# The perception of commercial forestry managers of fire management challenges in rural Mpumalanga, South Africa

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## PREFACE AND ACKNOWLEDGEMENTS

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# ABSTRACT

Around 20 000ha of plantation area in South Africa is lost per annum to forest fires, with a direct annual economic plantation loss of R402 million. The majority of larger forestry organisations are well equipped to deal with forest fires, with the assistance of well organised Fire Protection Associations (FPAs). Despite forestry organisations' focus on fire prevention, the number of wildfires remains unacceptably high, threatening the sustainability of commercial forestry in Mpumalanga.

**Research Aim:** This study identified and evaluated the perception of commercial forestry managers of fire prevention challenges and opportunities in the study area. Understanding the forestry managers' perception of fire prevention challenges and identifying opportunities may assist in changing fire prevention practices, to reduce the devastating impact of fires on commercial forestry.

**Methodology:** The research used an embedded mixed method design, with the convergent use of quantitative and qualitative data. The quantitative Likert Scale data formed the primary dataset to determine the level of agreement of commercial forestry managers with fire prevention challenges identified in the literature review, while the qualitative data was used to better understand the fire prevention challenges and identify fire prevention opportunities.

**Results and conclusions:**

To develop an effective fire prevention strategy, a better analysis of fire causes and their locations at FPA level is needed, driven by larger forestry organisations. Communities within or surrounding forestry areas pose a high fire risk to commercial forestry. Maintaining sound community relations and understanding the socio-economic needs of high fire risk communities, a high fire risk to forestry, are community support opportunities for forestry organisations. Support could include corporate social investment (CSI) projects, such as providing cattle grazing, soccer fields, training, potable water and preferential employment as examples. This could further reduce the most important source of wildfires, which occur mostly in community areas. Support by forestry organisations should be prioritised by focussing on the high fire risk communities, identified by spatial fire location data provided by the camera fire detection centres. Fire awareness education should focus on the identified high risk communities and driven by forestry organisations through their FPAs.

Engineering fire prevention options, such as fuel load reduction (burning) and mechanical fuel management should focus more on fuel load management at the regional level, rather than on

the individual landowner level. Fuel management programmes should focus on regionally identified high fire risk areas.

Less than 10% of forest residue is currently used as a fuel source for bio-energy. This provides an opportunity to reduce fuel loads in a more environmentally sustainable way, while reducing smoke emissions, soil damage and biomass wastage from burning.

Compliance to and enforcement of FPA rules and regulations are currently ineffective. To improve the administration of the National Veld and Forest Fire Act that aims to prevent and combat wildfires in South Africa, and ensure that it remains responsive and relevant in combatting and preventing veld and forest fires, the *National Veld and Forest Fire Amendment Bill of 2021* was recently introduced in parliament. The Bill aims to ensure that local government drives and implements the Act, through Fire Protection Associations, by ensuring that state landowners become FPA members, include FPA regulations in municipal by-laws and training municipal law enforcement officers to enforce the legal provisions regarding veld fires. If the Bill is adopted and implemented, it will address the key enforcement challenges identified in this study.

**Recommendations for future research**

Further research is required to better understand the socio-economic challenges facing high fire risk communities, their impact as a source of fires in commercial forestry areas and what could be done to address these challenges. Such research could further assist to reduce the number of accidental fires. Research to investigate the impediments to commercial forestry organisations in the increased use of available biomass for bio-energy as a fuel load reduction alternative, may also promote the implementation of this fire prevention opportunity.

**Keywords: Commercial Forestry (Forestry), Fire Prevention Challenges, Fire Prevention opportunities**

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **AFIS** | Advanced Fire Information System |
| **CSIR** | Council for Scientific and Industrial Research |
| **DAFF** | Department of Agriculture, Forestry and Fisheries |
| **EIA** | Environmental Impact Assessment |
| **EVS** | Envirovision Solutions camera fire detection centres |
| **FDI** | Fire Danger Index |
| **FMU** | Forest Management Unit |
| **FPA** | Fire Protection Association |
| **GIS** | Geographical Information System |
| **IDP** | Integrated Development Plan |
| **KZN** | Kwazulu-Natal |
| **LEFPA** | Lowveld and Escarpment Fire Protection Association |
| **MAT** | Mean Annual Temperature |
| **MFPA** | Mkhondo Fire Protection Association |
| **MUFPA** | Mpumalanga Umbrella Fire Protection Association |
| **NEMA** | National Environmental Management Act 107 of 1998 |
| **NFDRS** | National Fire Danger Rating System |
| **NVFFA** | National Veld and Forest Fire Act 101 of 1998 |
| **NWA** | National Water Act 36 of 1998 |
| **PAFPA** | Platorand Area Fire Protection Association |
| **PMB** | Prescribed management burning |

| | |
|---|---|
| **RSA** | Republic of South Africa (South Africa) |
| **SOE** | State owned enterprises |
| **UFPA** | Umpiluzi Fire Protection Association |

# KEY DEFINITIONS

**Introductory Note:**

Commercial forestry organisations produce raw materials for different products requiring different plantation management prescriptions. These may have an impact on fire prevention, and fire fuel management practices in particular. Therefore, it is important to understand the forestry terminology used in this dissertation.

**Clearfelling:** The harvesting of all the trees in specific compartments (plantation management units) at the end of the rotation (growing cycle).

**Commercial forestry:** Large blocks of exotic trees planted in plantation form (straight rows), which are actively managed to produce logs suitable for specific products. The term *"forestry"* will be used in the text.

**Commercial forestry industry:** The entire value chain starting with the conversion of exotic commercial tree species in plantation form into raw materials (logs) for use in the secondary processing of products with different specifications. Examples are pulp, cellulose, poles, veneer, mining timber, wood chips and lumber, which are processed further into end products. Also referred to as the "*forestry industry".*

**Commercial plantations:** Can be used as a synonym for commercial forestry. The term "*forestry"* will be used in the text when referring to forestry landholdings as a whole, while *''plantations*" will be used when referring specifically to the production areas which are commercially harvested.

**Communities:** Previously disadvantaged individuals in rural forestry areas, far from who have resource challenges, particularly land. These resource challenges need to be addressed to ensure the sustainability of the forestry industry e.g. the incidence of fires (Ojwang A., 2000:1).

**Compartment:** The smallest management units of forestry plantations, with the same age, species and management prescriptions, which are grown for a specific management objective (end product).

**Fire management:** ***"****Fire management is the discipline of using fire to achieve land management and traditional use objectives, together with the safeguarding of life, property and resources through the prevention, detection, control, restriction and suppression of fire in forest and other vegetation in rural areas"* (FAO, 2006:3).

**Fire prevention:** ***"****The means of reducing or preventing the number of unwanted, uncontrolled or escaped wildfires"* (Heikela et al., 2007:62).

**Forest management unit:** A group of plantations, managed as one unit over the rotation period to produce a long term sustainable volume of raw material for specific end use forest products.

**Forest products processing plants:** Production facilities using exotic commercial timber as raw material for the production of end products or input products for downstream processing.

**Forestry organisations:** A collective term referring to the six large forestry legal entities in this dissertation, which are made up of listed companies, parastatals and co-operatives.

**Management objective:** The specific end product for which commercial trees are grown (e.g. sawtimber, plywood, pulp, poles or mining timber) which require different species and management prescriptions with possible impacts on fire prevention (Bakker & Nel, 2000:194-195).

**Mechanical fuel management (manipulation):** The altering of fuel load characteristics by the manipulation of the spatial geometry, the size of fuel fractions, levels of fuel compaction or the mixing of fire fuel into soil to prevent fires, to raise the ignition threshold in unfavourable weather conditions or reduce the intensity of fires (Rummer, 2010:1-5).

**Non-commercial areas:** Areas not planted with commercial trees, making up roughly a third of total forestry land holdings, which are managed as conservation areas to limit the environmental footprint to production areas while promoting biodiversity and ecosystem services Forestry South Africa, 2019c).

**Prescribed management burning:** The use of fire as a management tool to reduce fuel loads (Meira-Castro *et al*., 2015:3011).

**Pruning:** The removal of tree branches in plantations to improve the quality, if necessary of the final product (Owen, 2000:730).

**Rotation**: The time period in years between establishment (planting) and clearfelling (harvesting) of standing commercial trees, normally varying from 8 to 30 years in South Africa.

**Standing compartments or plantations:** Management units in a commercial timber plantation where the commercial tree species have been established and are actively growing.

**Thinnings**: The selective removal or felling of trees at specified intervals to reduce competition, stimulate diameter growth to increase the yield of useful end products (Owen, 2000:732).

**Understory burning:** The use of low intensity prescribed management burning in standing plantations to reduce fuel loads by burning a portion of the litter layer without damaging the trees or humus layer (De Ronde *et al*., 1990:217)

# TABLE OF CONTENTS

**PREFACE AND ACKNOWLEDGEMENTS** ..... **I**

**ABSTRACT** ..... **II**

**ABBREVIATIONS AND ACRONYMS** ..... **IV**

**KEY DEFINITIONS** ..... **VI**

**CHAPTER 1 INTRODUCTION** ..... **1**

**1.1 The importance of the commercial forestry industry in rural Mpumalanga** ..... **1**

**1.2 The extent of fire problems in forestry** ..... **1**

**1.3 Fire risk in Mpumalanga forest plantations** ..... **3**

1.3.1 Climate, vegetation and fire risk ..... 3

1.3.2 Climate change and future fire risk ..... 5

**1.4 Fire management and fire prevention** ..... **6**

**1.5 Problem statement and rationale for the study** ..... **7**

**1.6 Research aim / objective / question** ..... **7**

**1.7 Structure and outline of the dissertation** ..... **8**

**1.8 Delineation** ..... **9**

**CHAPTER 2 LITERATURE REVIEW** ..... **11**

**2.1 Introduction** ..... **11**

**2.2 The National Veld and Forest Fire Act 101 of 1998 (NVFFA)** ..... **11**

**2.3 Fire prevention framework** ..... **12**

**2.4 Fire causes and their locations** ..... **12**

**2.5 The role of education and awareness in fire prevention ..... 16**

2.5.1 Fire awareness in fire prevention ..... 16

2.5.2 Fire danger rating indices ..... 16

**2.6 Engineering options in fire prevention ..... 17**

2.6.1 Factors to consider in fuel management ..... 17

2.6.2 Burning as a fuel management method ..... 19

2.6.2.1 Strategic fuel load reduction across boundaries on a landscape level ..... 19

2.6.2.2 Prescribed management burning in standing plantation commercial compartments ..... 19

2.6.2.3 Prescribed management burning after timber clearfelling ..... 20

2.6.2.4 Burning of non-commercial areas ..... 21

2.6.3 The topographic positioning of firebreaks in the landscape ..... 21

2.6.4 Other fuel load management measures ..... 21

2.6.4.1 The removal of unutilised biomass for biofuel and bio-energy ..... 22

2.6.4.2 The fire prevention and social benefits of controlled cattle grazing by communities ..... 22

**2.7 The role of compliance and enforcement in fire prevention ..... 23**

2.7.1 FPA membership ..... 23

2.7.2 FPA rules and regulations ..... 24

2.7.2.1 Minimum resource and equipment requirements using Lowveld and Escarpment FPA as an example ..... 24

2.7.2.2 The burning prohibition period and burning permits ..... 25

2.7.2.3 Offences and penalties ..... 26

**2.8 Conclusion ..... 27**

**CHAPTER 3 METHODOLOGY ..... 28**

**3.1 Introduction ..... 28**

**3.2 Research design ..... 28**

**3.3 The identification of fire prevention challenges and opportunities ..... 29**

**3.4 Participant selection and sampling ..... 29**

3.4.1 Selection of participant organisations ..... 29

3.4.2 Sampling technique, selection of participant individuals and sample size ..... 30

3.4.3 Development and testing of the questionnaire ..... 31

3.4.3.1 Closed ended questions – quantitative data ..... 31

3.4.3.2 Open ended questions – qualitative data ..... 33

**3.5 Data collection and completion of the questionnaires ..... 33**

**3.6 Data analysis ..... 33**

3.6.1 Quantitative data analysis ..... 33

3.6.2 Qualitative data analysis ..... 34

**3.7 Ethical considerations and informed consent ..... 34**

**3.8 Limitations to this study ..... 35**

**3.9 Conclusion ..... 35**

**CHAPTER 4: DATA ANALYSIS AND DISCUSSION ..... 37**

**4.1 Introduction ..... 37**

**4.2 Profile of participants, the study areas and the organisations ..... 37**

4.2.1 Profile of the study areas ..... 37

4.2.2 Profile of the participant organisations ..... 38

4.2.3 Profile of individual participants ..... 38

**4.3 Fire causes and their locations ..... 39**

4.3.1 The lack of knowledge of fire causes, their locations, opinions on the levels of fire reporting and their impacts on fire prevention ..... 39

4.3.2 The levels of arson fires in forestry areas and accuracy of reporting..... 42

4.3.2.1 Levels of arson fires..... 42

4.3.2.2 The accuracy of arson fire reporting ..... 42

4.3.2.3 The reporting levels of arson fires to the police..... 43

4.3.3 The impact of communities, including informal settlements, on fire prevention..... 44

4.3.3.1 The presence of communities, including informal settlements, in forestry areas ..... 44

4.3.3.2 Perceptions on the reasons why communities start fires..... 45

4.3.4 The risk posed by lightning fires in forestry areas ..... 47

**4.4 The role of education and fire awareness in fire prevention ..... 48**

4.4.1 The levels of fire awareness and its impact on the number of fires in forestry areas..... 48

4.4.2 Opportunities to improve fire awareness in forestry areas ..... 48

4.4.3 The accuracy of the Lowveld Fire Danger Index fire danger predictions ..... 49

**4.5 Engineering options for fire prevention..... 50**

4.5.1 Strategic regional fuel load reduction..... 50

4.5.1.1 The effectiveness of regional strategic fuel load reduction..... 50

4.5.1.2 Opportunities for improving strategic fuel load management..... 50

4.5.2 Fuel load management in standing timber compartments..... 51

4.5.2.1 The effectiveness of fuel load reduction in standing forestry compartments..... 51

4.5.2.2 Burning as a fuel management option in standing trees ..... 51

4.5.2.3 Fuel load reduction methods, apart from burning, in standing trees ..... 52

4.5.3 Fuel load management of harvesting residue in clearfelled (harvested) compartments ..... 53

4.5.3.1 The sufficiency of fuel load reduction in clearfelled compartments ..... 53

4.5.3.2 Other fuel management options used after clearfelling and their use in relation to burning ..... 53

4.5.4 The topographic positioning of firebreaks in the landscape ..... 55

4.5.4.1 The sub-optimal topographic positioning of firebreaks ..... 55

4.5.4.2 Potential challenges in moving firebreaks to more optimal positions ..... 55

4.5.5 The fire prevention and social benefits of cattle grazing ..... 56

4.5.5.1 The demand for cattle grazing in forestry areas ..... 56

4.5.5.2 Types of fire prevention challenges caused by cattle grazing in forestry areas ..... 57

**4.6 Compliance and enforcement ..... 58**

4.6.1 Fire protection association membership ..... 58

4.6.2 Compliance with the National Veld and Forest Act 101 of 1998 as determined by the rules and regulations of the Fire Protection Associations ..... 59

4.6.2.1 The compliance to resource, equipment and personnel requirements by state landowners ..... 59

4.6.2.2 The compliance of state and private landowners to burning permit and burning prohibition requirements ..... 60

4.6.2.3 The enforcement of the National Veld and Forest Fire Act as prescribed by the fire protection association regulations ..... 62

4.6.2.4 Penalties for non-compliance to the National Veld and Forest Fire Act as prescribed by the fire protection association regulations ..... 62

4.6.2.5 State and private landowner categories with resource and equipment challenges as prescribed by the National Veld and Forest Fire Act ..... 63

**4.7 Ranking of the top five fire prevention challenges by the respondents ..... 64**

**4.8 Conclusion ..... 65**

**CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS ..... 67**

**5.1 Introduction ..... 67**

**5.2 Fire causes and locations ..... 67**

5.2.1 Analysis of fire causes and their locations ..... 67

5.2.2 The levels and reporting accuracy of arson as a cause of fires in forestry areas ..... 68

5.2.3 The presence of communities as a fire source ..... 68

**5.3 Education and the role of fire awareness ..... 69**

5.3.1 The effectiveness of fire awareness campaigns ..... 69

**5.4 Engineering options for fire prevention ..... 69**

5.4.1 Regional strategic fuel load reduction ..... 69

5.4.2 The opportunity to remove forestry residue biomass as a raw material for bio-energy generation to reduce fuel loads in forestry ..... 69

**5.5 Compliance and enforcement ..... 70**

5.5.1 Low levels of fire protection association membership ..... 70

5.5.2 Compliance with the National Veld and Forest Fire Act 101 of 1998 as determined by the fire prevention associations rules and regulations ..... 70

5.5.3 Lack of enforcement and low penalties for non-compliance to the National Veld and Forest Fire Act as prescribed by the local FPA rules and regulations ..... 71

5.5.4 Concluding remarks on compliance and enforcement ..... 71

5.6 The top fire prevention challenges identified by respondents ..... 71

5.7 Conclusion ..... 72

5.8 Opportunities for future research ..... 73

BIBLIOGRAPHY ..... 74

ANNEXURE A ..... 87

# LIST OF TABLES

Table 1.1 The importance of the forestry industry in Mpumalanga (Forestry South Africa, 2019d). ..... **1**

Table 1.2 Total numbers of fires per main vegetation class between 2003 and 2011 (Strydom & Savage, 2016: 86). ..... **5**

Table 1.3 Dissertation structure ..... **8**

Table 2.1 Aspects of the National Veld and Forest Fire Act relevant to fire prevention (National Veld and Forest Fire Act 101 of 1998). ..... **11**

Table 2.2 Fuel parameters manipulated in fuel management. Bradstock *et al.* (cited by Goldsmith, 2019:10). ..... **18**

Table 2.3 The time fuel takes to become an ignition source under sufficiently low relative humidity conditions (Teie, 2005:83) ..... **19**

Table 2.4 Fire protection association membership summarised from the Lowveld and Escarpment Fire Protection Association and Umpiluzi Fire Protection Association annual reports (Alberts, 2020; Ludick 2020c). ..... **23**

Table 2.5 Summarised offences and penalties relevant to fire prevention (ss. 24 and 25 of the *National Veld and Forest Fire Act 101 of 1998*). ..... **26**

Table 4.1 Percentage of reasons why communities start fires provided by forestry managers grouped into socio-economic and other factors ..... **45**

Table 4.2 State owned landowner categories commonly found in forestry areas with resource and equipment challenges to meet the legal requirements of the National Veld and Forest Fire Act in the Lowveld and Escarpment and Umpiluzi Fire Protection Association areas ..... **64**

Table 4.3 Private landowner categories found in forestry areas with resource and equipment challenges to meet the legal requirements of the National Veld and Forest Fire Act, in the Lowveld and Escarpment FPA and Umpiluzi FPA areas ..... **64**

Table 4.4 Weighted and unweighted ranking of the top five fire prevention challenges for all respondents ..... **65**

# LIST OF FIGURES

Figure 1.1 Forestry plantation area lost to fires in South Africa between 2000 and 2016 (Forestry South Africa, 2019b). ..... **2**

Figure 1.2 Plantation area burnt in the Lowveld and Escarpment Fire Protection Association and Umpiluzi Fire Protection Areas between 2017 and 2019 (Alberts, 2020; Ludick, 2020c). ..... **2**

Figure 1.3 The location of South African and Mpumalanga plantations along the Eastern Escarpment and Highveld, indicated with a red ellipse (Xulu *et al.,* 2019:4). ..... **4**

Figure 1.4 Map showing the location of Mpumalanga plantation within the grassland biome, indicated with a red ellipse (Lechmere-Oertel, 2014:5). ..... **4**

Figure 1.5 Location of Lowveld and Escarpment FPA and Umpiluzi FPA within the Mpumalanga Umbrella Fire Protection Association (Mpumalanga Umbrella Fire Protection Association, 2020). ..... **10**

Figure 2.1 Lowveld and Escarpment Fire Protection Association fire losses in hectares expressed as a percentage damage per cause in 2017, including the municipal boundaries of Barberton, Lydenburg, Mpulaneng, Nelspruit, Pilgrims Rest and White River (Department of Agriculture Forestry and Fisheries, 2018). ..... **13**

Figure 2.2 Mpumalanga South (Highveld), representative of the Umpiluzi Fire Protection Association, fire losses in hectares, expressed as a percentage damage per cause in 2017, including the municipal boundaries of Carolina, Eerstehoek, Ermelo, Piet Retief and Waterval Boven (Department of Agriculture Forestry and Fisheries, 2018). ..... **14**

Figure 2.3 Fire behaviour triangle (Alberta-Wildfire, 2019). ..... **18**

Figure 2.4 Photo illustrating understory burning in a pine compartment (Mitchell *et al.*, 2009:392). ..... **20**

