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# Wildland fire-related fatalities in South Africa – A 1994 Case study and looking back at the year 2001

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ABSTRACT: During 1994 a wildfire occurred in even-aged industrial plantations, in the Sabie district of the Mpumalanga Province of South Africa, which caused the death of ten fire fighters, while another eight were injured. In the history of South African Forestry, this was the highest number of fire fighters that died and were injured during a single plantation fire. The reasons for these fatalities can be attributed to a number of factors, which include (i) the occurrence of extreme spotting conditions, (ii) lack of escape routes, (iii) wrong or unclear fire fighting instructions and (iv) lack of training in basic fire fighting procedures and (v) vital safety measures not being applied. During the last decade, South Africa also experienced regular (almost yearly) fatalities as a result of motor accidents in thick smoke originating from wildfires. During recent years up to nine people died yearly as a result of these accidents, in smoke from uncontrolled or controlled fynbos or grassland fires. This paper will discuss methods to improve this serious situation by means of training of fire fighters (and prescribed burners) in smoke management, and by means of better co-operation with the Weather Bureau and other Government bodies, such as traffic control institutions. During the 4-6 September 2001 period, thirty-one fire-related fatalities were experienced in the northeastern part of South Africa. Twenty-three of these were civilians collecting grass for thatching in the Kruger National Park. They were trapped by an uncontrolled grassland wildfire in a temporary camp, where they stayed overnight. Seven civilians also lost their lives during fires elsewhere, and one fire fighter fatality was recorded at yet another wildfire site in the area. The lack of public awareness about the impact of serious wildfires is a major national shortcoming. However, the absence of a suitable disaster management plans - as well as proper assessment of wildfire situations – have also been identified as major stumbling blocks. The implementation of improved fire danger rating is also recommended, as most of the 2001 wildfires occurred within a very short (three-day) period, during which these extreme fire weather conditions were experienced. Effective early warning could also have avoided (or at least reduced) the high number of fatalities. It is recommended that the South African Government, in co-operation with private institutions, give urgent attention to the problem areas identified.

## 1 INTRODUCTION

It is important that any fatalities as a result of wildfires are thoroughly investigated, to prevent reoccurrence of such tragedies in the future. Sometimes action as a result of panic directly or indirectly causes mortality, but it can also in certain cases be attributed to a lack of knowledge about what can be expected in terms of fire behaviour, and in a few instances wrong command decisions gave rise to fire fighter mortality.

South Africa is no exception to these problems, and although some in-depth investigations have been conducted in the case of most fatalities experienced, we need to investigate some of these more closely. In this report, we will look at aspects such as weather conditions, terrain, the status of fuel and fire behaviour experienced and other relating factors. When some of these fires were experienced, incorrect fire fighting procedures were followed, related to unsuitable Incidence Command Procedures. Later in this report some recommendations will be formulated to prevent future mortality as a result of wildland fires.

It was particularly during the 1994 and 2001 wildfires that losses in terms of human lives where very serious (loosing 10 and 23 people respectively as a result of two wildfire occurrences), but some other recent fatalities during 2001 also need to be investigated and discussed. In this paper all known circumstances will be studied to provide some solutions for local fire management staff. The wildfire cases discussed in this paper will relate to both fire fighting staff deaths, as well as fatalities not related to fire fighting action.

## 2 THE 1994 SABIE FIRE

### 2.1 *Circumstances in relation to fire weather, fuel and terrain*

During the dry winter season of 1994, a fire was ignited at approximately 13h35 SA time, inside a clearfelled industrial plantation stand, situated near a minor road inside this plantation. The cause of the fire was never clearly established, although arson or negligence was thought to be the most probable reason for the fire. The fuel base at the fire ignition point was a light slash cover, with a dominating *Setaria* weed base, which only provided a small percentage available fuel, with a low profile. Slope was an average 7 degrees, with a southwesterly aspect.

Average wind speed at the time of ignition was 12 km/hour (10-m wind speed above the crown canopy) from a northwesterly direction and the fuel was very dry after a long spell without rain. Air temperature was high at approx. 29.5 degrees C, and a relative humidity of 14% was recorded.

The fire spread very slowly at first, mainly because the site was situated on the leeside of an adjoining mature timber stand. When the first fire manager arrived at the scene by 13h43, he decided that the fire could probably be contained by fire fighters at his disposal, without aerial assistance. The first fire fighters then started fighting the fire by 13h57.

As the fire started spreading outside the leeside area of the trees, the head fire became directly exposed to a now somewhat stronger wind (average of 15 km/hr at 10-m). Although the slope was actually becoming more unfavourable for a fast fire rate of spread (10 degrees, with a southerly aspect sloping downwards in the direction of maximum spread), the fire started spotting over a minor road, into a 2.5 year old, even-aged *Pinus patula* stand, becoming uncontrollable within minutes.

