence on flora and fauna abundance. There are types of species which can become extinct by the absence of fire. Furthermore, there are certain species which cannot germinate unless fired. Fire is used by different land-users and it presents a merit of benefits and if it is applied appropriately it can be a cheap and effective management tool.