Figure 2.5 Number of fires, with and without burning permits, detected by Envirovision fire detection cameras during the firebreak burning period, requiring burning permits, in the Lowveld and Escarpment Fire and Umpiluzi Fire Protection Association areas in June and July between 2017 and 2019 (van Aswegen, 2020). ..... **25**

Figure 4.1 Respondent's number of years' of fire management experience ..... **39**

Figure 4.2 Participant perceptions of a lack of knowledge of fire causes and their locations ..... **39**

Figure 4.3 Participant perceptions of the level(s) at which wildfire causes and their locations should be reported and analysed ..... **41**

Figure 4.4 Participant perceptions that the current levels of arson fires are a fire prevention challenge in commercial forestry areas ..... **42**

Figure 4.5 Participant perceptions on whether they think that fires are correctly reported as arson fires ..... **43**

Figure 4.6 Participant perceptions of the reasons why arson fires are not reported to the police ..... **43**

Figure 4.7 Participant responses on whether they have communities and informal settlements within or adjacent to their forestry landholdings ..... **44**

Figure 4.8 Participant perceptions on whether fires in their areas of responsibility originate from communities or informal settlements ..... **45**

Figure 4.9 Participant perceptions of the statement that there is a high incidence of lighting fires in their areas between October and March ..... **47**

Figure 4.10 Participant level of agreement with the statement that the levels of fire awareness campaigns amongst the public and communities ineffective in reducing the number of fires in forestry areas ..... **48**

Figure 4.11 Participant perceptions that the Lowveld Fire Danger Index (FDI) does not give accurate fire danger predictions in certain areas ..... **49**

Figure 4.12 Participant perceptions that fire risk is not sufficiently mitigated by applying regional strategic fuel load reduction between forestry organisations and surrounding landowners ..... **50**

Figure 4.13 The current level of fuel load management in standing timber compartments is ineffective in preventing and mitigating fire damage ..... **51**

Figure 4.14 Other methods of fuel load reduction, apart from burning, in standing commercial timber compartments in the Lowveld and Escarpment and Umpiluzi Fire Protection Association areas ..... **52**

Figure 4.15 Participant perceptions that the current level of fuel management in clearfelled compartments is ineffective in preventing and mitigating fire damage ..... **53**

Figure 4.16 Fuel load reduction methods used after clearfelling ..... **54**

Figure 4.17 Participant perceptions that firebreaks are not situated in optimal topographic positions in the landscape ..... **55**

Figure 4.18 Participant responses to the statement that there is a demand for cattle grazing in their forestry area of responsibility ..... **56**

Figure 4.19 Participant perceptions of the fire prevention challenges from allowing cattle to graze on forestry land ..... **57**

Figure 4.20 Participant perceptions that the fire protection association membership of state owned land is low ..... **58**

Figure 4.21 Participant perceptions that the fire protection association membership of privately owned land is low ..... **58**

Figure 4.22 Participant perceptions that there is a lack of compliance of fire protection association resource, equipment and personnel requirements by state landowners ..... **59**

Figure 4.23 Participant perceptions that there is a lack of compliance of state and private land owners to obtain burning permits from the fire protection associations during the burning prohibition period ..... **61**

Figure 4.24 Participant perceptions of the inadequate enforcement of the National Veld and Forest Fire Act as prescribed by the fire protection association regulations ..... **62**

Figure 4.25 Participant perceptions the inadequacy of penalties for non-compliance to the National Veld and Forest Fire Act as prescribed by the fire protection regulations ..... **62**

# CHAPTER 1 INTRODUCTION

## 1.1 The importance of the commercial forestry industry in rural Mpumalanga

South Africa (RSA) has approximately 1.2 million hectares of commercial forestry plantations located in five provinces (Forestry South Africa, 2019d). Commercial plantations in Mpumalanga, referred to as plantations, are exotic human-made forests that are grown to produce raw materials for different products, e.g. solid wood products, pulp, cellulose, paper products, poles and mine supports. The forestry industry investment in South Africa is R46.7 billion, of which 51.6% or R24.1 billion is invested in trees (Godsmark & Oberholzer, 2019). The commercial forestry industry, referred to in this dissertation as the forestry industry, consists of commercial plantations, non-commercial areas, as well as forest products processing plants. The forestry industry provides approximately 158 000 jobs and contributes R69 billion to the South African economy annually (Forestry South Africa, 2019a, 2019b). Mpumalanga is the province with the biggest area of plantations in South Africa (Forestry South Africa, 2019d; Rudzani & Amani, 2013:2). Key statistics (Table 1.1) indicate the importance of the forestry industry in Mpumalanga in terms of economic and social development.

**Table 1.1 The importance of the forestry industry in Mpumalanga (Forestry South Africa, 2019d).**

| Scale | Statistics |
|---|---|
| Afforested plantation area | 489 073ha |
| Percentage of RSA afforested area | 41% |
| Total direct and indirect employment **(A)** | 50 400 |
| Number unemployed dependents **(B)** | 173 300 |
| Number of employed and unemployed dependent on the forestry industry **(A+B)** | 223 700 |
| Proportion of RSA forestry investment | 42% |

## 1.2 The extent of fire problems in forestry

Around 20 000 ha of plantations on average between 2000 and 2016, with the exception of 2006 and 2007, when abnormal fires losses were experienced, are lost to fire in South Africa annually, affecting the long term sustainability of the forestry industry, employment, personal property and agriculture (Figure 1.1). The rural population living in the forestry areas depend on all of these for their sustenance (Department of Agriculture Forestry and Fisheries, 2015).

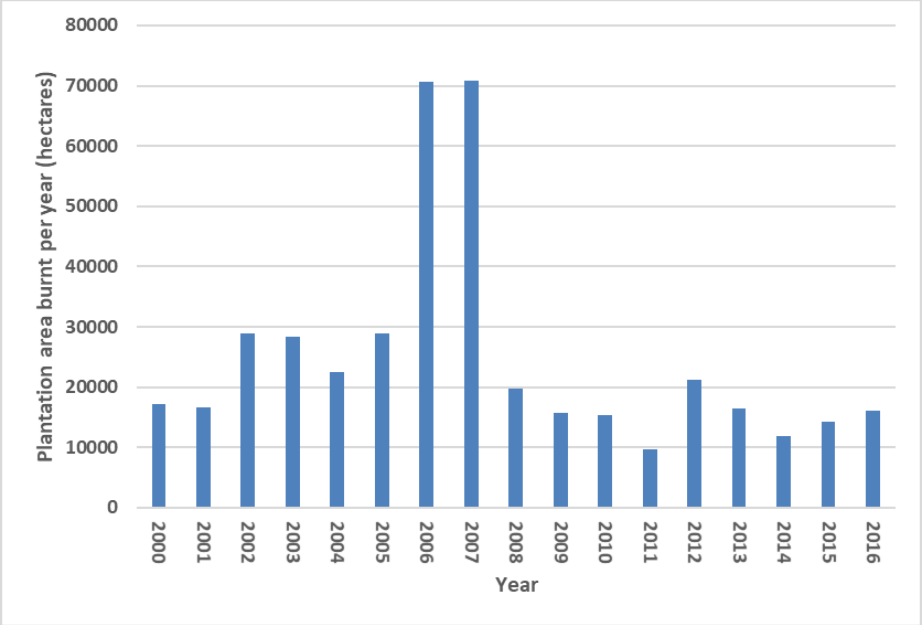


**Figure 1.1 Forestry plantation area lost to fires in South Africa between 2000 and 2016 (Forestry South Africa, 2019b).**

According to Rudzani and Amani (2013:2), Mpumalanga lies the North Eastern part of the country is a province that experiences a high incidence of plantation fires in South Africa. Data obtained by the author from Fire Protection Association (FPA) reports, indicate plantation losses in Mpumalanga in the Lowveld and Escarpment FP (LEFPA) and the Umpiluzi FPA (UFPA) areas for 2017 to 2019 (Figure 1.2).

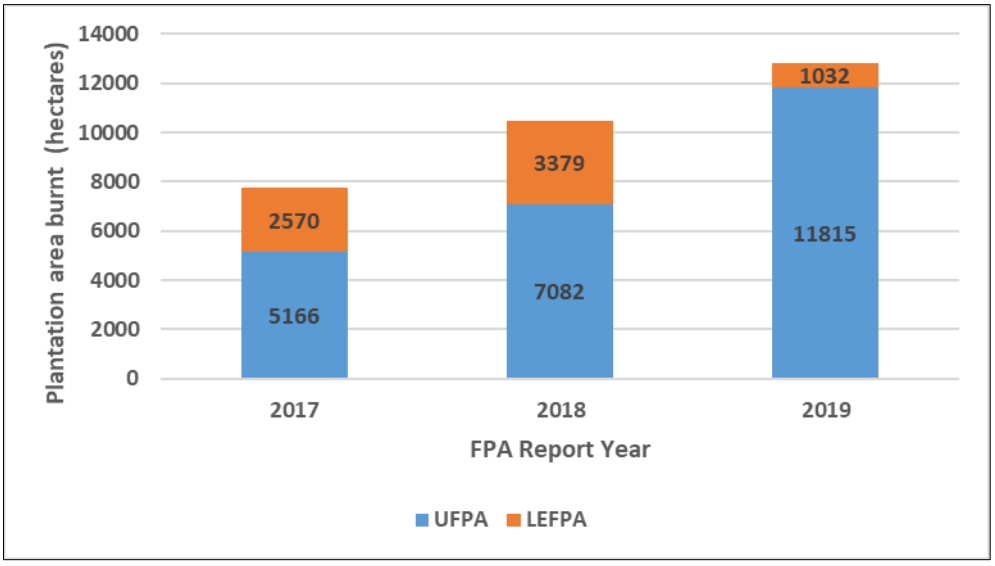


**Figure 1.2 Plantation area burnt in the Lowveld and Escarpment Fire Protection Association and Umpiluzi Fire Protection Areas between 2017 and 2019 (Alberts, 2020; Ludick, 2020c).**

In the absence of economic impact figures of fire damage for Mpumalanga, national figures were extrapolated to provide context. The 20 000 ha plantations damaged by fire annually represents 1.67% of the South African forestry area of 1.2 million ha. Based on the R24.1 billion invested by forestry in trees, the direct fire damage to South African plantations can be estimated at approximately R402 million (R24.1 billion X 1.67%) per annum. Because Mpumalanga plantations represent 41% of the South African plantation area, (Forestry South Africa, 2019d), therefore the direct economic losses of fire damage in Mpumalanga is estimated at 41% of the total R402 million South African plantation fire losses or at least R165 million per annum.

## 1.3 Fire risk in Mpumalanga forest plantations

### 1.3.1 Climate, vegetation and fire risk

The majority of South African plantations are located in the eastern and southern parts of the country, which includes Mpumalanga, (Jackelman *et al.,* 2006:5), (Figure 1.3). Furthermore, these plantations are situated predominantly in the grassland biome in Mpumalanga, particularly in the Mesic Highveld, Mesic High Altitude and Mesic Sub-Escarpment grassland ecosystems (Figure 1.4). All forestry landscapes in South Africa also typically consist of a mosaic of areas with plantations and areas not planted which are managed as conservation areas to reduce the environmental impact of plantations on non-afforested areas. The unplanted areas normally cover about 30% of the total forestry landholdings (Forestry South Africa, 2019c).

A higher fuel load and increased fire risk is more typical in plantation areas where a cooler climate and higher rainfall is present than warmer drier areas. When combined with a long dry season this creates conditions conducive to regular wildfires in forestry areas (Archibald *et al.*, 2009:613; Nunes, 2012:584).

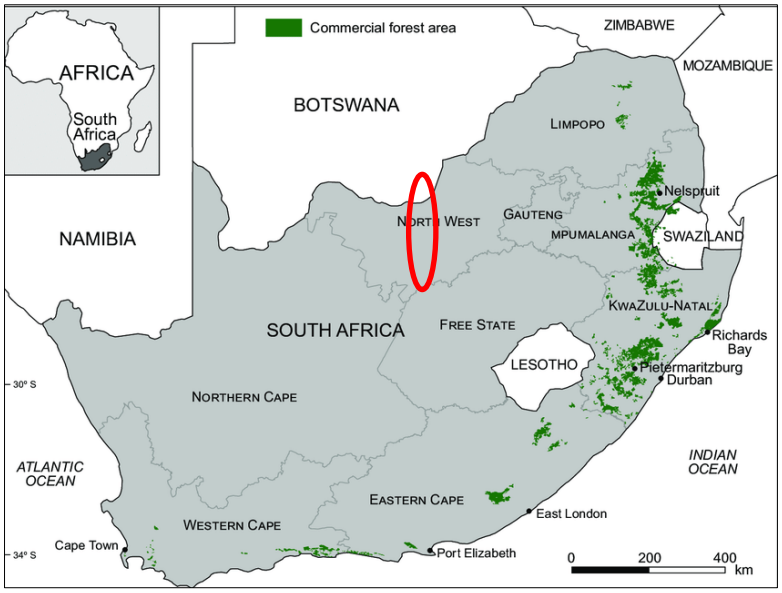


**Figure 1.3 The location of South African and Mpumalanga plantations along the Eastern Escarpment and Highveld, indicated with a red ellipse (Xulu *et al.*, 2019:4).**

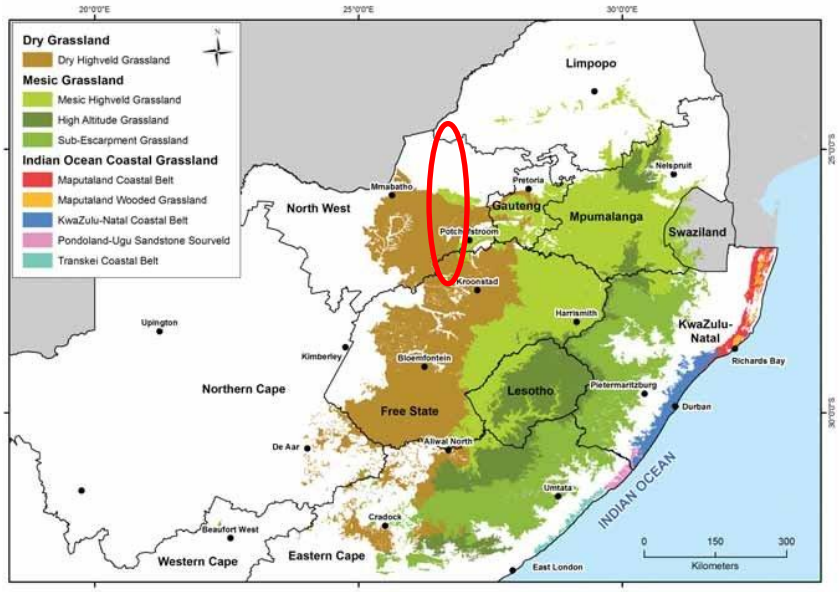


**Figure 1.4 Map showing the location of Mpumalanga plantation within the grassland biome, indicated with a red ellipse (Lechmere-Oertel, 2014:5).**

Fire dependent mesic grasslands, referred to as climax grasslands, occur in higher rainfall, high altitude areas which need fire as part of their ecology to prevent plant succession from grassland to forest or savannah (van Wilgen *et al.*, 1990:180). During the dry, cold winter season, the grasslands undergo a senescence (curing) process where the grassland fuel moisture content decreases and the grass dies aboveground, causing adverse fire risk and behaviour (Anderson *et al.*, 2011:804; McGranahan *et al.*, 2016:42). In such areas, grasslands need to be burned on a

periodic basis, not only to protect the plantations, but also to maintain the ecological health of the grasslands.

A study by Strydom and Savage (2016:83) titled, *"A spatio-temporal analysis of fires in South Africa",* plotted the density of fire ignition points in South Africa, using satellite data from 2003 to 2013, to determine where the most fires occur. The fire ignition points were analysed spatially as well as temporally on a monthly and yearly basis. (Strydom & Savage, 2016:85-87). The results indicate that the highest frequency of fires in South Africa occurred in the north-eastern areas of South Africa, which includes Mpumalanga, followed by the South Western Cape. Only the top ten fire prone vegetation classes were included (Table 1.2).

**Table 1.2 Total numbers of fires per main vegetation class between 2003 and 2011 (Strydom & Savage, 2016: 86).**

| Vegetation class | Number of fires per vegetation class | Percentage of fires occurring in the top ten vegetation classes |
|---|---|---|
| North-Eastern Mountain Grassland | 4513 | 12.71 |
| Moist Upland Grassland | 2711 | 7.63 |
| Moist Cool Highveld Grassland | 1228 | 3.46 |
| Wet Cold Highveld Grassland | 1113 | 3.13 |
| Moist Cool Highveld Grassland | 1228 | 3.46 |
| Mountain Fynbos | 3291 | 9.26 |
| Mixed Bushveld | 2516 | 7.08 |
| Sour Lowveld Bushveld | 1633 | 4.60 |
| Moist Sandy Highveld Grassland | 1598 | 4.50 |
| Rocky Highveld Grassland | 1596 | 4.49 |
| Natal Central Bushveld | 1225 | 3.45 |

### 1.3.2 Climate change and future fire risk

According to Flannigan *et al.* (2013:59) an increase in the number of fires and area burnt globally is expected in future, with climate change. The area burnt will increase with increased temperature, irrespective of changes in rainfall, although it will be worse for warmer and drier scenarios. The mean annual temperature (MAT) in South Africa has increased by at least 1.5 times the global average over the last five decades (Ziervogel *et al.*, 2014:605). It is therefore likely that there will be an increase in the frequency and intensity of wildfires in Mpumalanga driven by increases in temperature in the future.

Due to the future fire risks discussed above, the long term sustainability of plantations and the forestry industry in Mpumalanga is under threat due to the high current fire losses in forestry areas which persist in spite of measures taken to mitigate them (Figure 1.2). There is therefore an opportunity to improve the effectiveness of current fire management practice. Commercial plantation management

Plantation blocks consist of smaller management units, called compartments, which consist of trees of the same species and age. Trees are planted in rows, at a fixed spacing, with each compartment having its own unique management prescriptions linked to a specific management objective (end product), e.g. plywood (Department of Environment Forestry and Fisheries, 2020).

The exclusion of fires in grassland ecosystems, combined with active suppression of any fires, particularly in commercial plantation areas where fire is seen as a threat, resulted in a proliferation of woody species in grasslands worldwide and increased fire fuel loads (Toledo *et al.*, 2013:1). According to Vaux *et al*. (cited by Toledo *et al*., 2013:1), increased fuel loads, a higher incidence of catastrophic fires, with a higher risk to life and property, resulted in a shift from fire exclusion as a management strategy, to active fire management, by using planned fires to reduce fire fuel loads.

## 1.4 Fire management and fire prevention

There is no universal definition for fire management and defining the term is critical to delineate this dissertation. The FAO (2006), describes fire management as *"the discipline of using fire to achieve land management and traditional use objectives, together with the safeguarding of life, property through the prevention, detection, control, restriction and suppression of fire in forest and other vegetation in rural areas."* Natural Resources Canada (2019) defines fire management as the *"process of planning, preventing and fighting fires to protect people, property and the forest resource. It also involves fire to attain forestry, wildlife and landuse objectives."* From these definitions, fire management is defined in broad terms as the planning, prevention, detection, control and suppression of fires to safeguard plantations, people, property as well as meeting other land use objectives.

This dissertation will only focus on one aspect of fire management, i.e. fire prevention. According to Heikkilä *et al.* (2007:62) forest fire prevention is one of the most important functions of fire management and involves the reduction of the number of unwanted, escaped wildfires. These authors suggest that in areas where a high percentage of fire causes are anthropogenic, the focus should be greater on fire prevention than fire suppression, to prevent fires from occurring in the first place. Fire prevention is a more efficient means of reducing the impact of fires, because

spending money on fire prevention is cheaper than spending money on fire suppression (FAO, 2006; Heikkilä *et al*., 2007:62).

A study by van der Sijde (2003:142-143) in the Lowveld and Escarpment FPA area, found that between 1950 and 1999, 49.5% of the forest fires in Northern Mpumalanga were anthropogenic fires. This does not include an additional 11.9% of these fires that were caused by people searching for honey. The high percentage of anthropogenic fires in the study area, therefore support the focus of the research on fire prevention.

## 1.5 Problem statement and rationale for the study

Of the 1.2 million ha of commercial plantations in South Africa, 489 000 ha are situated in the Mpumalanga Province (Forestry South Africa, 2019d). The timber from plantations is used as raw material for the manufacture of various forestry products in processing plants.