This sequence of events, and changing fire behaviour, is illustrated in Table 1. Spotting started at approximately 14h20, but it was the higher fire intensity and abundance of spotting at approximately 14h45 that surrounded some of the fire fighters based at the head of the fire, some of which escaped when one of the fire managers drove through the approaching head fire front, with a load of fire fighters at the back of his van (some of which were injured from heat exposure in the process). Ten fire fighters died on the scene, in the subsequent Burnover.

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Table 1. Illustration of the sequence of fire spread, in relation to fuel characteristics and simulated fire behaviour, calculated with the use of developed custom models in BEHAVE (Burgan and Rothermel, 1984).

| **Fire behaviour** | **In *Setaria* 13h35** | **In *Setaria* 14h20** | **In *P. patula* 14h25** | **In *P. patula* 14h45** |
|---|---|---|---|---|
| Fire Rate of Spread (m/min.) | 3.0 | 5.0 | 19.0 | 48.0 |
| Flame Length (m) | 0.6 | 0.9 | 3.4 | 5.5 |
| Heat per Unit Area (kJ/sq.m.) | 2395 | 2355 | 11679 | 13137 |
| Fireline Intensity (kW/m) | 100 | 187 | 3741 | 10439 |
| Maximum Spotting Distance (km) | 0.0 | 0.2 | 0.6 | 1.1 |

### 2.2 *Cause(s) for the Burnover and mortality experienced*

The main cause of the sudden increase in fire intensity, increase in fire rate of spread and increased spotting potential in such a short period of time was not so much the change in weather conditions (wind speed only increased from 12 to 15 km/hour during the period) but the drastic change in the fuel status, from a low profile slash fuel with a mainly green *Setaria* weed cover, to a 2.5 year old *Pinus patula* stand with a 2.5 year old dynamic grassland base, with added slash from the previous rotation. This actually overshadowed the favourable (down-sloping) topographical conditions experienced in the direction of maximum spread. This caused fire behaviour parameters to increase approximately five times within minutes (Table 1), and resulted in the fire becoming uncontainable. The operational fire manager in control of the fire fighting operations misjudged the situation, and should have appreciated the changing fuel conditions. Under those conditions, he should never have dispatched the crew to the head of the fire to try to contain it.

A second contributing factor, was that the crew was send onto a plantation road which ended in a *cul de sac*, with no way out but to go back from where they came from. If this road had an escape route, the men would still have been alive. A helicopter on the scene at that crucial time might also have brought them to safety, where they were trapped by surrounding spot fires. The whole terrible sequence of events was photographed from a circling spotter plane.

## 3 MOTOR ACCIDENTS IN THICK SMOKE

This aspect is not getting sufficient attention in South Africa, although at least nine people lost their lives during the 1999 – 2001 period, in motor accidents directly related to thick smoke from wildfires. Most of these fatalities occurred during the dry winter season, in grassland plains of the summer rainfall area in South Africa. In one extreme case the grassland-covered road shoulders were ignited by arsonists from a nearby motor repair shop. This was done to create an accident and in that way to increase their turnover!

Although lack of smoke management during prescribed burning application has been identified as one cause of motor accidents in some regions, no fatalities have been recorded to the knowledge of the writer, and recent fatalities can all be linked to uncontrolled grassland wildfires.

During extreme fire weather conditions, grassland wildfires spread very fast, and surface fires can reach a rate of spread of up to 6 km/hour during strong windy conditions (Cheney and Sullivan, 1997). High spotting potential can even make such situations worse. That is one of the reasons why authorities, such as traffic officers and fire fighting teams, can many times not reach such wildfire sites in time to warn motorists, particularly in the sparsely populated rural areas of South Africa.

Lack of understanding of the danger that thick smoke presents in the case of fast-moving wildfires, by both the authorities and the public at large, is another shortcoming, which indirectly contributed to the high number of smoke-related fatalities experienced in South Africa. As a result of the lack of urgency experienced in such cases, airborne transport to such wildfire scenes is also seldom used, or at least not immediately after receiving the alarm.