Around 20 000ha of plantation area in South Africa is lost per annum to veld and forest fires, with a direct annual economic plantation loss of R402 million. This loss excludes the additional costs of fire management, plantation re-establishment, downstream economic losses, unemployment and damage to the environment caused by wildfires. This is not only the case in South Africa, but also in the Mpumalanga plantations that are situated in mesic sourveld grasslands, which have the highest fire risk of the 13 fire ecology types in South Africa. The majority of larger forestry organisations are well equipped to deal with forest fires, with the assistance of well organised FPAs, four of which are located in Mpumalanga forestry areas. (Mpumalanga Umbrella Fire Protection Association, 2020). Two of these four FPAs have been included in the study area.

Despite well equipped forestry organisations and FPAs, the number of fires that cause economic losses to plantations and the forest products industry is still unacceptably high. The annual financial losses and additional fire management costs threaten the long term sustainability of the forestry industry in Mpumalanga.

## 1.6 Research aim / objective / question

**Research Aim:** The study identified and evaluated the perception of commercial forestry managers of fire prevention challenges and opportunities in the study area. It is assumed that the forestry managers' perceptions of fire prevention challenges and opportunities drive current fire prevention practice. Understanding the forestry managers' perception of fire prevention challenges and fire prevention opportunities may therefore assist in improving fire prevention practices, to reduce the devastating impact of fires on forestry.

**Research Question (Objective):** What are the perceptions of commercial forestry managers of the fire prevention challenges and opportunities in rural Mpumalanga, South Africa?

## 1.7 Structure and outline of the dissertation

The structure and outline of the dissertation as well as the chapter content is presented in below (Table 1.3).

**Table 1.3 Dissertation structure**

| Chapter Number | Chapter Content |
|---|---|
| **Chapter 1: Introduction** | • Gives a brief outline of the topic of the research and describes the problem statement and aim of the dissertation. |
| **Chapter 2: Literature Review** | • Review of international and South African literature on fire prevention, to identify fire prevention practices, opportunities and challenges;<br>• The review included peer reviewed journals, similar dissertations and theses, as well as relevant South African legislation;<br>• The literature was sourced from the internet, Google Scholar, the NWU library, databases, such as Scopus, information from fire detection centres, FPAs and other sources due to a lack of published data on the research topic in the Lowveld and Escarpment FPA and Umpiluzi FPA study area. |
| **Chapter 3: Methodology** | This chapter describes the methods that were used to address the aim and answer the research question. |
| **Chapter 4: Research Results** | The following results are discussed in this chapter:<br>• Firstly, the perceptions of forestry managers of the fire prevention challenges identified in the literature review;<br>• Secondly, explanations and motivations of forestry managers to motivate their responses and assist in identifying opportunities to improve fire prevention practices where applicable;<br>• Finally, the perceptions of forestry managers about what they feel the top five fire prevention challenges.are. |

| | |
|---|---|
| **Chapter 5: Conclusion** | • In this chapter concluding remarks are made, on the research aim and question, based on the most important research findings;<br>• Opportunities to address the challenges are discussed;<br>• Finally there is a reflection of possible further related research topics that could be investigated in future |

## 1.8 Delineation

The plantation areas in Mpumalanga fall under four FPAs: Lowveld and Escarpment Fire Protection Association (LEFPA), the Umpiluzi FPA (UFPA), the Mkhondo FPA (MFPA) and the Platorand Area FPA (PAFPA) (Mpumalanga Umbrella Fire Protection Association, 2020) (Figure 1.5). According to the four FPA Managers, Lowveld and Escarpment FPA has four large forestry organisations in its area; UFPA has five, MFPA two and PAFPA one (Ludick, 2020d; Prinsloo, 2020; Scheepers, 2020b; Wright, 2020). Note that the areas managed by DAFF are excluded from this dissertation because they are managed more like a state entity in contrast to the selected organisations which are profit orientated. The reason for choosing Lowveld and Escarpment and Umpiluzi fire protection associations as the study areas, was the presence of the majority of large forestry organisations in these two FPAs. The Mkhondo and Platorand Area FPAs do not have any additional large organisations in their areas and many or the selected organisations are not represented in these two areas. The research is based on the perceptions of forestry managers in four organisations in the Lowveld and Escarpment FPA area and five in the Umpiluzi FPA area. A more detailed discussion on the reasons for the selection of Lowveld and Escarpment FPA and Umpiluzi FPA for the study area, the organisations selected and the participants is provided in chapter 3.

**Figure 1.5 Location of Lowveld and Escarpment FPA and Umpiluzi FPA within the Mpumalanga Umbrella Fire Protection Association (Mpumalanga Umbrella Fire Protection Association, 2020).**

# CHAPTER 2 LITERATURE REVIEW

## 2.1 Introduction

This chapter is based on a review of international and South African literature, focussing specifically on the fire prevention element of fire management. Where gaps were identified in the literature, unpublished primary and secondary data relating specifically to the Lowveld and Escarpment FPA and Umpiluzi FPA study areas, were used to supplement the literature on potential fire prevention challenges and opportunities. The identification of the fire prevention challenges and opportunities identified in this chapter was used to assist in developing the questionnaire to be used to determine the perception of commercial forestry managers of fire prevention challenges in the Lowveld and Escarpment FPA and Umpiluzi FPA and to identify opportunities to improve fire prevention practice.

## 2.2 The National Veld and Forest Fire Act 101 of 1998 (NVFFA)

Chapters and broad aspects relevant to fire prevention were identified directly from the Act and summarised (Table 2.1). Chapters which are not relevant to fire prevention, including chapter 1 containing introductory provisions, were omitted.

**Table 2.1 Aspects of the National Veld and Forest Fire Act relevant to fire prevention (National Veld and Forest Fire Act 101 of 1998).**

| Chapter | Aspects of the Act relevant to fire protection |
|---|---|
| **Chapter 2** | Makes provision for Fire Protection Associations which create enforceable fire prevention rules and regulations relevant to local conditions |
| **Chapter 3** | Communication of fire danger using a fire danger rating system |
| **Chapter 4:** | The legal requirement to prepare firebreaks |
| **Chapter 5** | • Having the necessary firefighting capacity available;<br>• Section 17(1)a and b requires that landowners must have equipment, protective clothing and trained personnel available to extinguish fires;<br>• A responsible person to be present in the landowner's absence. |
| **Chapter 7** | Offences and penalties |
| **Chapter 8** | Enforcement of the NVFFA |

## 2.3 Fire prevention framework

The first step in the literature review involved the development of a fire prevention framework, incorporating elements of the fire management framework from Chandler *et al.* (cited by Tshering, 2006:25). According to these authors, *"successful fire management depends on utilising the 3 E's – Education, Enforcement and Engineering - in logical well planned combinations." "Increasingly, wildfire management is being viewed as a form of risk management, with a corresponding increase in analytical rigor and alignment with risk management principles" (Thompson & Calkin, 2011:1896).*

With regard to fire prevention, which is the focus of this research, the following authors (cited by Tshering, 2006:25-26) further state the following: Firstly, *"Effective fire prevention begins with identifying problem fires and their sources of ignition."* Chandler *et al.* (cited by Tshering, 2002:25). Secondly, *"An important component of fire prevention is education".* Thirdly, *"Other components crucial for prevention of fires are: engineering to separate risk from hazard by deliberate design in machinery and built environment".* Finally, "*enforcement to regulate behaviour under threat of legal action."* Pyne *et al*. (cited by Tshering, 2002:26).

Based on the above, the fire prevention framework that was used as a basis for the literature review and the research included the following aspects: Firstly, the identification of problem fire causes and their sources of ignition. Secondly, the role of education and awareness in fire prevention. Thirdly, engineering options for fire prevention and finally, the role of compliance and enforcement in fire prevention.

## 2.4 Fire causes and their locations

Harnett (2015:23) estimated that half of the wildfires in New Zealand were from unknown causes. In South Africa, Godsmark and Oberholzer (2019), from Forestry South Africa, reported that 33% of plantation fire causes in South Africa were unknown and 14% were suspected to be arson. van der Sijde (2003:140), in a study of 846 plantation fire records between 1950 and 1999 fires in Komatiland Forests, Mpumalanga, found that unknown causes of fires accounted for only for only 7% of fires while 16% of fires were caused by arson. It must be noted that this study only contained around 17 fires per year over a 49 year period. This study seems to have made use of limited fire data were causes were available over a long period

The plantation fire damage in hectares was expressed as a percentage per broad cause in a Department of Agriculture Forestry and Fisheries report on commercial timber resources in South

Africa for the 2017 fire season. Mpumalanga South includes other FPAs but is representative of Umpiluzi FPA, because the municipal areas listed are all located on the Mpumalanga Highveld in which the entire Umpiluzi FPA area is situated. There is a high level of fire damage from unknown fire causes in the Lowveld and Escarpment FPA area Figure 2.1). This suggests that fire causes are not all being investigated and reported to the FPA by the forestry organisations, or that fires are reported but their causes not analysed at forestry organisation, FPA or national level. The FPA may also not report fire causes in their annual reports that are submitted as required by s 5(1)i of the National Veld and Forest Fire Act 101 of 1998 (NVFFA). The exceptionally high damage caused by arson fires in the Umpiluzi FPA representative area is also a major concern (Figure 2.2). A potential challenge could be that the number of arson fires may not be arson but could in fact have been incorrectly reported as arson if the fire causes are unknown. Particularly for the Lowveld and Escarpment FPA area it seems that fire causes are being reported.

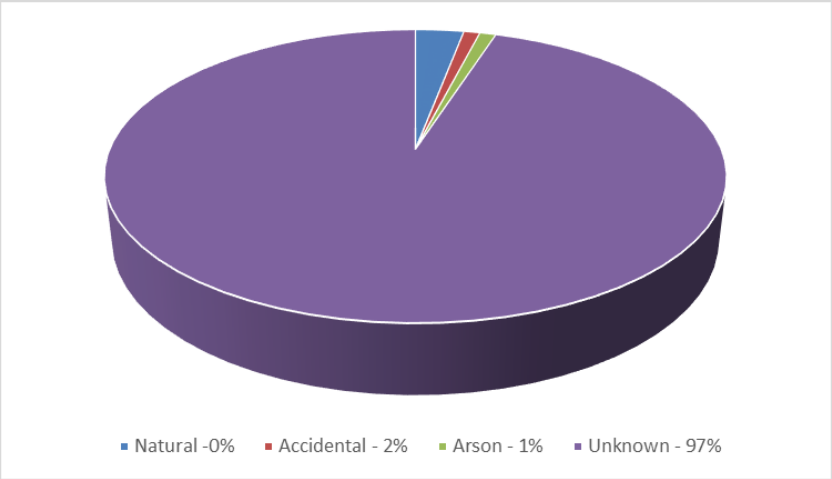


**Figure 2.1 Lowveld and Escarpment Fire Protection Association fire losses in hectares expressed as a percentage damage per cause in 2017, including the municipal boundaries of Barberton, Lydenburg, Mpulaneng, Nelspruit, Pilgrims Rest and White River (Department of Agriculture Forestry and Fisheries, 2018).**

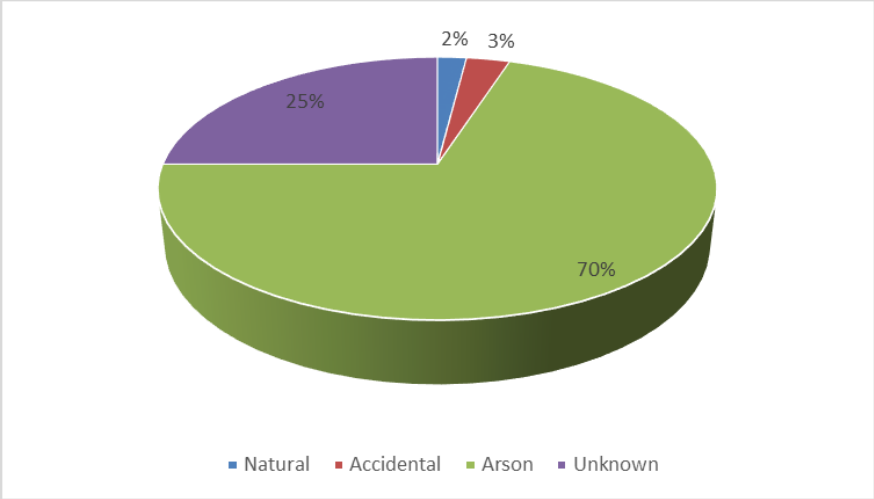


**Figure 2.2 Mpumalanga South (Highveld), representative of the Umpiluzi Fire Protection Association, fire losses in hectares, expressed as a percentage damage per cause in 2017, including the municipal boundaries of Carolina, Eerstehoek, Ermelo, Piet Retief and Waterval Boven (Department of Agriculture Forestry and Fisheries, 2018).**

The grassland areas in the north eastern regions of South Africa have the highest incidence of lightning fires in South Africa with up to 16.2 strikes /km$^2$ annually (Manry & Knight, 1986:74). According to Schulze (2007:2) there is about one lightning induced veld fire for every 500 ground flashes. He furthermore states that many of the lightning flashes in the summer rainfall areas strike green vegetation and fires caused by these are often extinguished by accompanying rain. A study of fire history in Komatiland Forests plantations in Mpumalanga found that 22% of fires were caused by lightning (van der Sijde, 2003:142). There are however low levels of plantation damage by natural fires in the Lowveld and Escarpment FPA and Umpiluzi FPA areas of 0% and 2% respectively (Figures 2.1 and 2.2). It would therefore appear that there are a large number of lightning fires in Mpumalanga but that the damage in area burnt is low and insignificant. The frequency and area lost through lightning fires should be investigated to confirm the evidence that lightning, a major source of natural fires, cause do not cause great damage to plantations in Mpumalanga.

An important part of fire prevention planning is to know what the causes of fires are to prevent fires from starting (Harnett, 2015:23; Heikkilä *et al.*, 2007:65). Great support is given for fire suppression, through FPAs and their members, but very little emphasis is placed on the causes of fires and analysing data from fire events to formulate a fire prevention strategy. No fire prevention and fire mitigation policy has been implemented in South Africa on a regional level (Department of Agriculture Forestry and Fisheries, 2015:2).

Lowveld and Escarpment FPA and Umpiluzi FPA annually report the number of hectares lost to fires which are either reported by FPA members or when the FPAs provided ground or aerial

firefighting support , although not all fire losses are reported by FPA members, and no fire causes are included in their FPA reports (Alberts, 2020; Ludick, 2020c). There is no analysis of causes of fires done on an FPA level because fire causes are not currently comprehensively reported to the FPA by their members (Scheepers, 2020a). The only current figures of fire causes and their locations at FPA level which were available were obtained from a 2017 DAFF report. These figures appear to be incorrect and incomplete (Figures 2.1 and 2.2).

It would be useful if ignition points could be linked to their causes for fire prevention purposes. Envirovision Solutions (EVS) and Firehawk has a network of fire detection cameras linked to a Geographical Information System (GIS) in the two FPA areas that log the exact GPS location of all fire alarms once a fire event is confirmed (Envirovision Solutions, 2022; Firehawk, 2022). This may present an opportunity to at least determine the point locations of all fires, including fires which are not reported to the FPAs.

A 2010 Council for Scientific and Industrial Research (CSIR) report referred to a national fire information system which DAFF was supposed to develop but which never materialised. The CSIR developed a system called the Advanced Fire Information System (AFIS) that became the only de facto national information system but the departments were not willing or able to support it. The system utilized various satellites such as MODIS, VIIRS and MSG for the near real time detection of active fires across Southern Africa. Burned area maps were produced based on the Sentinel-2 data and historical burnt area data derived from MODIS 500m data. Climate models provided inputs to derive various fire danger forecasts. AFIS was the only system globally that provided prediction, detection and assessment information and delivered outputs via its own mobile application and dashboards. Based on 20 years of personal experience in this domain, and knowledge of the extremely dysfunctional state of all entities involved, any change of a new national system that will actually work is very slim (Frost, 2020).

According to Bachmann *et al*. (cited by Corona *et al*., 2015:4), fire risk assessment requires the determination of two aspects: Firstly, the risk of ignition and spread, and secondly, the probable damage that could be caused. Further suggestions were to focus fuel modification in the most fire prone areas because of the difficulty in treating large areas. This can be done by using maps of forest areas as well as the use of geospatial information of historic fire locations. Umpiluzi FPA is currently in the process of developing a fire risk management plan (Ludick, 2020e). From the above it is clear that data of historic fire locations and their causes is incomplete and conflicting depending on which sources or information are used. This is of concern and should be the first fire prevention priority to be addressed to understand the focus areas needed when developing a fire prevention strategy.

The second step in fire prevention described in the fire prevention framework (section 2.3), after addressing fire causes and their locations, is the role of education and awareness in fire prevention which will be discussed in section 2.5.

## 2.5 The role of education and awareness in fire prevention

### 2.5.1 Fire awareness in fire prevention

Fires are influenced by bio-climatic factors but are highly anthropogenic or caused by people (Corona *et al.*, 2015:3; Harnett, 2015:23). Excluding the unknown causes, anthropogenic causes were 85% and 70% in Australia and New Zealand respectively (Beale & Jones, 2011:508; Harnett, 2015:23). Fire awareness through education is important to reduce the number of fires (Langer & McGee, 2017:4). In Australia, fire awareness programmes in primary schools are critical in reducing fire numbers (Beale & Jones, 2011:510). The most effective fire prevention approach is to work with communities in high fire risk areas (Beale & Jones, 2011:516). Most ignitions occur in low income rural areas according to Beale and Jones (2011:513), which seems to suggest that these areas should be the focus for fire awareness campaigns. It is better to focus on fire awareness than enforcement because arsonists are difficult to catch (Beale & Jones, 2011:516). Communities should be made aware of the requirement to obtain burning permits to ensure burning operations take place under safe conditions (Harnett, 2015:24).

Both Umpiluzi FPA and Lowveld and Escarpment FPA conduct fire awareness campaigns at rural schools and communities in high fire risk areas identified by members. Both FPA managers concur that fire awareness campaigns are insufficient and that the government should make more funds available for raising fire awareness (Ludick, 2020e; Scheepers, 2020e). The high number of fires in the two FPAs was highlighted in chapter 1, confirming the probability that fire awareness is a challenge in these areas that should be addressed.

### 2.5.2 Fire danger rating indices

*"Forest fire danger rating schemes underlie all contemporary fire management schemes. These systems are the principal means by which scientific knowledge of fire potential is synthesized and integrated with operational experience into practical fire management applications"* (Taylor & Alexander, 2006:121). Fire danger ratings, fuel types, fire behaviour models and terrain can be used to predict fire behaviour (Harnett, 2015:25).

In practice, infield operations, especially high risk operations involving chainsaws, road mowers *("bossiekappers"*), road machines, harvesting equipment and any other machinery which can cause sparks can be suspended when the fire danger index (FDI) reaches a certain threshold to

reduce the risk of fires starting (Harnett, 2015:24). Firefighting teams can also be put on standby at strategic points to enable a quick response that is critical during high FDI periods, based on the FDI prediction. The accuracy of the FDI forecast therefore has financial (lost production) and fire risk implications if it is not predicted accurately.

Chapter 3 of the NVFFA states that the minister is responsible for maintaining a national fire danger rating system (NFDRS) and high fire danger must be communicated through the media. FDIs are supplied by SMS and email to both FPAs' members at 10h00 and 14h00 daily. Real time FDIs are also available through the Vital Fire website link (CW Price & Co., 2020). Miekle and Heine (cited by Bridget et al., 2003:1) introduced the Zimbabwean fire danger index (FDI) model, known as the *"Lowveld system",* to South Africa. The Lowveld FDI system is applied throughout South Africa. However, the Lowveld FDI model has been criticised as very simplistic and not appropriate for all areas in South Africa (van den Dool, 2020). The Umpiluzi 2019 FPA report stated that the Lowveld FDI forecast is inaccurate at times (Ludick, 2019:4). In addition, a Lowveld and Escarpment FPA fire risk assessment noted that the FDI forecast areas need to be decreased in size, fuel moisture needs to be taken into account and that the FDI becomes increasingly inaccurate at higher FDI ranges (Hopkins, 2019). The accuracy of the Lowveld FDI may therefore not be accurate in some areas.

GIS spatial information including fuels and topography together with fire behaviour models, weather and fuel moisture can be simulated under different scenarios (Fernandes & Botelho, 2003:119). The AFIS system was developed by the CSIR in South Africa. This is the only system in the world that provides prediction, detection and assessment information, delivering outputs via a mobile application dashboard. It incorporates different weather models and terrain models that can predict the rate and direction of fire spread. This system is operational but is currently not being used by the FPAs (Frost, 2020). The use of AFIS by the FPAs could be an opportunity to improve fire prevention.

The third step in fire prevention, described in the fire prevention framework (section 2.3), after addressing fire education and awareness, are engineering options for fire prevention which will be discussed in section 2.6.

## 2.6 Engineering options in fire prevention

### 2.6.1 Factors to consider in fuel management

Pyne *et al.* (cited by Tshering, 2006:25) defines engineering as the separation of fire risk (ignition) from the fire hazard (fuel). Fire behaviour is influenced by the weather, topography and fuels**,** known as the fire behaviour triangle (Agee, 1996:52; Fernandes, 2013:176). The fire behaviour

triangle is illustrated below (Figure 2.3). Only fuel can be manipulated to prevent fires and influence fire behaviour (Agee, 1996:52; Fernandes & Botelho, 2003:117; Goldsmith, 2019:8).

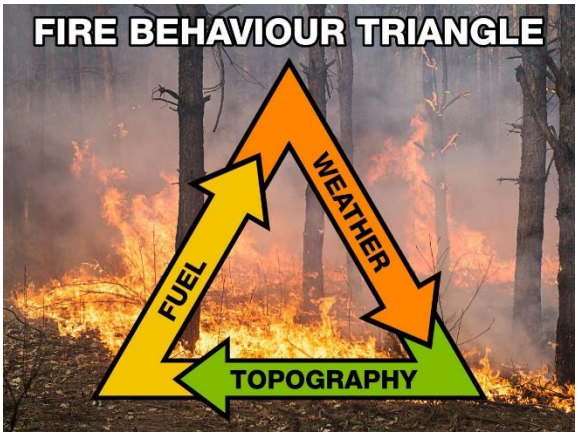


**Figure 2.3 Fire behaviour triangle (Alberta-Wildfire, 2019).**

Fuel management lowers the probability of ignition and increases fire suppression capacity by reducing the rate of fire spread and damage as well as increasing the range of weather conditions where suppression is viable (Fernandes *et al.*, 2014:380). Pine plantations, depending on species and site, can have pine needle litter layers up to 35cm deep in the case of *Pinus patula,* one of the most commonly planted pine species in the study area, resulting in a highly flammable fuel bed (De Ronde *et al.*, 1990:224). A study in Mpumalanga by Ross (2004:53) indicated that the fuel loads in *Pinus patula* compartments ranged from 21 to 168t $ha^{-1}$ and 27 to 72t $ha^{-1}$ in sawtimber and pulpwood compartments respectively. Certain fuel parameters need to be manipulated to modify fire behaviour (Table 2.2). This is important, especially for mechanical fuel load management.

**Table 2.2 Fuel parameters manipulated in fuel management. Bradstock *et al.* (cited by Goldsmith, 2019:10).**

| Fuel Parameter | Impact on fire behaviour |
|---|---|
| **Fuel shape and size** | Smaller fuel particles ignite more easily and reach equilibrium moisture content quicker. Removing finer fuels can prevent fires from starting. Rougher surfaces require more heat to ignite. |
| **Compactness** | More compact (dense) fuel is more difficult to ignite as less oxygen is available. |
| **Fuel load** | Higher fuel loads cause more intense fires and more fire damage. |
| **Horizontal continuity and vertical arrangement of fuels** | Have an impact on fire exclusion, rate of spread and damage. |

To prevent or reduce fires, emphasis should be on managing the fuel fraction that will ignite under current and predicted weather conditions. These fuels are dead surface fuels with a diameter less

than 75mm and live fuel with diameters under 6mm (Teie, 2005:69). This is illustrated below (Table2.3). The available fuel in plantations is therefore the total amount of fuel that is available to burn and the amount of time it takes for the finer fuel fractions to reach equilibrium moisture content by drying sufficiently to become and ignition source for heavier fuels under low humidity conditions. (Teie, 2005:82-83)

**Table 2.3 The time fuel takes to become an ignition source under sufficiently low relative humidity conditions (Teie, 2005:83)**

| Time lag | Fuel diameter | Examples | Fire prevention focus |
|---|---|---|---|
| **1 hour** | Less than 6mm | Annual grass, fine fuels in standing compartments | Fuel to be managed in fire prevention to remove ignition sources in order of priority |
| **10 hours** | 6-25mm | Thickets | |
| **100 hours** | 27-75mm | Harvesting residue | |
| **1000 hours** | 75-200mm | Logs and standing timber | |

### 2.6.2 Burning as a fuel management method

#### 2.6.2.1 Strategic fuel load reduction across boundaries on a landscape level

There is a good understanding of the forest structure, fire relationship on a forest management unit (FMU) scale but the major challenges remain on a landscape level (Agee, 1996:68). This means that fuel load reduction should include high risk areas surrounding the FMU which could spread to forestry areas from the outside. Fuel treatments need to be placed strategically in priority areas because studies have shown that diminishing returns occur if more than 10-20% of areas are treated (Ager *et al.*, 2010:1566). In the 2019 Umpiluzi FPA report it was noted that although forestry had strategically burnt breaks, buffer zone management on a regional level needed more attention (Ludick, 2019:3). The Lowveld and Escarpment FPA fire risk assessment also recommended the strategic placement of firebreaks on a regional basis (Hopkins, 2019). A possible opportunity is to manage fuel loads regionally across landowner boundaries.

#### 2.6.2.2 Prescribed management burning in standing plantation commercial compartments

Homogenous continuous landscapes, such as plantations, with high fuel loads and a high connectivity are favourable for the start and spread of high intensity fires (Loepfe *et al.*, 2010:2366). Many studies on the use of low intensity prescribed management burning (PMB) in plantation standing trees, referred to as understory burning, to reduce the surface fuel litter layer have been conducted in South Africa, Australia, Portugal and the United states. These

studies show that understory burning, under the right conditions, is safe for use in plantations (Bartlett, 2012; Bird & Scholes, 2005; De Ronde *et al.*, 1990; Kobziar *et al.*, 2009; Meira-Castro *et al.*, 2015; Mirra *et al.*, 2017; Vlok & de Ronde, 1989). PMB in plantations is one on the most cost effective means of fuel load reduction (Goldsmith, 2019:15)

PMB in standing plantation compartments is only widely practiced by two biggest companies, SAFCOL and York Timbers, in Mpumalanga which have sawtimber production as their main management objective. This was confirmed by their respective fire managers (de Wet, 2020; van Wyk, 2020). An illustration of PMB in standing pine compartments can be seen below (Figure 2.4).

**Figure 2.4 Photo illustrating understory burning in a pine compartment (Mitchell *et al.*, 2009:392).**

It is however important to note that understory burning is not a suitable option where the management objective is pulpwood production because of limits to carbon residues allowed during the pulping process. Carbon residues after understory burning and species susceptibility to cambium damage limits its application in pulpwood stands (du Plessis, 2020). Alternatives to understory burning are mechanical fuel load management options e.g. studies by Goldsmith (2019) and Pool (2013).

#### 2.6.2.3 Prescribed management burning after timber clearfelling

After harvesting, a large fuel load remains due to unutilised harvesting residue which may need to be burnt to reduce available fuel loads and aid access for re-establishment (De Ronde & Everson, 2004:155). The total average residual fuel loads in Mpumalanga *Pinus patula* compartments, including the litter layer and the harvesting residue for sawtimber and pulpwood

production, were 85.4 t $ha^{-1}$ and 86.6 t $ha^{-1}$ respectively (Ross, 2004:80). Similar to standing trees, burning or mechanical fuel management can be applied after clearfelling.

#### 2.6.2.4 Burning of non-commercial areas

Under s 12(1) of the NVFFA, landowners on whose land a fire may start or spread from must prepare a firebreak on their side of the common boundary, although s 12(7) permits firebreaks to be moved by mutual consent between landowners. Firebreaks are non-commercial areas because they do not have trees on them which may include traditional linear firebreaks but can include any area such as a grassland which is burnt to stop a fire entering or spreading between different landowners. There can also be fire prevention challenges if the firebreaks are incorrectly positioned in the landscape to prevent or stop the spread of fires into neighbouring properties.

### 2.6.3 The topographic positioning of firebreaks in the landscape

Firebreaks mostly follow property boundaries and are located along topographic features which are not necessarily optimal in preventing and stopping fires in extreme weather conditions. Firebreaks do not necessarily need to follow property boundaries but could be situated outside property boundaries by agreement on a broader landscape level rather than everyone preparing firebreaks along their cadastral boundaries. (De Ronde & Everson, 2004:152; Fernandes, 2013:175). This could cause fire prevention challenges if firebreaks are situated on sub-optimal topographic positions. The previous sections on the engineering element of fire prevention have focussed exclusively on burning. The next section will deal with other measures apart from burning i.e. altering the spatial geometry of fuels (section 2,6.1, Table 2.2) and the physical removal of fuel for biomass.

### 2.6.4 Other fuel load management measures

There is a need to investigate mechanical fuel management techniques universally as an alternative to burning because of the ever increasing lack of suitable burning days due to climate change (Ximenes *et al.*, 2017:88). Mechanical fuel management may also appropriate in standing pulpwood plantations where burning may not be appropriate. Apart from fire, other fuel management techniques include mechanical measures to change the geometry, density and continuity of fuels (Corona *et al.*, 2015:5). Studies by Pool (2013) proposed mulching, while Goldsmith (2019) suggested inter tree row discing in plantations as effective fuel management techniques. Mechanical fuel management techniques can be applied under most weather conditions but their use is limited to moderate slope classes due to machine access challenges (Goldsmith, 2019:95). Mechanical fuel management, particularly mulching, has high operational

costs (da Costa, 2020). In the next two sections, opportunities for the reduction and removal of fuel will be discussed in contrast to mechanical fuel load management where the fuel altered but left in situ. The extent and methods of mechanical fuel management in the Lowveld and Escarpment FPA and Umpiluzi FPA will be researched in chapter 4.

#### 2.6.4.1 The removal of unutilised biomass for biofuel and bio-energy

A possible opportunity exists to use plantation residual timber waste as biomass for biofuel if markets are available to avoid fuel reduction burning and mechanical fuel treatments. Currently only 8% of all sources, not only from plantations, of available biomass, in South Africa is utilised for bio-energy of which most is located in the North Eastern parts of the country, where the study area is located. Significant investment and political changes are required to better utilise the available biomass (Lundqvist, 2020:41). Another method to reduce grass fuel loads by cattle grazing is discussed in the following section.

#### 2.6.4.2 The fire prevention and social benefits of controlled cattle grazing by communities

Finally there is an opportunity for allowing controlled grazing by communities to reduce fuel loads and prevent fires (De Ronde *et al.*, 1990:220-221). Many fires, particularly in the Umpiluzi FPA area, are started by communities who need grazing for their cattle (Ludick, 2020g). In South Africa there is a 40% difference between the rural poverty rate (64.5%) and urban poverty rate (25.4%) (World Bank, 2018). There may therefore be social benefits by providing cattle grazing on forestry land. The reasons why communities start fires, which may be socio-economic, needs to be investigated in this research. In addition to this the challenges posed by allowing cattle grazing will be investigated in chapter 4. The opposing statements of potential fuel reduction by cattle grazing vs the fact a major source of fires is burning for grazing present two potential opportunities: Firstly cattle grazing can reduce grass fuel loads in forestry areas and secondly, allowing cattle grazing under well managed conditions could potentially reduce the number of fires by addressing the needs of the communities where possible.

The fourth and final step in the fire prevention framework (section 2.3) is enforcement, together with compliance, to determine to what extent the legal the legal requirements of the NVFFA as prescribed by the local FPA regulations are complied with will be discussed in the following section.

## 2.7 The role of compliance and enforcement in fire prevention

The introduction to chapter 2 of the NVFFA dealing with FPAs states that: ***"****These associations must deal with all aspects of veldfire prevention and firefighting."* Furthermore, s 3(1) states that: *"Owners may form an association for the purpose of predicting, preventing, managing and extinguishing veldfires and apply for its registration as a fire protection association in terms of this Chapter."* Compliance and enforcement required by the NVFFA is discussed within the context of the FPAs.

### 2.7.1 FPA membership

Chapter 2 of the NVFFA makes provision for the establishment of FPAs. FPAs facilitate a collective approach to managing fires which cannot be practiced by individual landowners (Department of Water Affairs and Forestry, 2005:11). Section 4(6) states that "*all owners in an area for which a fire protection association has been registered have a right to join the fire protection association, provided they undertake to abide by its constitution and rules."* Membership of FPAs is therefore voluntary for individual landowners (Meyer, 2015:606). Section 4(8) however states: "*The owner in respect of State land must join any fire protection association registered in the area in which the land lies."* Lowveld and Escarpment FPA has membership categories consisting of forestry, agriculture, conservation, municipal, and residential as members which are also divided into privately and state owned land (Lowveld and Escarpment Fire Protection Association, 2020a). FPA membership from FPA reports is summarised below (Table 2.4).

**Table 2.4 Fire protection association membership summarised from the Lowveld and Escarpment Fire Protection Association and Umpiluzi Fire Protection Association annual reports (Alberts, 2020; Ludick 2020c).**

| Membership Figures | Umpiluzi FPA Membership | | | Lowveld and Escarpment FPA Membership | | |
|---|---|---|---|---|---|---|
| | 2016_17 | 2017_18 | 2018_19 | 2017_18 | 2018_19 | 2019_20 |
| FPA Area ( ha ) | 660 000 | 660 000 | 660 000 | 1 799 915 | 1 736 211 | 1 736 211 |
| Membership ( ha ) | 334 000 | 350 433 | 350 433 | 908 172 | 976 290 | 995 631 |
| Membership % | 51% | 53% | 53% | 50% | 56% | 57% |
| No of FPA members | 234 | 163 | 163 | 467 | 496 | 480 |
| No of municipalities in FPA | 3 | 3 | 3 | 12 | 12 | 12 |
| Number of municipal FPA members | 1 | 1 | 1 | 8 | 8 | 8 |
| Number of non- paying municipal members | 2 | 3 | 3 | 1 | 2 | 8 |

It is possible that the low areas under FPA membership of between 50 and 60 percent for both FPAs is a fire prevention challenge which could undermine the effectiveness of fire prevention, particularly in the case of state, which is legally required to be an FPA member where it has

landholdings in an FPA area. The Lowveld and Escarpment FPA and Umpiluzi FPA managers confirmed that all state and private forestry landowners are FPA members (Ludick, 2022; Scheepers, 2022). The membership requirement is particularly important for municipalities which are located in an FPA (Meyer, 2015:607). It is clear that membership of municipalities, 33% and 66% for Umpiluzi FPA and Lowveld and Escarpment FPA respectively is a challenge as well as the current 100% non-payment of FPA municipal membership fees that effectively means they are not members.

### 2.7.2 FPA rules and regulations

The NVFFA is enabling but places an obligation on landowners to take certain precautions or actions where there is a risk of veldfires starting or spreading. Compliance with the Act is therefore determined by the principle of "reasonability" based on local conditions and requirements (Department of Water Affairs and Forestry, 2005:3-4; Meyer, 2015:604-605). Section 5(4)c of the NVFFA requires that FPAs make rules that bind its members. Although the FPA rules apply to members, s 34(1) b of the Act states that non-members are presumed negligent in the case of a dispute or legal action. FPA rules therefore apply to both members and non-members and compliance with the Act should therefore be measured against compliance with the FPA rules and regulations. Both Lowveld and Escarpment FPA and Umpiluzi FPA specify in their annual FPA reports that the State does not comply with the Act in terms of the FPA rules and regulations (Alberts, 2020; Ludick, 2020c).The Lowveld and Escarpment FPA rules and regulations relevant to fire prevention are discussed briefly.

#### 2.7.2.1 Minimum resource and equipment requirements using Lowveld and Escarpment FPA as an example

Section 17 of the NVFFA requires that landowners maintain a state of readiness and have adequate equipment, trained personnel and personal protective equipment available at all times. When a person is absent from their property a person must be appointed to act on their behalf in case of fires (Meyer, 2015:610). Lowveld and Escarpment FPA has specific requirements based on landowner category (e.g. forestry) and the size of the landholdings in hectares. The following standards are included (Lowveld and Escarpment Fire Protection Association, 2020b): Firstly, minimum equipment required for fire prevention (firebreaks) and suppression activities. Secondly, personal protective equipment (PPE) requirements are listed. Thirdly, training requirements are stipulated. Finally, the trained personnel must be available within 30 minutes during the fire season. In their 2018_2019 annual report, Umpiluzi FPA raises the issue of emerging farmers and tribal areas not having the skills and resources to deal with

fires, in particular on the South African Eswatini border (Ludick, 2020c). This was the only shortcoming in the report, bearing in mind that the reports received were very short and contain very little information.

#### 2.7.2.2 The burning prohibition period and burning permits

The NVFFA stipulates in s 10(2) that no person may light or maintain a fire in the open air when the fire danger is high. In terms of the NVFFA, Lowveld and Escarpment FPA and Umpiluzi FPA issue annual burning prohibitions between 1 July and 31 October, requiring a burning permit for open fires. Furthermore, no burning may take place if the FDI exceeds 55. No slash burning (harvesting residue) is allowed annually between 1 June and 31 October (Lowveld and Escarpment Fire Protection Association, 2020b). Data from the Envirovision Solutions (EVS) camera fire detection centres indicate the fires during the firebreak burning period between 2017 and 2019 where no burning permits were requested from the FPAs (Figure 2.5). It should be noted that the camera detection centres are funded by the forestry companies. These cameras cover most of the forestry landholdings, with the exception of a few blind spots. It is also important for these cameras to detect fires outside forestry boundaries which may become a threat. The fires with and without burning permits include all landholding types within the 10km detection radius. The relevance of this is that any form of burning without a permit during the burning prohibition period increases the risk of fires starting and spreading and is a contravention of the NVFFA. It is therefore necessary to investigate whether this a fire prevention challenge to forestry organisations.

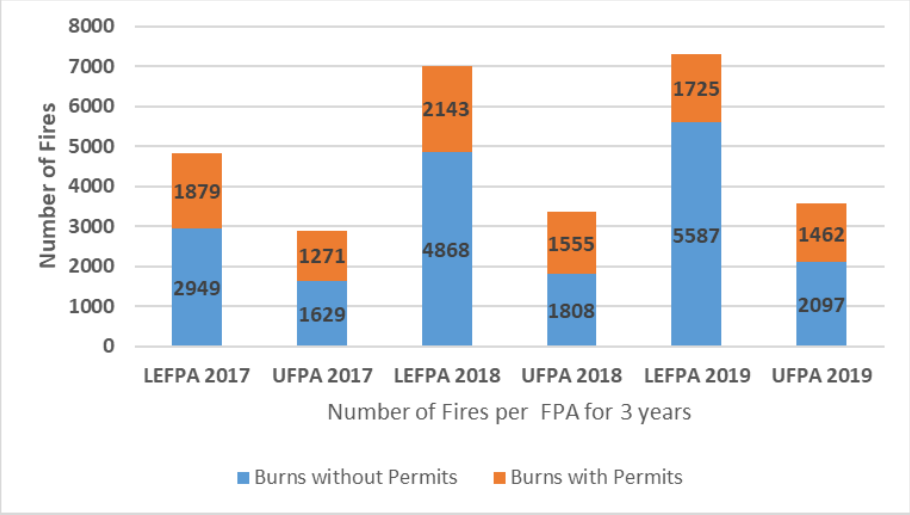


**Figure 2.5 Number of fires, with and without burning permits, detected by Envirovision fire detection cameras during the firebreak burning period, requiring burning permits, in the Lowveld and Escarpment Fire**

and Umpiluzi Fire Protection Association areas in June and July between 2017 and 2019 (van Aswegen, 2020).

#### 2.7.2.3 Offences and penalties

Anyone who commits any of the listed offences will be presumed guilty unless they are members of an FPA (Meyer, 2015:611-612). The advantage of FPA membership comes from enforceable rules in the FPA constitution (Department of Water Affairs and Forestry, 2005). A summarised list of offences is shown in Table 2.5 (Department of Water Affairs and Forestry, 2005:27; Meyer, 2015:611)

**Table 2.5 Summarised offences and penalties relevant to fire prevention (ss. 24 and 25 of the *National Veld and Forest Fire Act 101 of 1998*).**

| Category and kind of offence | Penalty |
|---|---|
| **Category 1**<br>Lighting or maintaining a fire when the FDI is high<br>Not taking reasonable measures to extinguish a fire or prevent it from causing damage to neighbouring property. | First conviction: fine and/or imprisonment for a period of up to two years |
| **Category 2**<br>Leaving a fire unattended<br>Lighting a fire that spreads<br>Prohibited smoking<br>No firebreak<br>Failure to give notice of burning<br>Unauthorised burning<br>Failure to notify neighbours of fires | First conviction: fine and/or imprisonment (1 year)<br>Second conviction: fine and/or imprisonment (2 years) |

Section 26 delegates the responsibility to enforce and issue penalties in terms of the NVFFA to the FPOs. The current financial penalties applicable to Lowveld and Escarpment FPA , dated 20 May 2013, provide for a maximum penalty of only R5000 (Scheepers, 2020f). According to FPA reports, one warning was issued in Umpiluzi FPA in the 2018-2019 report and five warnings in the 2020 Lowveld and Escarpment FPA report (Alberts, 2020; Ludick, 2020c). The two possible challenges are therefore the lack of enforcement of the FPA regulations as well as the low penalties that seem not to be a sufficient deterrent for effective fire prevention.