## 4 4 – 6 SEPTEMBER 2001

### 4.1 *Thirty fatalities in three days*

During this period, extremely high fire hazard conditions occurred after many months without rain, and strong (mainly) west to northwesterly winds were experienced. Losses during these three days can be summarised as follows (Table 2):

Table 2. Summary of losses experienced in the summer rainfall area of South Africa, during the 4 – 6 September 2001 period (Fire Report compiled by the FFA, tabled during FITTSA meeting 26-27 November 2001).

| Name of wildfire | Hectare burned | Material/animal losses | Loss of human lives |
|---|---|---|---|
| Kruger National Park | > 250 000 ha Savanna grassland | A temporary camping site, numerous wild animals and grazing | 23 lives |
| Helvetia | 700 ha Pine plantations and 3000 ha grassland | Plantations and grazing | No record |
| Lenjane | 500 ha plantations | Plantations | No record |
| Kambula and Scheepersnek | 18 000 ha plantations | 1 house and outbuildings, 1 car, 1 tractor and 100 cattle and plantations | 5 lives |
| Speenkoppies | 1500 ha plantations and 1000 ha grassland | Plantations and grazing | None |
| Mad Max | 800 ha of plantations and 4000 ha of grassland | Plantations and grazing | None |
| Heinertsburg | 170 ha of plantations and 200 ha of grassland | Plantations and grazing | None |
| Usutu | 800 ha of plantations and 500 ha of grassland | Plantations and grazing | None |
| The Brooke | 5000 ha of plantations | Plantations | None |
| Carolina | Thousands of ha of grassland | One farmhouse and grazing | None |
| Ermelo* | 100 000 ha of grassland | Grazing | No record |
| Volksrust* | Plantations, unknown area | Plantations and 14 houses | One life |
| Northern Province* | 70 000 ha of grassland and plantations | Plantation and orchards | None |
| Tzaneen and Letsitele* | Unknown | Timber pole factory 15000 fruit trees and 63 head of game | None |
| Bandalierskop and Soekmekaar* | 50 000 ha of grassland | Orchards and grazing | None |
| Giyani* | 1200 ha of grassland | Grazing, game camp and lapa | None |
| Mamre* | 1300 ha of plantations and 1000 ha of grassland | Grazing and plantations | One fire fighter |

* = These fires occurred during the 14th of August to the 6th of September 2001 period

Apart from the fatalities summarised in Table 2, at least one person also died in a motor accident in thick smoke. Thirty-one people lost there lives in these August/September 2001 fires, approximately half a million ha of grassland and savanna bush were lost as well as 30 000 ha of commercial timber plantations, and millions of Dollars worth of other property was lost or damaged. Most remarkable, more than 80% of this was lost during the fires experienced during 4 – 6 September 2002 period. During this period, thirty out of the thirty-one total fatalities were recorded.

What made this three-day period so remarkable? The very strong windy conditions experienced, making all these fires uncontrollable within minutes after ignition. The Fire Danger Rating Index did identify this period as a typical "Red – extremely dangerous" fire hazard, and in the forestry regions all personnel, vehicles and equipment were removed from the field and stopped (LFPA *et al.,* 1987). All fire crews and equipment were also on full standby. The status of the alert situation, in the agricultural and nature conservation sectors at the time, is not known.

## 4.2 *The Kruger National Park Fire*

This fire burned through an amazing 250 000 ha of savanna-grassland and bush in the southern part of the nature reserve, and also burned through a temporary camp set up for workers cutting thatch material in the field, for roofing purposes. Twenty-three of these people lost their lives. The circumstances around this disaster have still not been made public at the time of writing (the case is still under in-house investigation).

One aspect is, however, clear at this stage: The general age of the grassland at the time the wildfire occurred was much older than it used to be in previous years, particularly if compared to the period before 1992. Above-average grassland biomass was also produced during recent years because of the good rainy seasons experienced. This combined effect of age and increased biomass, contributed significantly to the high fuel loading (all of it cured) at the time the fire occurred and directly caused such an enormous area to be burned by this uncontrollable fire.

To understand how the Kruger National Park arrived at such an extreme fire hazard status just before the fire, it is necessary to study the history of fire management policies applied in the Park since its proclamation, during 1926 (Table 3).

Table 3. Different fire management policies applied in the Kruger National Park since its proclamation in 1926 (van Wilgen *et al.*, 1990, and van Wilgen *et al.*, 1998).

| **Dates** | **Approach to fire management** | **Rationale for approach** |
|---|---|---|
| 1926 – 1947 | Occasional and limited burning | Provision of green grazing for wildlife |
| 1948 – 1956 | All prescribed burning stopped and fire breaks established to assist in the control of wildfire | Concern about the perceived negative effects of fire |
| 1957 – 1974 | Formal system of prescribed burning once every three years in spring on fixed management areas ("burning blocks") | Necessity of fire in the maintenance of ecosystem health recognized |
| 1975 – 1992 | As above, but allowing of longer periods between fires in drier areas, with season varied between late summer and autumn | Application of fires over longer period spread the workload more evenly and ensured better utilization of post-fire grazing. |
| 1993 to present | Lightning fires combined with suppression of anthropogenic fires | Simulation of "natural" conditions under which the biota evolved |