## 2.8 Conclusion

The fire prevention framework for the research was developed based on literature sources (section 2.3). The literature review in this chapter was conducted using this framework. Furthermore, the literature review determined what potential fire prevention challenges and opportunities could be identified to serve as a basis for the questionnaire to determine the perceptions of commercial forestry managers of these fire prevention challenges and opportunities and to assess their relevance in the Lowveld and Escarpment FPA and Umpiluzi FPA areas. This literature review only focussed on fire prevention and its impacts on large commercial forestry organisations. The following aspects will be assessed in the research based on the literature review. Firstly, the knowledge of fire causes and their locations including fire reporting. Arson fires will be investigated as a fire cause as well as the impacts of communities on fire prevention. The impact of lightning as a natural fire cause will be investigated briefly. Secondly, fire education and awareness will be investigated, concentrating specifically on fire awareness campaigns and the fire danger index. Thirdly, under engineering, fuel load management together with potential challenges and opportunities posed by community cattle grazing and its use as a potential fuel load reduction technique. Fourthly, the role of compliance and enforcement will be investigated, including FPA membership, compliance to FPA regulations, the level of enforcement of the FPA (NVFFA) regulations and the level of penalties for non-compliance. Finally, respondents will be asked to rank the top five fire prevention challenges out of a list of 21.

# CHAPTER 3 METHODOLOGY

## 3.1 Introduction

This chapter explains the research methodology followed to evaluate the perception of fire prevention challenges by commercial forestry managers, in forestry areas, in Mpumalanga, South Africa to achieve the research aim and answer the research question. The following aspects are discussed:

- The research design;
- The identification of fire prevention challenges;
- The selection of the organisations and study participants, as well as the sampling technique and sample size;
- The development of the measuring instrument (questionnaire);
- The method of data collection;
- The method of data analysis; and
- Ethical considerations and methodical limitations in the study.

## 3.2 Research design

The research approach is based on an embedded mixed method design, involving the convergent use of quantitative and qualitative data, with the quantitative data as the primary data set. Research questions, where the quantitative or qualitative research data when used on their own, are insufficient to develop a complete understanding and contextualisation of the research problem are most suited to a mixed method approach (Creswell, 2009:203; Creswell *et al.*, 2011:6; Guest *et al.*, 2013:16; Shorten & Smith, 2017:75). This was the case in the current research. Mixed method approaches involve combining quantitative and qualitative data in research. Quantitative research normally uses closed ended questions, with predetermined response options, while qualitative research uses open ended questions, which do not provide predetermined response options (Creswell, 2009:14).

The convergent use of quantitative and qualitative data involves the collection of quantitative and qualitative data at the same time, and the integration of the data during the analysis and interpretation of the results (Creswell, 2009:16). When combined, it is important to determine the weighting of the qualitative and quantitative data relative to each other. The weighting of the quantitative and qualitative data may be equal, or one type of data may be emphasised above the other (Creswell, 2009:206). In this dissertation the quantitative data forms the primary data set which is has more emphasis than the qualitative data, to which the qualitative data is merged

to provide greater context and understanding of the quantitative data. Data will be obtained by sending questionnaires to the participants, with follow up telephonic interviews and email communication to provide clarity to their responses if necessary.

## 3.3 The identification of fire prevention challenges and opportunities

Possible fire prevention challenges in commercial forestry were primarily identified through a review of international and South African scientific literature in chapter 2 (sections 2.4, 2.5, 2.6 and 2.7). South African scientific literature sources were used to back up international literature sources on fire prevention challenges. Where gaps were identified in the South African literature, unpublished primary and secondary data relating specifically to the Lowveld and Escarpment FPA and Umpiluzi FPA study area were used. The primary data originated from questionnaires, personal communication and the summary of camera fire detection centre data. FPA annual reports are secondary data sources, submitted annually by the FPAs to the Minister as required by the NVFFA, s 5(1)i, which are available to FPA members on request. The potential fire prevention challenges identified in the literature review and unpublished data were included in the fire prevention questionnaire to evaluate the perceptions of these challenges as well as opportunities for improvement.

## 3.4 Participant selection and sampling

Participant selection followed a two stage approach. Firstly, the participant organisations in the study area that met the selection criteria were selected and secondly individuals within these organisations were chosen based on their experience. The selection of the participant organisations and individuals, the sampling technique and sampling size are discussed in this section.

### 3.4.1 Selection of participant organisations

Forestry organisations occupy large contiguous tracts of land that focus only on plantation forestry as their land use type. Smaller timber growers are generally mixed farming enterprises, with a combination of forestry plantations and other forms of agriculture which differ from the sole focus on forestry by larger forestry organisations (Ludick, 2020a). This is the case in the Umpiluzi FPA area but not in the Lowveld and Escarpment FPA. Large forestry organisations focus predominantly on protecting their plantation assets from fire, whereas mixed farming enterprises may have other objectives, such as maintaining grassland quality for grazing. The large difference in land use management between different landowners made it necessary to focus only on large forestry organisation managers' perceptions of fire prevention challenges

and opportunities. The term “forestry organisations” is used as a collective term to refer to the listed companies, parastatals and co-operatives, which make up the large forestry legal entities.

The four forestry organisations included in the Lowveld and Escarpment FPA study area have a combined title deed area of 355 044 ha (Kühl, 2021). The four organisations selected in the Lowveld and Escarpment FPA area are Sappi, York Timbers, SAFCOL and MTO Forestry. The five organisations included in the Umpiluzi FPA area have a combined title area totalling 153 604 ha (Ludick, 2021). These five Umpiluzi FPA organisations include Sappi, York Timbers, SAFCOL, Mondi and the TWK Forestry Division. The combined title deed area of the six organisations included in the dissertation is therefore 508 648 ha. The total title deed figures were obtained from the EVS camera detection centre for the Lowveld and Escarpment FPA area which bases the camera fire detection fees on the total title deed area of the four forestry organisations. The Umpiluzi FPA title deed area was obtained by requesting the total title deed area of the five organisations included in Umpiluzi FPA area. Neither the EVS camera detection centre manager nor the Umpiluzi FPA manager were willing to provide the split between plantation and non-plantation areas as this information is deemed as confidential. Considering that the non-plantation areas make up roughly 30% of total forestry landholdings on average in South Africa (Forestry South Africa, 2019c), the plantation area included in the study is then approximately 70% of the title deed area ha or 356 053 ha.

The latest figure for total afforested area, excluding unplanted land, in Mpumalanga is 489 073 ha (Forestry South Africa, 2019d). The plantation area included in this dissertation therefore represents very close to 73% or roughly three quarters of the afforested plantation area in Mpumalanga. The plantation area included in this study is sufficiently representative of the total Mpumalanga forestry landholdings.

### 3.4.2 Sampling technique, selection of participant individuals and sample size

A purposive, non-probability sampling technique was used for the selection of participants. Such a technique is appropriate where expert knowledge of the research subject is required to answer the research question (Langos, 2014:40; Mack *et al.*, 2005:5; Rudestam & Newton, 2007:106-107). Purposive sampling is most effective when data review and analysis is done in conjunction with data collection (Mack *et al.*, 2005:5)

For the purposes of this research, the term “*Forestry Managers”* was interpreted to include only the managers of large forestry organisations who are directly involved in fire management, who would therefore be better equipped to identify shortcomings and opportunities in fire prevention. Forestry managers with at least five years of fire management experience were chosen. The categories of forestry managers chosen were District or Area Managers, Fire Managers,

Plantation Managers, Foresters and FPA representatives that represent their respective organisations in the two FPAs. The study participants were chosen to provide an approximately equal representation in the Lowveld and Escarpment FPA and Umpiluzi FPA study areas. The forestry managers participating in the study were asked to fill out some basic demographic questions to identify their normal role in the forestry operations and their experience in forest fire management.

In qualitative studies, it is important that sufficient data be collected to a point where no further insights can be gained on the research topic, which in practice lies between 5 and 30 participants (Rudestam & Newton, 2007:107). A sample of 22 participants was initially selected of which five declined to participate leaving a total of 17 respondents. There are a limited number of operational forestry personnel with sufficient experience, limiting the available participants.

### 3.4.3 Development and testing of the questionnaire

A questionnaire is a common instrument to collect research data on the opinions of participants in a study which consists of structured questions (Oden, 2018:2). A questionnaire has the ability to obtain views of key stakeholders quickly and cost effectively (Kumar, 2014:181). Questionnaires may pose the same questions to all participants using Likert scales which can measure the opinions or perceptions of the study participants numbers numerically (University of Newcastle library guides, 2020). Likert Scales, have predetermined response possibilities which are easy for researchers to analyse (Glasow, 2005:8). Quantitative data uses predetermined response options with closed ended questions. Qualitative data does not have predetermined responses and allows the study participants to answer the questions in their own their own words (Creswell, 2009:4).

#### 3.4.3.1 Closed ended questions – quantitative data

Different types of closed ended questions were included in the questionnaire, to achieve the following specific objectives: To determine the level of agreement of forestry managers with the proposed fire prevention challenges, these challenges were represented as 16 Likert scale statements based on potential fire prevention challenges identified in the literature review.

A 3 point Likert scale was chosen for this study. The scale response options were "*agree", "neither agree or disagree", and "disagree"*. The "*neither agree or disagree"* category was added for study participants who did not have any level of agreement or disagreement with specific challenges in the Likert scale statements. In addition an *"unable to judge"* option was included for participants not having the knowledge or information to select an answer.

The choice of a 3 point Likert scale was based on the following arguments in the literature, which recommended the least possible number of response categories. The following should be considered: Firstly, Hoffstee (2020a:3) suggests using the fewest number of Likert scale response categories to reach the level of detail that is required. Secondly, when respondents are asked to compare their own views to a question or statement, emotive response options such as *"strongly agree"* should be avoided (Glasow, 2005:2-5). Thirdly, when respondents are asked to compare their own views to a question or statement, emotive response options such as *"strongly agree"* should be avoided (Glasow, 2005:2-5). Finally, Hoffstee (2020a:3) feels that having a *"no opinion" (Unable to judge)* option will prevent participants being forced to express an opinion when they do not have one.

Pre-coded closed ended response options are used provide options for respondents to select from. The option "other "should be added to make provision for responses which are not anticipated, where necessary. Other closed ended question types may have "Yes", "No" response options as well as skip, branching or contingency questions to determine whether a group of questions are only applicable to a sub group of respondents (Hoffstee, 2020b:4). Pre-determined response options as well as skip, branching and contingency questions were included in the study. Respondents were also asked to rank fire prevention challenge options in order of importance for a quantitative fire prevention ranking analysis approach as proposed by the following authors (Dey, 1993:23; Hoffstee, 2020a:3). Refer to Annexure A for the full questionnaire. The following quantitative data was included in the dissertation:

- Percentages of the different response options for each of the 16 Likert scale statements included in chapter 4 (Response options were *"Unable to judge", "Disagree", "Neither agree or disagree", "Agree"*);
- Percentages of *"Yes", "No"* response options to obtain a deeper understanding of specific fire prevention challenges and opportunities;
- Percentages of *"Yes", "No"* response options to identify certain fire prevention challenges; which may not be applicable to certain study participants at all;
- Percentages of selection of pre-determined response options;
- Closed ended questions requiring numerical answers were provided;
- One ranking question where the top five fire prevention challenges were ranked from one to five out of a list of 21 fire prevention challenges including an option for *"other"*.

#### 3.4.3.2 Open ended questions – qualitative data

Open ended questions allow the respondents to answer in their own words and provide additional information where greater insight is required (Glasow, 2005:7). Both Morrison-Saunders and Bailey (2009:287) and Tshering (2006:40) used open ended questions to gain a better understanding of the Likert scale responses. More specific open ended questions followed the Likert scale statements to gain a more detailed understanding of the fire prevention challenges and identify opportunities to improve current fire prevention practice (Annexure A).

It is important for a pilot study to be done so that any problems can be rectified before the survey takes place (Hoffstee, 2020b:4; Rudestam & Newton, 2007:115). For the pilot study, two forestry managers, who were also used in the actual survey due to the small available sample size, were asked to fill in the questionnaires and provide feedback. Changes were made to the questionnaire based on their feedback and responses.

## 3.5 Data collection and completion of the questionnaires

The main method of data collection was by means of questionnaires, but follow-up emails and telephone discussions were used, where required, to clarify any of the questionnaire responses. Completion of the questionnaires. Questionnaires were distributed to selected individuals with a high level of experience in fire management within the six organisations. The questionnaires were sent to the participants in advance for completion due to its integrated nature and time constraints. Detailed instructions were provided for completing the questionnaires.

## 3.6 Data analysis

### 3.6.1 Quantitative data analysis

The extent of agreement to each of the 16 Likert scale statements representing fire prevention challenges was analysed using bar charts to indicate percentages of each response option from all respondents for the both areas combined (Lowveld and Escarpment FPA and Umpiluzi FPA) as well as separately. *"Yes", "No"* response question types were analysed using percentages to determine the percentage of *"Yes", "No"* response options. The first set of *"Yes", "No"* questions are relevant to all study participants. A second set of *"Yes", "No"* questions was used to separate the possibly of fire prevention challenges being present but not perceived by respondents to be important, from fire prevention challenges which are applicable to certain respondents only. The pre-determined response options were also analysed and depicted on bar charts using percentages of responses for each response option. These response options were included to

examine in more detail who was responsible for specific fire prevention challenges, fire prevention options as well as fire prevention methods used by the study participants.

Each of the respondents were asked to rank what they felt the top five fire prevention challenges for the 21 fire prevention challenge response options, including an additional option for “other”. The frequency of each rank (1-5) was tabulated for each of the 21 response options. To obtain a weighted average, a ranking of 1 was awarded 5 points, a rank 2 was awarded 4 points, down to rank 5 which scored 1 point. For each fire prevention challenge, the frequency total for each rank (1-5) was multiplied by its corresponding ranking point and totalled to calculate the top five weighted fire prevention challenges that are represented in a table. The unweighted ranking for all respondents was calculated as the sum of the unweighted individual responses for each of the 21 fire prevention challenges to calculate an unweighted ranking score. The unweighted response totals were used to check the ranking similarity between the weighted and unweighted rankings. Similarity in ranking between the weighted and unweighted rankings improve confidence in the reliability of top five fire prevention challenge rankings (Table 4.4).

### 3.6.2 Qualitative data analysis

Certain qualitative data can be integrated with quantitative data in the form of numerical information. This is achieved through transforming the qualitative data by counting the occurrence of different response themes in open ended response questions and displaying the qualitative data in the form of tables and figures to represent qualitative data in numerical format (Creswell *et al.*, 2011:5). Tshering (2006:40) analysed key words and phrases for a certain and analysed how many times they were used for each question. Certain qualitative data was analysed by counting the number of open ended qualitative response themes and analysing their frequency of occurrence by converting the response options into percentages and displaying these percentages in bar charts and tables. In certain cases qualitative response options added more value by grouping and listing the responses as themes.

## 3.7 Ethical considerations and informed consent

Mack *et al.* (2005:10) and Hoffstee (2020a:8) noted that to obtain informed consent from the participants it is important that they be made aware of the following:

- The purpose of the research;
- What is expected and the amount of time it will take;
- Participation is voluntary and participation can be withdrawn at any time;
- Confidentiality will be protected; and
- The contact details of the researcher will be made available.

All of these requirements were included in the questionnaire (Annexure A). In addition to this, five individuals exercised their right not to participate. As this study does not involve studies on human subjects, the risk can be regarded as low. Ethics clearance was obtained for the study and renewed in August 2022 (Ethics clearance number: NWU-01316-20-A9).

## 3.8 Limitations to this study

The first limitation is geographical, as the study only represents the Lowveld and Escarpment and Umpiluzi FPAs of Mpumalanga. This was mitigated by selecting all the large organisations in these two FPAs which have a combined plantation area making up roughly three quarters of the afforested area in Mpumalanga. Secondly, the exclusion of the private forestry growers from the study which was necessary because smaller plantation growers are normally mixed farming enterprises consisting of plantation forestry and agriculture. Including smaller growers would cloud the study due to their diverse nature of agriculture and forestry management objectives. To simplify the study, only large forestry organisations were included. Fourthly, a sample size of 22, of which 17 responded, is relatively small. There were not enough participants in the two research areas with sufficient experience. The sample size was also limited due to the use of quantitative and qualitative data in a mixed methods research approach. The fifth limitation is that the role of communities and their impact on fire prevention could not be investigated in detail due to the scope of this dissertation. Finally, different forestry areas in different areas may have different fire prevention challenges and therefore the results may not be applicable through all forestry areas in South Africa. Using a similar methodology, the study could be repeated in different areas of South Africa.

## 3.9 Conclusion

The use of the embedded mixed methods design, using quantitative data as the primary dataset was motivated and explained. A review of South African and International literature is used to identify potential fire prevention challenges and opportunities. The rationale behind the selection of the study participants, the commercial forestry organisations as well as the reason for the selection of large forestry organisations over other landuse types was discussed in this chapter. The combined Lowveld and Escarpment FPA and Umpiluzi FPA study area is a representative sample of the Mpumalanga commercial forestry areas as they represent approximately 73% of the total afforested area in Mpumalanga. Participant sampling is based on a purposive non-probability sampling technique because of low number of forestry managers with sufficient experience in forest fires. Based on forestry experience in the Lowveld and Escarpment FPA and Umpiluzi FPA areas, the sample size was limited to 22, of which only 17 eventually responded, which included respondents who exercised their right not to participate. Data collection is based

on a questionnaire with email follow-up and telephonic follow up, where further clarity of the responses is required. To gauge the perceptions of forestry managers of fire prevention challenges, Likert scales are primarily used to measure the level of agreement to the possible fire prevention challenges identified in the literature review. Other closed ended questions to gain specific information are also used in this dissertation. Qualitative data was used to better understand the context of responses of the participants. Ethics clearance was obtained before the commencement of this study (Ethics clearance number: NWU-01316-20-A9). Finally, limitations of the study were discussed.

# CHAPTER 4: DATA ANALYSIS AND DISCUSSION

## 4.1 Introduction

Fires in forestry areas are one of the biggest threats to the long term sustainability of the industry. In the literature review, it was mentioned that the exotic tree species in the Lowveld and Escarpment FPA and Umpiluzi FPA areas are established in grassland areas where fire was historically present as part of the natural sourveld grassland ecosystems. Forestry organisations implement various measures to reduce the risk of fires, including camera fire detection systems, ground and aerial firefighting resources to detect and extinguish fires. Despite all these measures, fires continue to cause damage in forestry areas. This research attempted to identify fire prevention challenges, gather data on how fire managers perceive these challenges and to identify opportunities to reduce the number of fires by focusing on the fire prevention.

The structure for the fire prevention challenges and opportunities in chapter 4 corresponds to Table 2.6 in the literature review. This is followed by the weighted and unweighted rankings of the top five fire prevention challenges chosen by the respondents from a list of 21 fire prevention challenges.

## 4.2 Profile of participants, the study areas and the organisations

### 4.2.1 Profile of the study areas

The locations of the two study areas, the Lowveld and Escarpment Fire Protection Association (LEFPA) and the Umpiluzi Fire Protection Association (UFPA), was indicated in chapter 1 (Figure 1.5). The total sawtimber production area in Mpumalanga is 211 647 ha, most of which is in the Lowveld and Escarpment FPA and Umpiluzi FPA areas. This land belongs mostly to the two organisations included in this study, with private and other growers having small areas relative to the total sawtimber production area. The total pulpwood production area in Mpumalanga is 251 888 ha of which most is owned by two large corporates. The “other” management objective category only represents roughly 25 538ha ha of the afforested area in Mpumalanga (Godsmark & Oberholzer, 2019:31).

From a fire prevention perspective, there are a number of important considerations to take note of when comparing the two FPA areas: Firstly, the Lowveld and Escarpment FPA area is situated in a warm temperate climatic zone, mostly on the mid altitude Mpumalanga escarpment, in a more mountainous area extending down to the Mpumalanga Lowveld. The Umpiluzi FPA area is

situated in the cool temperate, Eastern Mpumalanga Highveld plateau, which has a much flatter topography (Louw & Smith, 2012:33). The flatter Umpiluzi FPA terrain makes it more suitable for mechanical fuel reduction as an alternative to burning. A second important distinction between the two areas is that the Lowveld and Escarpment FPA area consists of large consolidated forestry plantation blocks, owned by large forestry organisations, with commercial forestry (forestry) as the primary land use type. In contrast, the Umpiluzi FPA area has more land use types, with more small private timber growers than in the Lowveld and Escarpment FPA area, with mixed farming operations which often include forestry. All timber growers realise the huge fire risk they face, in terms of potential fire losses and the potential legal liabilities, should a fire on their properties spread to an adjacent landowner if they are not FPA members (van Heerden, 2021). Thirdly, the Umpiluzi FPA area has a larger number of rural communities than Lowveld and Escarpment FPA , who burn areas for cattle grazing, within or adjoining forestry plantations which are a major sources of fires within Umpiluzi FPA (van Heerden, 2021).

### 4.2.2 Profile of the participant organisations

Plantations are established primarily to produce sawtimber (solid wood products), pulp, or other products (mining timber, poles, and wood chips). It is important to note that the different organisations in this study have different management objectives due to differing end products for which the trees are grown. The organisations' differing management objectives and tree species planted could cause some variations in their perceptions of fire prevention challenges and opportunities. Sawtimber and pulp production are however the predominant forestry management objectives in Mpumalanga.

### 4.2.3 Profile of individual participants

A sample of 22 participants was initially selected, with two respondents electing to withdraw from the study, one because they felt uncomfortable about supplying company information and the second senior manager declined due to insufficient knowledge of operational fire management in the organisation. A further three failed to submit their questionnaires, despite numerous requests. A total of 17 respondents remained, nine from the Lowveld and Escarpment FPA area and eight from Umpiluzi FPA.

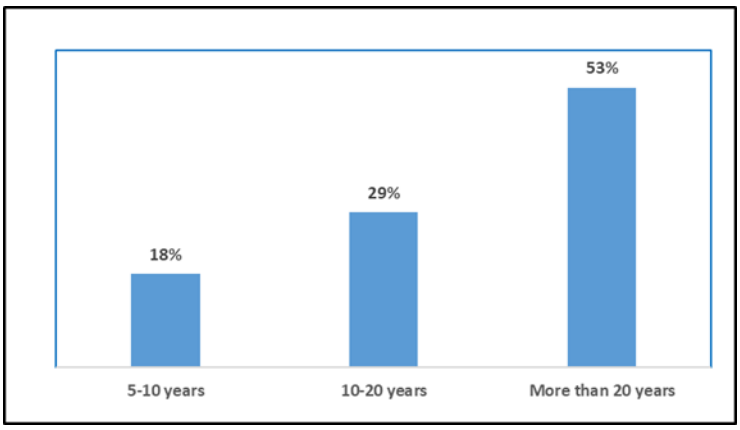


**Figure 4.1 Respondent's number of years' of fire management experience**

Respondents with at least five years fire management experience were chosen for the study. It was clear that all of the respondents have more than five years' experience, with 53% having more than 20 years of fire management experience (Figure 4.1). All forestry respondents also have a tertiary forestry qualification. As either a Diploma in Forestry or a four year BSc degree in forestry is the minimum academic requirement to be appointed as an operational forestry manager, all of the respondents in the study also meet this minimum requirement.

## 4.3 Fire causes and their locations

### 4.3.1 The lack of knowledge of fire causes, their locations, opinions on the levels of fire reporting and their impacts on fire prevention

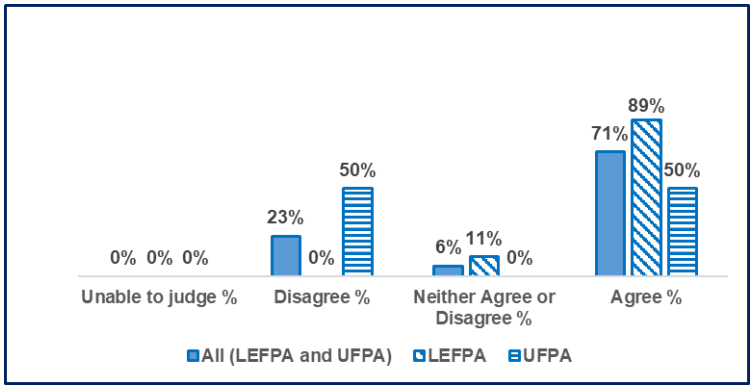


**Figure 4.2 Participant perceptions of a lack of knowledge of fire causes and their locations**

Knowledge of fire causes and their locations is important to prevent fires and implement mitigation measures. From the literature, it was clear that the causes of a large percentage of fires reported to the Department of Agriculture, Forestry and Fisheries (DAFF) were unknown. During the 2017

fire season, the causes of 97% of the reported fires in the Lowveld and Escarpment FPA region and 25% of those in the Umpiluzi FPA region were unknown (Figures 2.1 and 2.2).

The result indicates that 71% of all respondents agreed that a lack of knowledge of fire causes and fire locations is a fire prevention challenge. When the results for the Lowveld and Escarpment FPA and Umpiluzi FPA areas were analysed separately, the responses between the areas differ substantially. In the Lowveld and Escarpment FPA area, 89% of respondents agreed that a lack of knowledge of fire causes and fire locations is a potential fire prevention challenge, while only 50% of respondents in the Umpiluzi FPA area agreed with the statement (Figure 4.2). The other half of the respondents in the Umpiluzi FPA area disagreed with the statement.

The difference between the results for the two areas can probably be explained, at least partially, by the fact that most fires in the Umpiluzi FPA area occur near communities and are recognised by the Umpiluzi FPA participants as being caused by arson. This is confirmed by data in the 2018 DAFF report on commercial timber resources in South Africa, which states that in the 2017 fire season, only 1% of commercial plantation fire damage in the Lowveld and Escarpment FPA area was caused by arson, while 70% of commercial plantation fire damage in the Umpiluzi FPA area was caused by arson (Figures 2.1 and 2.2). Perceptions of the level of arson as a fire cause and the presence of communities as a source of fire was further investigated in sections 4.3.2 and 4.3.3 respectively.

It is not clear how fire causes are recorded, analysed or reported at plantation, organisation, FPA or national level, bearing in mind that the national records are the fourth and last step in the reporting chain, which might not reflect the knowledge of fire causes and their locations at operational or FPA level. Participants were therefore requested to indicate and explain at what level(s) they think fire causes should be reported and analysed. The respondents were provided with six response combinations of the incorporating the four reporting levels. The six response combinations received from all the respondents do not necessarily include all the steps in the reporting hierarchy, for example the response “Plantation and FPA“ skips the organisation and the response “Organisation and FPA” skips the plantation in the reporting sequence. It is merely a question of where in an organisation the respondent feels fire cause and fire location data should be collated and reported. In other words, does the reporting of fire causes and locations stop at plantation level, organisational level, FPA level or National level. The highest level reporting in each of the six response combinations received from the respondents should therefore be considered to represent the level to which fires are reported. All the response combinations, with the percentages of the responses received are indicated (Figure 4.3).

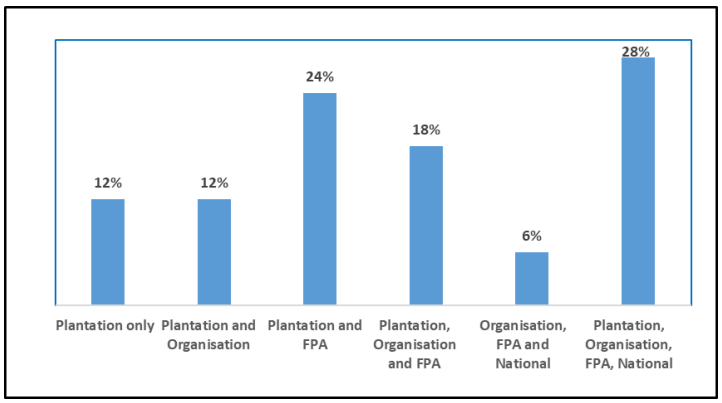


**Figure 4.3 Participant perceptions of the level(s) at which wildfire causes and their locations should be reported and analysed**

Twenty four percent of the respondents believed that reporting and analysis should not go further than organisation level (Plantation only plus Plantation and Organisation), 48% up to FPA level (Plantation and FPA plus Plantation and Organisation plus Plantation only) and only 34% up to National level (Organisation, FPA and National plus Plantation, Organisation, FPA and National). Only 28% of the respondents felt that fires should be reported and analysed at all four levels. Based on the responses it therefore clear that there are high differences of opinion on where fire causes and locations should be reported. This will be discussed further in the following section.

All 17 respondents indicated that they report their fires to the FPA. Section 5(1)i of the NVFFA requires FPAs to present fire statistics to the Minister every twelve months. However, the level of reporting is not intended to be more than what is needed for good governance and the level of benefits it provides to its members (Department of Water Affairs and Forestry, 2005:12) The FPA managers, however, expressed an opinion that many fires are not reported. This opinion is supported by Scheepers (2020d), who stated that fires in the Lowveld and Escarpment FPA region are only reported to Lowveld and Escarpment FPA by corporate FPA members, but that not all fires are reported. Similarly in the Umpiluzi FPA area, only fires which the Umpiluzi FPA respond to for assistance are included in their fire statistics (Ludick, 2020f).

It is therefore clear that not all fires are being reported in the reporting chain. Fire prevention needs to be addressed at all levels to develop a strategy to reduce the impact of fires and this cannot be done if the causes of fires and their locations are not known and if all fires are not reported at organisation, FPA and national level. It is clear that there are big differences in opinion amongst respondents on where fire causes and locations should be reported and analysed (Figure 4.3), which may explain why there are gaps in the data (section 2.4). In the light of these findings, fire reporting and analysis presents an opportunity to improve fire prevention, which will be discussed further in chapter 5.

### 4.3.2 The levels of arson fires in forestry areas and accuracy of reporting

#### 4.3.2.1 Levels of arson fires

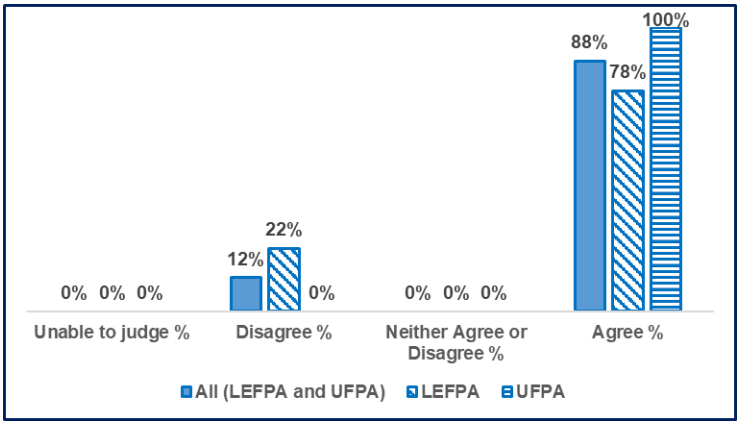


**Figure 4.4 Participant perceptions that the current levels of arson fires are a fire prevention challenge in commercial forestry areas**

The combined result indicates that 88% of all respondents agreed with the statement that the current levels of arson fires is a fire prevention challenge in forestry areas. However, an analysis for the Lowveld and Escarpment FPA and Umpiluzi FPA areas separately, shows a substantial difference in the two areas, with 78% and 100% agreement with the statement for the Lowveld and Escarpment FPA and Umpiluzi FPA areas respectively (Figure 4.4). One potential reason for the difference between the two areas could be that there are more communities adjoining or living within commercial forestry landholdings in the Umpiluzi FPA area. The presence of communities on fire prevention challenges was further investigated and the results are provided (section 4.3.3).

#### 4.3.2.2 The accuracy of arson fire reporting

In the literature study data from the regulator (DAFF) indicated that 70% of fires in the Umpiluzi FPA area are related to arson (Figure 2.2), while only 1% of fires in the Lowveld and Escarpment FPA area were related to arson (Figure 2.1). The correctness of the Lowveld and Escarpment FPA data however is uncertain, because 97% of the reported fires had unknown causes.

When respondents were asked whether arson fires are correctly reported, only 47% of all respondents in both FPA areas felt that arson fires were correctly reported. However, there was a big difference between the perceptions from the Lowveld and Escarpment FPA and Umpiluzi FPA areas. While 56% of Lowveld and Escarpment FPA respondents felt that arson fires were correctly reported, only 37% of Umpiluzi FPA respondents were of the same opinion (Figure 4.5).

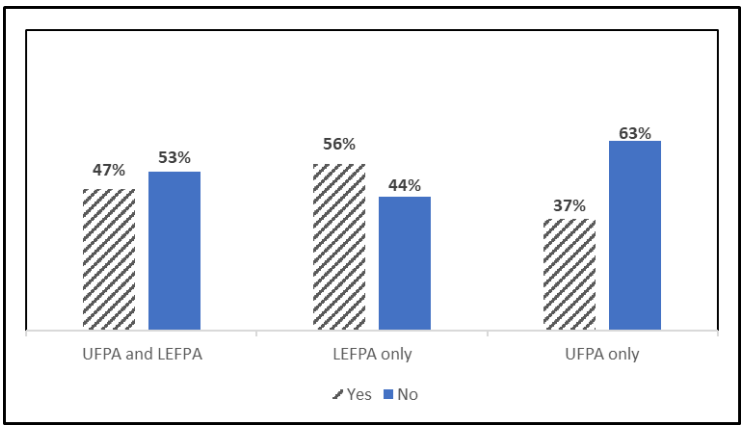


**Figure 4.5 Participant perceptions on whether they think that fires are correctly reported as arson fires**

The main reasons why respondents from both areas combined were of the opinion that arson fires are not correctly reported were as follows: Firstly, and most importantly, arson is difficult to prove, even if it seems evident that arson was involved. Secondly, due to poor fire report quality, causes may be vague, such as suspected arson or unknown causes, which results in fires being incorrectly categorised. Finally, the inaccuracy of arson fire reporting includes their non-reporting. It could be expected that if fires were arson related, forestry organisations would expect these fires to be reported to the police. The non-reporting of arson fires could therefore be linked to the following section.

#### 4.3.2.3 The reporting levels of arson fires to the police

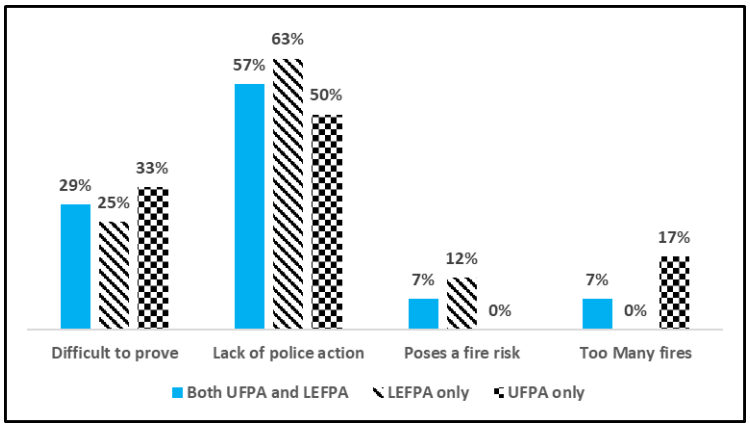


**Figure 4.6 Participant perceptions of the reasons why arson fires are not reported to the police**

Respondents from both areas that indicated that they did not report arson fires to the police were asked to explain their reasons for the non-reporting (Figure 4.6). It was clear that the lack of police action was the single most important reason for not reporting arson fires. This accounted for 57% of the combined respondents' reason for not reporting arson fires. In the

Lowveld and Escarpment FPA and Umpiluzi FPA areas, it accounted for 63% and 50% of the non-reporting, respectively, followed by the difficulty in proving definitively that the fires were caused by arson (29%).

None of 16 respondents was aware of any successful convictions for arson throughout their entire forestry careers in the Lowveld and Escarpment FPA and Umpiluzi FPA areas. This is an additional reason for the inaccurate reporting or non-reporting of arson fires (section 4.3.2.2). The challenges posed by arson fires is therefore exacerbated by the lack of successful prosecutions, particularly in the Umpiluzi FPA area. According to respondents who indicated that they report arson fires as part of company policy, the only reasons that organisations report arson fires to police is for insurance claims and to pre-empt possible lawsuits and convictions, particularly in the case of large fires.

### 4.3.3 The impact of communities, including informal settlements, on fire prevention

#### 4.3.3.1 The presence of communities, including informal settlements, in forestry areas

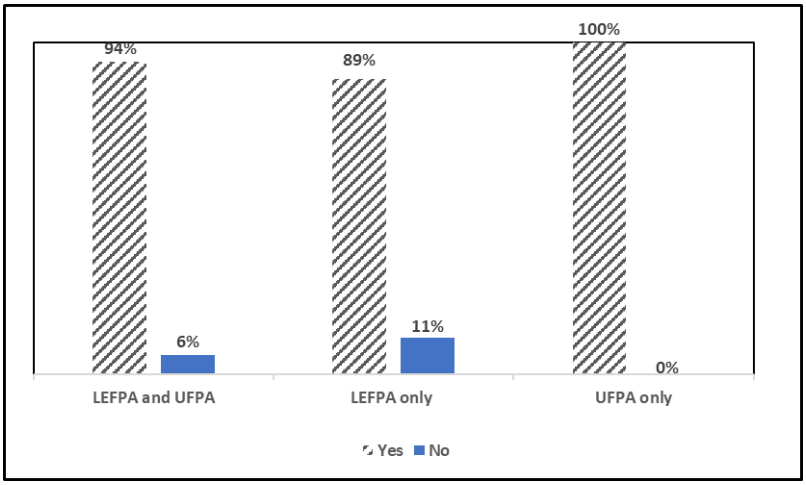


**Figure 4.7 Participant responses on whether they have communities and informal settlements within or adjacent to their forestry landholdings**

Communities in this study are historically disadvantaged individuals in rural areas, far from urban centres, who may have housing tenure (occupation) rights or live in informal (illegal) settlements without municipal services and with limited access to employment in the formal sector. They focus primarily on agriculture, cattle farming in particular, to sustain themselves but do not have access to resources, land in particular, to sustain themselves because most the land is occupied by commercial forestry and agriculture.

When respondents were asked whether they had communities, including informal settlements, within or adjacent to their landholdings, 89% of the respondents in the Lowveld and

Escarpment FPA area and 100% in the Umpiluzi FPA area, indicated that they had communities living within or adjacent to their forestry landholdings (Figure 4.7). It is clear that communities are live in or border on forestry areas in both the Lowveld and Escarpment FPA and Umpiluzi FPA areas. The impact of community presence as a source of fires therefore needs to be investigated further.

#### 4.3.3.2 Perceptions on the reasons why communities start fires

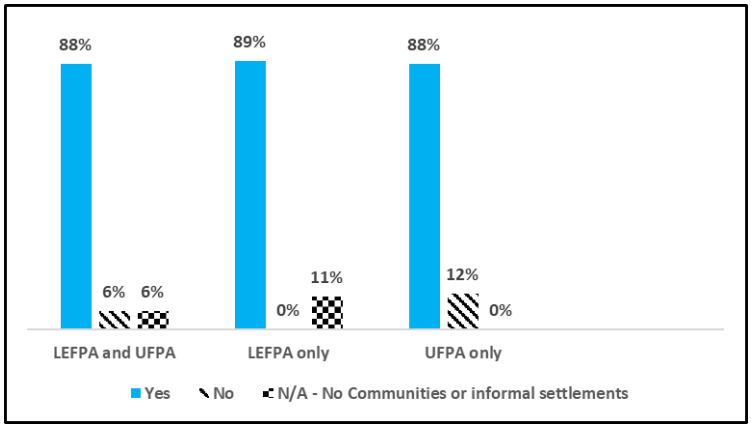


**Figure 4.8 Participant perceptions on whether fires in their areas of responsibility originate from communities or informal settlements**

Respondents that indicated that they had communities within or bordering on their forestry landholdings, were asked whether fires in their areas originate from these communities. The majority of respondents for both research areas combined (88%), as well as for the Lowveld and Escarpment FPA (89%) and Umpiluzi FPA (88%) areas respectively, indicated that they were of the opinion that fires originate from communities or informal settlements (Figure 4.8). Based on participant perceptions it would appear that fires may be more prevalent where communities are present.