The policy followed after 1992 (Table 3) directly contributed to the extreme grassland fuel loading before the 4$^{th}$ of September 2001 fire occurred. Large fires did burn in the Kruger National Park before, and the 1953 fire covered 25% of the park, the 1969 fires burned 36% of the park, and between 1992 and 1999 22% of the park was covered by fire. It has also been determined that the large fires do not have any dramatic effects on the ecosystem in the medium term (Romme *et al.*, 1998, in Geldenhuys *et al.*, in preparation). This conclusion will support the idea that substitution of occasional large fires by a series of prescribed burns would not have any negative effect on the ecosystem, and that a combination of prescribed burning application and the allowance of lighting fire in pre-selected areas could form the solution for the park. Latest changes in the fire management policy of the Kruger National Park appear to point in this direction.

## 5 CONCLUSIONS AND RECOMMENDATIONS

### 5.1 *Prescribed burning and fuel reduction measures for fire prevention purposes*

The role of fire in the South African ecosystems, as well as the need for prescribed burning, has been emphasized during the past decade. A decrease in the percentage areas prescribed burned have indirectly resulted in larger wildfire areas being burned by higher intensity fires than would otherwise have been the case. This may indirectly have attributed to the high number of fatalities and increased fire damage recorded during recent years during South African fires. In the past decade this pattern has been observed for wildfires burning through industrial plantations, fynbos and various types of grassland and savanna vegetation (own observations).

It is important that a good balance is found between ecological requirements, fuel and fire management in South Africa to reduce the impact of wildfires and subsequent loss of life and property.

### 5.2 *Smoke management during prescribed burning operations and when wildfires occur*

This subject should form an integrated part of fire management training, and fire managers should be in a position to know how to consider smoke management when prescribed burning is applied near public roads, urban areas, railways and airports. Traffic control officers should have access to the use of helicopters to transport them to threatening wildfire sites, to control, divert or stop traffic flow as soon as possible after an uncontrolled wildfire has been reported. Fire detection in these cases should also directly be channeled to these authorities.

### 5.3 *Dangerous camping, rural and urban interface sites*

The temporary camping site in the Kruger National Park, used for the contract workers during the period they collected the thatch material, was apparently not safe enough for temporary residence during the 2001 fire season. This may have equally applied to other urban interface problem areas, identified elsewhere in the country.

The responsible authorities will have to ensure that these problem areas are dealt with on a continuous basis, particularly before the fire season, and also in the case of temporary residence sites used. Areas around more permanent residence sites must also always be cleared effectively of burnable material, to safeguard houses and other property against wildfire damage. In the case of five of the wildfires discussed in this paper, camping sites, houses or other property such as farms, were destroyed (Table 2), where early attention to housekeeping in and around these sites could have made a difference.

### 5.4 *Maintenance of access and escape routes*

To get to a fire site in the shortest possible time, the main access roads must be brought in a good condition before the fire season. Not only will rough road surfaces waste valuable time of fire fighters to get to the fire scene, but may slow down an escape at a crucial stage. Where possible, escape routes should also be constructed and, if this is not possible, fire managers should take note of any *cul de sac* roads in the area under their control.

## 5.5 *Predicting fire behaviour*

It is important that fire managers can appreciate and predict fire behaviour during wildfires, and can related this to fuel characteristics, weather conditions and terrain features. The most common cause of Burnover has been identified as sudden change in fire behaviour, and has in Australia caused 15 out of 37 Burnover incidents. In a further five cases, existing fire behaviour was underestimated (unknown author, 1999). Wrong appreciation of fire behaviour directly contributed to the Sabie 1994 fatalities experienced in South Africa (par. 2.2). Experienced fire managers, who know the terrain, fuel characteristics and weather patterns that can be expected, can appreciate and predict fire behaviour with confidence, and will be better positioned to safeguard crews against life threatening situations.

## 5.6 *Improved housekeeping and fuel management*

In many of the wildfire fatalities experienced in South Africa, there was a clear lack of housekeeping around homesteads, farms and (in the case of 2001 the Kruger National Park fire) around temporary camping and residence sites. Similar cases of mortality have been recorded earlier in South Africa, in informal settlements, which have been developed inside natural vegetation with total disregard of the (sometimes explosive) situation created by such action. The whole approach to urban interface problems in South Africa requires more dedicated action, to avoid future mortality and damage if wildfires are experienced within these conflict areas.

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