**Table 4.1 Percentage of reasons why communities start fires provided by forestry managers grouped into socio-economic and other factors**

| Reasons for starting fires | Both LEFPA and UFPA | LEFPA only | UFPA only |
|---|---|---|---|
| **Socio-Economic Factors** | | | |
| **Burning for early winter grazing (winter shortage)** | 24% | 21% | 28% |
| **Ignorance of fire risks and fire behaviour** | 16% | 21% | 11% |
| **Lack of service delivery protests** | 8% | 11% | 6% |
| **Conflict with landowners (lack of available land)** | 8% | 5% | 12% |
| **Unhappy about the high unemployment rate** | 8% | 5% | 11% |
| **Children start fires (working parents, unsupervised, boredom)** | 5% | 5% | 6% |

| Reasons for starting fires | Both LEFPA and UFPA | LEFPA only | UFPA only |
|---|---|---|---|
| **Smoking out wild beehives for honey** | 5% | 5% | 5% |
| **Internal conflict in communities (Available resources)** | 5% | 11% | 0% |
| **Hunting using fire to drive out animals** | 5% | 0% | 11% |
| **Disgruntled forestry employees and contactors** | 3% | 0% | 5% |
| **Unaware of where boundaries are** | 3% | 6% | 0% |
| **Total socio-economic factors** | **89%** | **89%** | **95%** |
| **Other Factors** | | | |
| **Clearing of vegetation** | 5% | 5% | 0% |
| **Reduce fire risk, burning around settlements** | 3% | 6% | 0% |
| **Retribution for prosecution for theft** | 3% | 0% | 5% |
| **Total other factors** | **11%** | **11%** | **5%** |

Respondents were asked why they thought the communities started fires. The responses were grouped into two broad categories, showing the percentage or reasons received from respondents on why communities start fires, i.e. socio-economic and other factors (Table 4.1). Socio- economic reasons were grouped based on the need for resources as well as ignorance due to lack of education. Other factors included responses that could apply to anyone regardless of their socio-economic status. The results indicate that the respondents perceive socio-economic factors as being by far the most important reasons why communities start fires, with response frequencies of 89% for both research areas combined and 89% and 95% for the Lowveld and Escarpment FPA and Umpiluzi FPA areas, respectively. The most important of these were perceived to be burning for early spring grazing and ignorance of fire risks and fire behaviour. In South Africa there is a 40% difference between the rural poverty rate (64.5%) and urban poverty rate (25.4%) (World Bank, 2018). The higher rural poverty rate is relevant because forestry is situated in rural areas with significant socio-economic challenges that may result in more wildfires. Socio-economic factors are considered critically relevant to fire prevention in rural areas and will be discussed further in chapter 5.

### 4.3.4 The risk posed by lightning fires in forestry areas

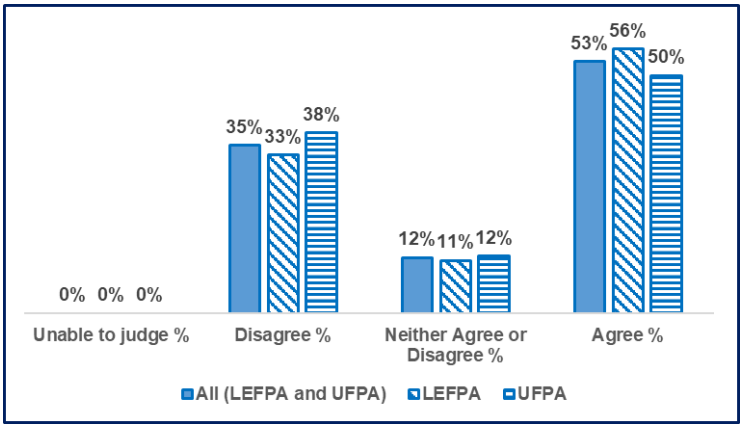


**Figure 4.9 Participant perceptions of the statement that there is a high incidence of lighting fires in their areas between October and March**

Although the 53% of respondents agreed with the statement that there is a high incidence of lightning fires during the lightning season, 35% disagreed, while another 12% neither agreed or disagreed (Figure 4.9). There is very little difference between the results from the Lowveld and Escarpment FPA and Umpiluzi FPA areas. The North Eastern parts of South Africa, which include the study areas, have the highest incidence of lightning fires in South Africa. However, in these areas lightning strikes are normally accompanied by rain, which extinguishes the resulting fires (Schulze, 2007:2). Unlike lightning fires which are left to burn naturally, lightning fires in the Lowveld and Escarpment FPA and Umpiluzi FPA forestry areas are always extinguished by firefighting teams if necessary but occasionally flare up in warmer weather after smouldering for a few days, but are easily extinguished because of green vegetation, their low intensity and moist burnable fuel during the rain reason (de Wet, 2021). All respondents supported this view and indicated that timber losses due to lightning fires are nothing to be concerned about. The intention was to exclude lightning fires as a source of concern warranting further investigation as in the Lowveld and Escarpment FPA and Umpiluzi FPA forestry areas, given the high incidence of lightning fires in the North Eastern parts of South Africa. It is clear that lightning fires do occur in the Lowveld and Escarpment FPA and Umpiluzi FPA areas but do not cause timber losses to be concerned about.

## 4.4 The role of education and fire awareness in fire prevention

### 4.4.1 The levels of fire awareness and its impact on the number of fires in forestry areas

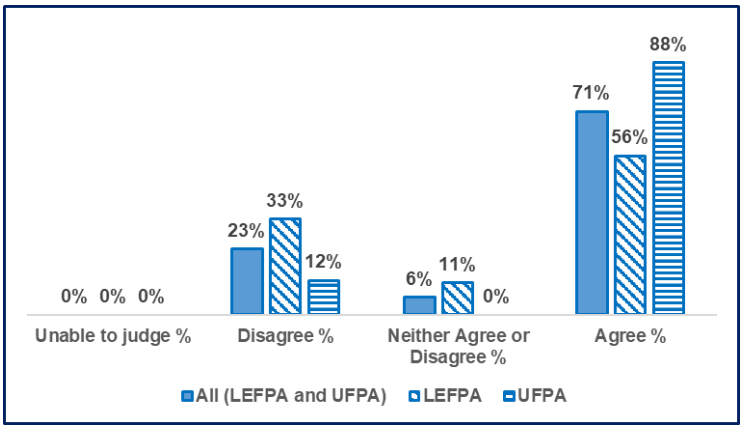


**Figure 4.10 Participant level of agreement with the statement that the levels of fire awareness campaigns amongst the public and communities ineffective in reducing the number of fires in forestry areas**

A total of 71% of all respondents were of the opinion that the level of fire awareness campaigns amongst the public and communities is not effective in reducing the number of fires. When the results from the Lowveld and Escarpment FPA and Umpiluzi FPA areas are analysed separately, it is clear that the results from the two areas differ to a large extent, with virtual full agreement with the statement in the Umpiluzi FPA area, while only 56% of respondents in the Lowveld and Escarpment FPA area supported the statement, while 33% disagreed and 11% neither agreed or disagreed (Figure 4.10). The disparity between the Lowveld and Escarpment FPA and Umpiluzi FPA results is probably due to the presence of more communities in the Umpiluzi FPA area (section 4.2.1). The perceptions of the respondents echoed the sentiments of the two FPA managers that a high number of fires persist in the Lowveld and Escarpment FPA and Umpiluzi FPA areas and that something must be done to address fire awareness effectiveness, given that most fires are caused by people (section 2.5.1).

### 4.4.2 Opportunities to improve fire awareness in forestry areas

All the respondents provided feedback on opportunities to increase fire awareness in forestry areas. The following grouped responses on opportunities to improve fire awareness were received: Firstly, more fire awareness education at schools, communities and in the media. Secondly, the development of partnerships between communities and forestry organisations so that the communities can also appreciate the impacts of fires. Finally, certain respondents feel that more financial support is required from the government for fire awareness campaigns. Based on the perceptions of the Umpiluzi FPA respondents and the high number of communities in the

Umpiluzi FPA area in particular (section 4.2.1), an opportunity to improve fire awareness amongst communities will be discussed in chapter 5.

### 4.4.3 The accuracy of the Lowveld Fire Danger Index fire danger predictions

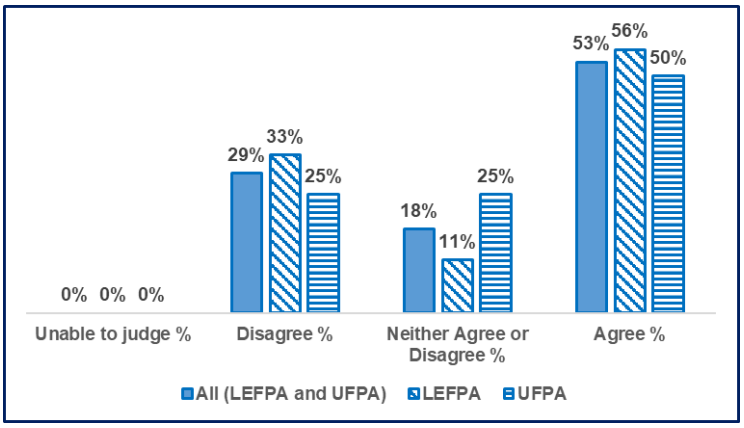


**Figure 4.11 Participant perceptions that the Lowveld Fire Danger Index (FDI) does not give accurate fire danger predictions in certain areas**

A total of 53% of all respondents agreed with the statement that the Lowveld Fire danger index (FDI) does not give accurate fire danger predictions in certain areas (Figure 4.11). The Lowveld FDI model as a simple one size fits all model, which is general accurate enough for most of the Lowveld and Escarpment FPA and Umpiluzi FPA areas, although it may be less accurate in a few cases and under high FDI ranges. The accuracy of the FDI prediction is important for effective fire prevention because firefighting teams can be placed strategically during high FDI periods to reduce the response time to fires. High risk forestry operations which can start fires, such as timber harvesting operations, can also be suspended until the FDI drops to acceptable levels.

The Lowveld FDI is a functional working system which can be improved on (section 2.5.2). There are however more important fire prevention challenges to be addressed before an upgrade of the Lowveld FDI should be considered.

## 4.5 Engineering options for fire prevention

### 4.5.1 Strategic regional fuel load reduction

#### 4.5.1.1 The effectiveness of regional strategic fuel load reduction

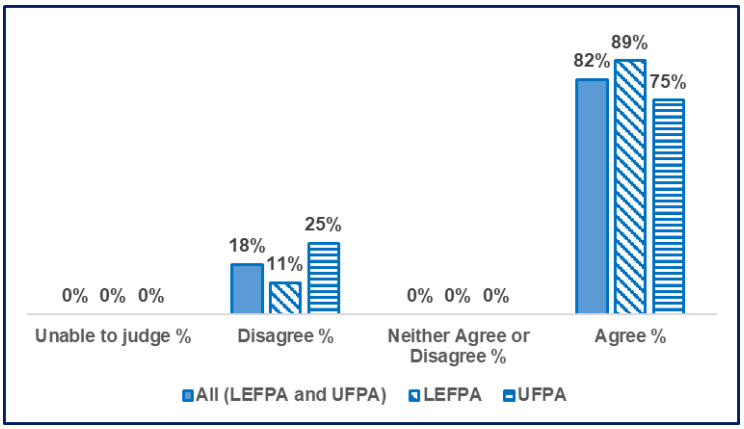


**Figure 4.12 Participant perceptions that fire risk is not sufficiently mitigated by applying regional strategic fuel load reduction between forestry organisations and surrounding landowners**

Strategic regional fuel load reduction refers specifically to co-operation between different forestry organisations as well as FPAs and other landowners who could benefit from considering fuel load reduction on a regional perspective rather than only on an individual landowner basis. A total of 82% of all respondents agreed with the statement that fire risk is not sufficiently mitigated by regional strategic fuel load reduction efforts, with slightly higher (89%) and lower (75%) levels of agreement in the Lowveld and Escarpment FPA and Umpiluzi FPA areas, respectively (Figure 4.12). This could also include mechanical fuel load management (sections 4.5.2.3 and 4.5.3.2). The high level of agreement by respondents suggests that opportunities should be considered on a broader scale than each organisations' cadastral boundaries.

#### 4.5.1.2 Opportunities for improving strategic fuel load management

When asked what opportunities there were for strategic fuel load reduction to be applied on a regional basis, nearly 40% of respondents mentioned the development and implementation of integrated fire management plans involving neighbours. According to the responses received, such interventions may involve the development and implementation of integrated fire management plans in high fire risk areas, involving collaboration between forestry organisations, land claimants and communities. It was also mentioned that most of the current interventions are implemented on an organisational level and that few organisations are willing to explore opportunities to collaborate. Strategic fuel load reduction between landowners is a

shortcoming which will be discussed further in chapter 5 as an opportunity to improve current fire prevention practice.

### 4.5.2 Fuel load management in standing timber compartments

#### 4.5.2.1 The effectiveness of fuel load reduction in standing forestry compartments

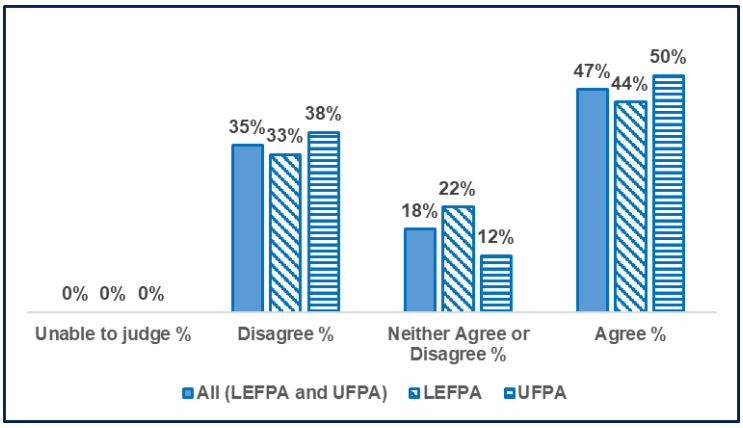


**Figure 4.13 The current level of fuel load management in standing timber compartments is ineffective in preventing and mitigating fire damage**

Compartments refer to the smallest management units of plantations, with the same tree species, age and management prescriptions, which have trees (standing timber) growing in them. Compartments can be any size but are normally smaller than 50ha in size. A total of 47% of all respondents agreed with the statement that fuel load reduction is ineffective in preventing and mitigating fire damage in standing forestry compartments which have trees growing on them. There is no major difference in the results of the Lowveld and Escarpment FPA and Umpiluzi FPA areas, with 44% and 50% agreement for the Lowveld and Escarpment FPA and Umpiluzi FPA areas respectively (Figure 4.13). To contextualise this result the extensive scale of forestry landholdings must be considered (section 4.2.1). Given the size of forestry areas under plantations it may not be possible to greatly improve fuel load reduction in standing compartments.

#### 4.5.2.2 Burning as a fuel management option in standing trees

All respondents grow exotic trees for sawtimber, pulp or “other” management objectives that may influence their use of understory burning. Low intensity understory burning can reduce fuel loads in standing trees. All the respondents working for the two organisations growing pine sawtimber for solid wood processing indicated that understory burning is standard practice. Respondents from pulp growing organisations indicated using understory burning as an exception because of carbon contamination caused by burning which renders the timber non-

utilisable in the pulping process. Respondents also indicated that understory burning is dependent on the susceptibility of certain species to cambium damage by burning.

#### 4.5.2.3 Fuel load reduction methods, apart from burning, in standing trees

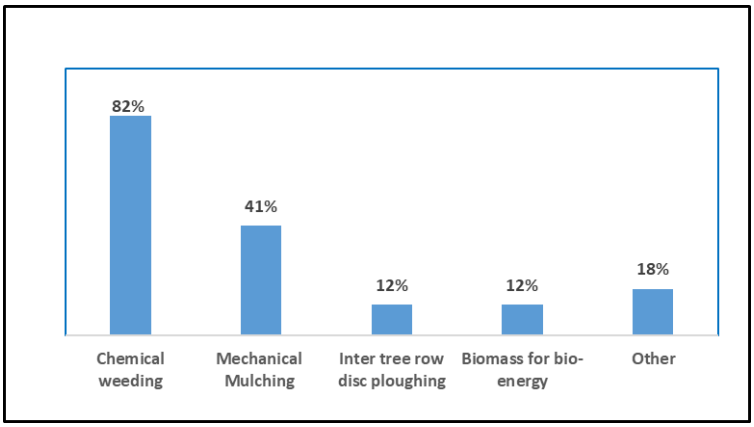


**Figure 4.14 Other methods of fuel load reduction, apart from burning, in standing commercial timber compartments in the Lowveld and Escarpment and Umpiluzi Fire Protection Association areas**

Respondents were asked what fuel load reduction methods, apart from burning, they used in standing trees from the options listed above. Chemical weeding, although an indirect long term fuel load reduction method, was included as a fuel reduction method option in the questionnaire because chemical weeding is standard practice in forestry. It is clear that not all respondents recognised chemical weeding as a fuel load reduction method because only 82% recognised it as such when it would be expected that this figure would be closer to 100%. Mechanical fuel load management involves the following methods. Mulching is the use of specialised mulching machines that chops up forest residue making it more compact and less susceptible to fires. Disc ploughs are used to mix forest residue (leaves, pine needles and branches) with soil between standing tree rows at intervals to create firebreaks in between commercial trees in a process referred to as inter tree row discing. Mechanical fuel load reduction made up 53% of the non-burning fuel load reduction methods What is of concern is the low levels of biomass (12%) used for bio-energy (Figure 4.14). The current low levels of forestry biomass utilisation as a more sustainable fuel reduction opportunity will be discussed in chapter 5. The utilisation of forestry biomass, such as pruning and thinning residue is likely to provide greater fire prevention benefits than small incremental changes in current fuel management practice.

### 4.5.3 Fuel load management of harvesting residue in clearfelled (harvested) compartments

#### 4.5.3.1 The sufficiency of fuel load reduction in clearfelled compartments

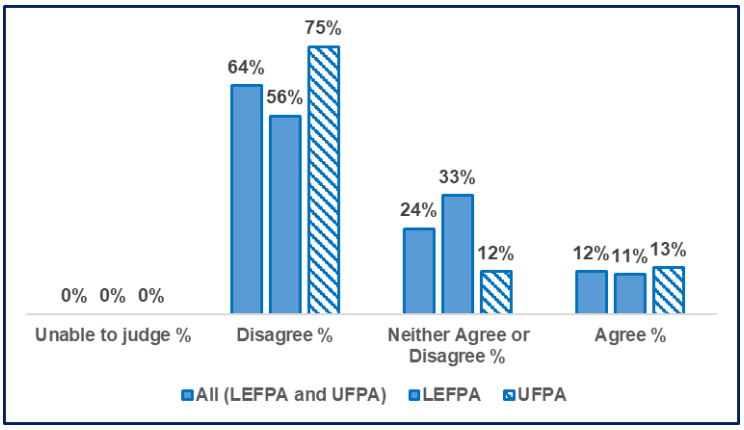


**Figure 4.15 Participant perceptions that the current level of fuel management in clearfelled compartments is ineffective in preventing and mitigating fire damage**

A compartment is clearfelled at the end of the rotation or growing cycle. There are typically large fuel loads, including branches, needles, leaves, offcuts and litter layers, which remain behind after clearfelling because not all the of the tree biomass is commercially utilisable. The results indicate that the majority of participants are of the opinion that fuel management in clearfelled compartments is effective in preventing and mitigating fire damage. This is true for the combined results (64%), as well as for the Lowveld and Escarpment FPA (56%) and Umpiluzi FPA (75%) areas separately. Only 12% of all respondents agreed with the statement that fuel load reduction in clearfelled (harvested) compartments is ineffective with 11% and 13% agreement for the Lowveld and Escarpment FPA and Umpiluzi FPA areas, respectively (Figure 4.15). Fuel load management in clearfelled compartments is therefore not perceived as a fire prevention challenge by the respondents. This result was as expected because all of the respondents indicated that they burn compartments after clearfelling.

#### 4.5.3.2 Other fuel management options used after clearfelling and their use in relation to burning

In addition to burning, the fuel load management options for clearfelled compartments included mechanical methods (mulching) and biomass removal. Apart from the fact that damage to standing trees is not applicable to fuel load management in clearfelled compartments, the advantages and disadvantages of mechanical fuel load management are essentially the same.

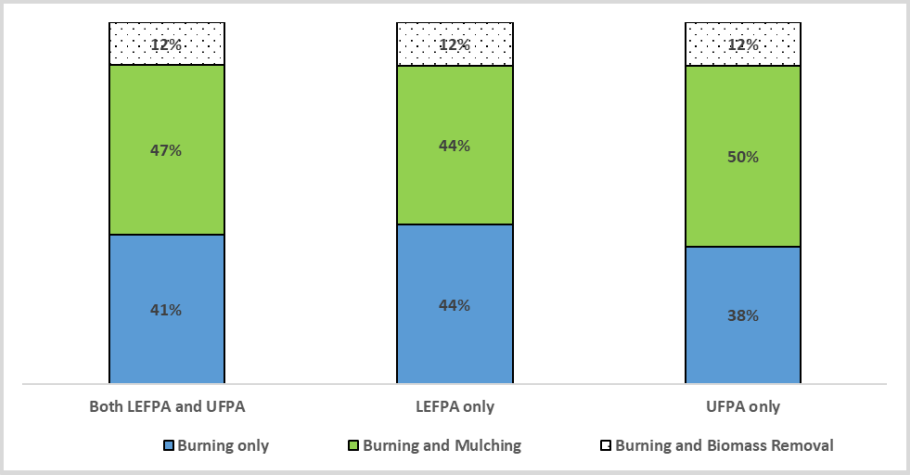


**Figure 4.16 Fuel load reduction methods used after clearfelling**

Respondents were asked what method(s) of fuel load management they used in clearfelled compartments. Burning was used by all respondents. For both the Lowveld and Escarpment FPA and Umpiluzi FPA areas combined, 41% of respondents used only burning as a fuel load reduction method, while 47% use both burning and mulching. In the Lowveld and Escarpment FPA area 44% used burning only, while 44% used a combination of burning and mulching. In The Umpiluzi FPA area 38% used burning only while 50% of respondents used a combination of burning and mulching. (Figure 4.16).

Finally, respondents were asked if any timber harvesting waste was utilised for the biomass market. Only two respondents from two organisations indicated that 10% timber waste in one case and between 2% and 4% in another is currenty being used, although this was expected to increase in future. The limited utilisation of harvesting residue and timber waste for bio-energy is an opportunity which will be discussed in chapter 5, rather than small incremental changes to existing fuel management practice.

### 4.5.4 The topographic positioning of firebreaks in the landscape

#### 4.5.4.1 The sub-optimal topographic positioning of firebreaks

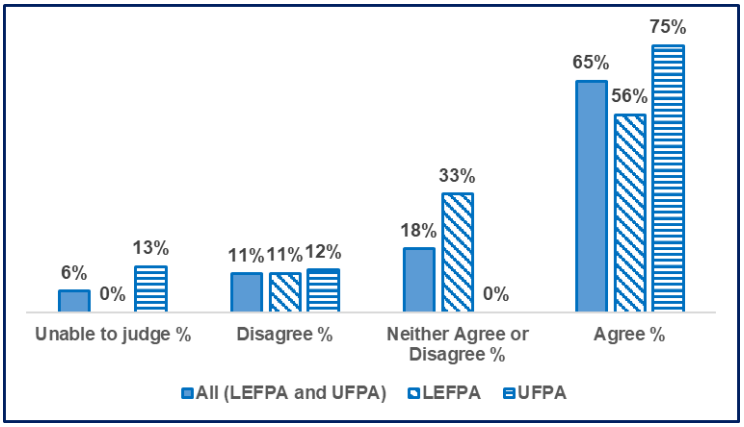


**Figure 4.17 Participant perceptions that firebreaks are not situated in optimal topographic positions in the landscape**

A total of 65% of all respondents agreed with the statement that firebreaks are not in optimal topographic positions in the landscape. When the results from the Lowveld and Escarpment FPA and Umpiluzi FPA areas were analysed separately, it is clear that the responses between the Lowveld and Escarpment FPA and Umpiluzi FPA areas differ, with a substantial proportion of respondents the Lowveld and Escarpment FPA area that neither agreed, nor disagreed (33% in the LEFPA area) or were unable to judge (13% in the Umpiluzi FPA area) (Figure 4.17).

#### 4.5.4.2 Potential challenges in moving firebreaks to more optimal positions

When respondents were asked to explain the challenges to moving firebreaks to more optimal topographic positions, the following challenges were identified: Firstly, moving firebreaks could require converting non-commercial, undisturbed areas, into firebreaks , which may trigger a listed activity, requiring an Environmental Impact Assessment (EIA) in terms of National Environmental Management Act 107 of 1998 (NEMA). Secondly, the authorities are unwilling to approve land use swops where plantations are excised from one place and moved to another in terms of the National Water Act 36 of 1998 (NWA). Section 21(d) of the NWA requires a water use license (WUL) if new plantation areas are established. Moving firebreaks would therefore result in a loss of commercial plantation area, irrespective of whether current plantation areas or non-commercial areas are used for firebreaks. Thirdly firebreaks on cadastral boundaries may be required for fire insurance. In light of the above, there do not seem to be any viable opportunities for moving existing firebreaks to improve fire prevention.

### 4.5.5 The fire prevention and social benefits of cattle grazing

#### 4.5.5.1 The demand for cattle grazing in forestry areas

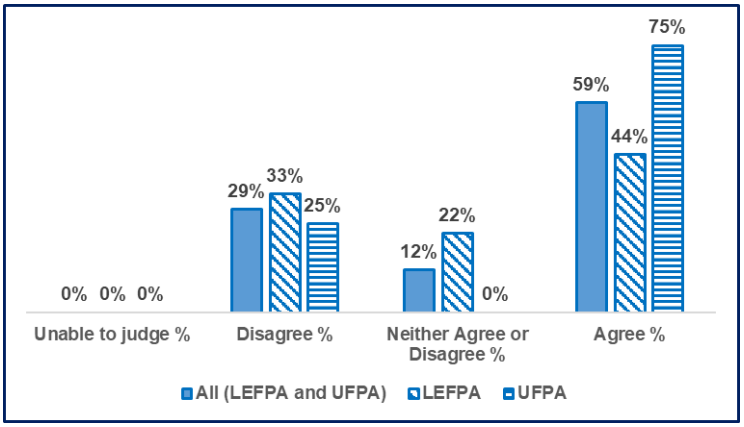


**Figure 4.18 Participant responses to the statement that there is a demand for cattle grazing in their forestry area of responsibility**

A total of 59% of all respondents agreed with the statement that there is a demand for cattle grazing in their management area. When the Lowveld and Escarpment FPA and Umpiluzi FPA areas are analysed separately, there is a clear difference between the responses of the Lowveld and Escarpment FPA and Umpiluzi FPA areas, with only 44% agreement in the Lowveld and Escarpment FPA area, Umpiluzi FPA 75%, while 33% and 22% of the respondents either disagreed or neither agreed nor disagreed (Figure 4.18).

When asked whether they allowed cattle grazing on their forestry land if there was a demand for it, 70% of respondents from the Lowveld and Escarpment FPA and Umpiluzi FPA areas indicated that they do allow cattle grazing if there is a demand. However, when the results from the two areas are analysed separately, only 56% of Lowveld and Escarpment FPA respondents confirmed that they do, compared with 87% of respondents from the Umpiluzi FPA area.

#### 4.5.5.2 Types of fire prevention challenges caused by cattle grazing in forestry areas

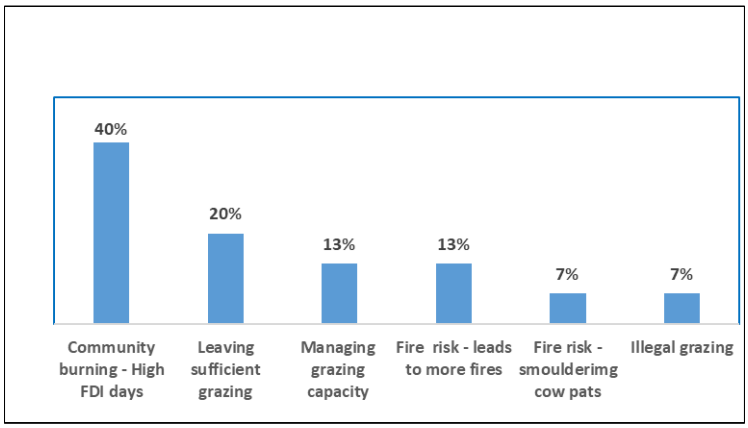


**Figure 4.19 Participant perceptions of the fire prevention challenges from allowing cattle to graze on forestry land**

When asked what fire prevention challenges they encountered from cattle grazing, the respondents identified six challenges (Figure 4.19). The most important challenges are communities burning for grazing when the fire danger index (FDI) is high (40%), leaving sufficient grazing for communities after fire prevention burning (20%), ensuring that the grazing capacity is not exceeded (13%) and more fires by allowing community access to graze their cattle (13%).

All the respondents indicated that they allowed communities to graze cattle if there is a need. Furthermore, everyone agreed that cattle grazing is a viable fuel load reduction method. Socio-economic factors are the main reason why communities start fires (section 4.3.3.2, Table 4.1). Allowing cattle grazing while maintaining good community relations and controls such as permit systems may reduce the number of fires caused by the communities, reduce the grass fuel load and the amount of areas which need to be burnt as long as the challenges of allowing cattle grazing are addressed. This opportunity will be further discussed in chapter 5.

## 4.6 Compliance and enforcement

### 4.6.1 Fire protection association membership

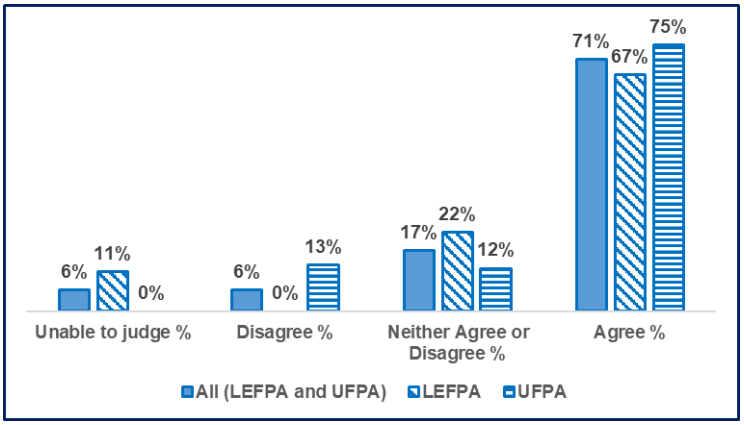


**Figure 4.20 Participant perceptions that the fire protection association membership of state owned land is low**

Fire Protection Associations (FPAs) were established to facilitate a collective approach to manage fires that cannot be provided by individual landowners (Department of Water Affairs and Forestry, 2005:11). If landowners are not members, this creates a serious fire prevention challenge because the landowners are not subject to the FPA rules and regulations relevant to local conditions. A total of 71% of all respondents agreed with the statement that the level of FPA membership of state owned land is low, with similar levels of agreement between the Lowveld and Escarpment FPA and Umpiluzi FPA areas (Figure 4.20).

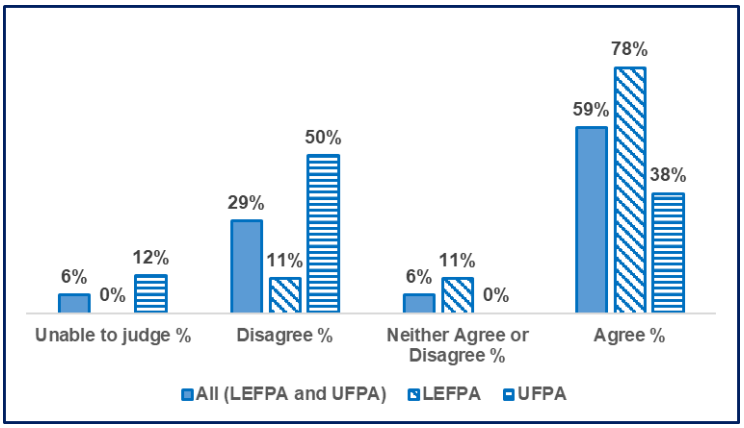


**Figure 4.21 Participant perceptions that the fire protection association membership of privately owned land is low**

A total of 59% of all respondents agreed with the statement that the level of FPA membership of privately owned land was low. An analysis of separate responses from the Lowveld and Escarpment FPA and Umpiluzi FPA areas revealed a substantial difference with 78% and 38% agreement (50% disagreement) for the Lowveld and Escarpment FPA and Umpiluzi FPA areas

respectively (Figure 4.21). The large difference in perception between Lowveld and Escarpment FPA and Umpiluzi FPA, could be explained by the large number of smaller timber growers in the Umpiluzi FPA area (section 4.2.1), who would normally become FPA members because of the high risk of fires to their plantations. When respondents from both areas were asked to explain their responses to the questions about state and private FPA membership the following considerations emerged: Firstly, it is clear that the lack of FPA membership of state owned land is a much bigger concern for forestry than private FPA membership, especially since the state is the custodian of the NVFFA. Section 4(6) of the Act states that "*all owners in an area for which a fire protection association has been registered have a right to join the fire protection association, provided they undertake to abide by its constitution and rules"*. Membership of FPAs is therefore voluntary for individual landowners (Meyer, 2015:606). Section 4(8) however states that "*The owner in respect of State land must join any fire protection association registered in the area in which the land lies;"* Secondly, the state land claim beneficiaries, smaller landowners and communities cannot afford FPA membership. When the state grants land to land claimants, state involvement ceases and the land claimants do not become FPA members. Finally, there is a lack of awareness amongst most state officials, as well as some private landowners of their legal obligations in terms of the NVFFA, as the legal consequences of not being FPA members is not evident as intended.

### 4.6.2 Compliance with the National Veld and Forest Act 101 of 1998 as determined by the rules and regulations of the Fire Protection Associations

#### 4.6.2.1 The compliance to resource, equipment and personnel requirements by state landowners

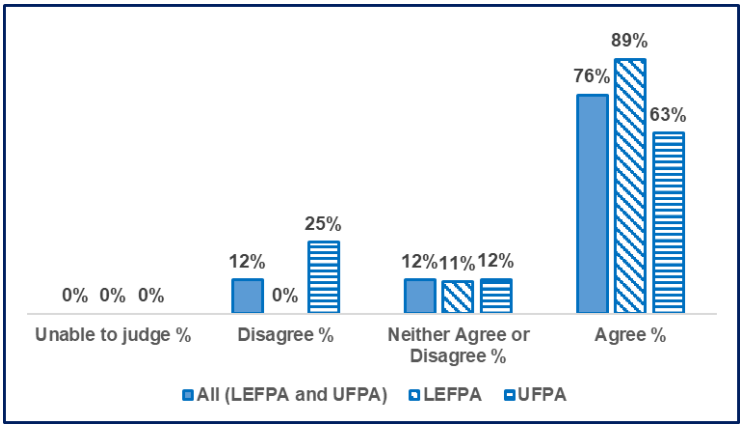


**Figure 4.22 Participant perceptions that there is a lack of compliance of fire protection association resource, equipment and personnel requirements by state landowners**

A total of 76% of all respondents agreed with the statement that there is a lack of compliance of FPA resource, equipment and personnel requirements by state landowners. When the Lowveld and Escarpment FPA and Umpiluzi FPA area respondents are analysed separately, it is clear that the responses differ substantially, with 89% and 63% agreement for the Lowveld and Escarpment FPA and Umpiluzi FPA areas, respectively. In the Umpiluzi FPA area, 25% of respondents disagreed with the statement, while another 12 % neither agreed nor disagreed (Figure 4.22). When respondents from both areas were asked what the resource and equipment challenges are for state and private landowners, they identified similar challenges for both groups: Firstly, both state landowners and private landowners lack the financial resources to acquire firefighting equipment and employ trained personnel. Secondly, both state landowners and private landowners experience a lack of skills knowledge and managerial capacity for fire prevention. Finally, there is a lack of understanding of the roles and responsibilities of state landowners and private landowners, their obligations in terms of the NVFFA, as well as the potential consequences of non-compliance.

#### 4.6.2.2 The compliance of state and private landowners to burning permit and burning prohibition requirements

FPA members are required to obtain burning permits before they commence with any burning operations to make sure that the risk of runaway fires is sufficiently low, based on an actual or forecast FDI which is 55 or below. Burning prohibitions are proclaimed annually in the Lowveld and Escarpment FPA and Umpiluzi FPA areas. No slash burning is allowed between 1 June and 31 October every year by anyone situated in these FPAs. Burning permits are required by everyone (FPA members and non-members) in Lowveld and Escarpment FPA and Umpiluzi FPA areas for all open fires between 1 July and 31 October every year (Lowveld and Escarpment Fire Protection Association, 2020b).

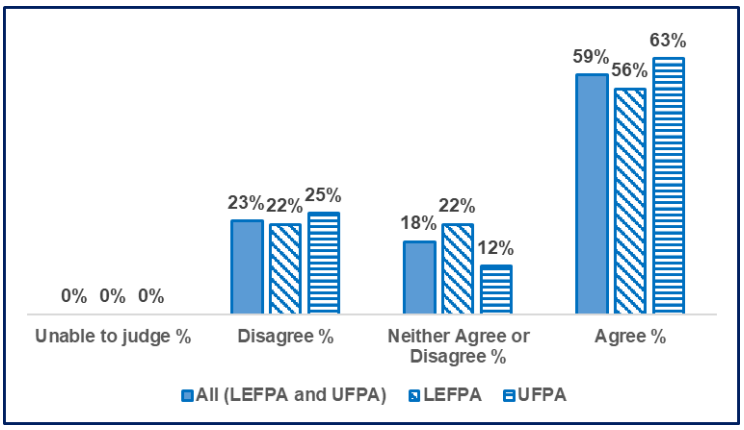


**Figure 4.23 Participant perceptions that there is a lack of compliance of state and private land owners to obtain burning permits from the fire protection associations during the burning prohibition period**

The majority of respondents were of the opinion that there is lack of compliance of state and private landowners to the FPA requirements to obtain a burning permit before commencing operations, as well as with FPA burning prohibition requirements for the combined Lowveld and Escarpment FPA and Umpiluzi FPA results (59%) (Figure 4.23). When the respondents were asked to explain their responses to the lack of lack of compliance in obtaining burning permits and abiding by burning prohibitions, they mentioned that the non-compliance is normally by non-FPA members, as FPA members generally comply, while communities, and absent landowners normally do not comply. The respondents also indicated that forestry organisations generally burn state land in forestry areas but are not compensated for it. There is an opportunity to address this through fire awareness campaigns facilitated by the FPAs together with improved enforcement of the burning prohibition period.

#### 4.6.2.3 The enforcement of the National Veld and Forest Fire Act as prescribed by the fire protection association regulations

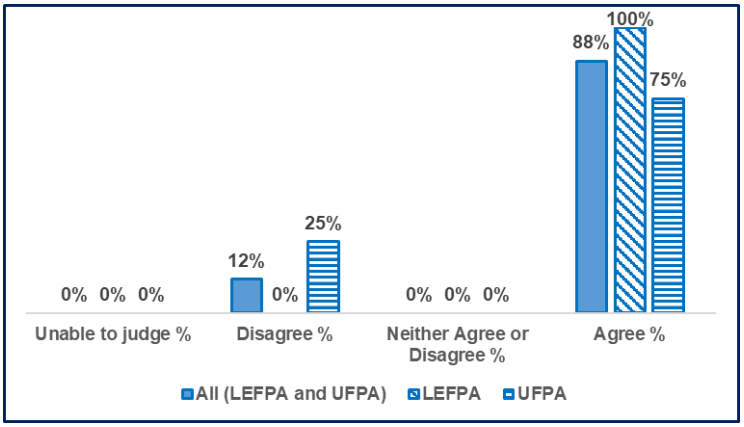


**Figure 4.24 Participant perceptions of the inadequate enforcement of the National Veld and Forest Fire Act as prescribed by the fire protection association regulations**

A total of 88% of all respondents is of the opinion that the enforcement of the NVFFA is inadequate. However, when the results from the Lowveld and Escarpment FPA and Umpiluzi FPA areas were analysed separately, it is clear that 100% of respondents in the Lowveld and Escarpment FPA area agreed, 25% of respondents in the Umpiluzi FPA area disagreed Figure 4.24). These results suggest better enforcement in the Umpiluzi FPA area. It is clear that the NVFFA is not being enforced as intended. Lack of enforcement is a a big concern and will be discussed as an opportunity in chapter 5.

#### 4.6.2.4 Penalties for non-compliance to the National Veld and Forest Fire Act as prescribed by the fire protection association regulations

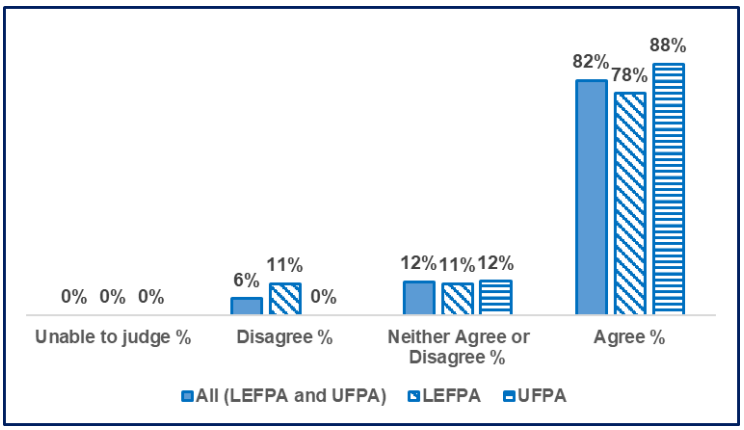


**Figure 4.25 Participant perceptions the inadequacy of penalties for non-compliance to the National Veld and Forest Fire Act as prescribed by the fire protection regulations**

A total of 82% of all respondents agreed with the statement that the penalties for non-conformance to the NVFFA are insufficient to prevent non-compliance, with similar results in both the Lowveld and Escarpment FPA and Umpiluzi FPA areas (Figure 4.25). When asked what should be done to improve the level of enforcement, respondents suggested the following: Firstly, the Fire Protection Officer (FPO) that is responsible for enforcement must fulfill this duty and not delegate authority for enforcement to the FPA manager. Secondly, the FPA boundaries must be revised to coincide with municipal boundaries, to solve the problems around the uncertaintly of legal jursidiction. Finally, better law enforcement and stricter penalties. However, no respondent offered any suggestions about how this should be applied in practice. In was noteworthy that the respondents lacked an understanding of the legal responsibility for enforcing the NVFFA and FPA regulations. Multiple respondents merely mentioned all of the government, FPO, FPA and South African police are parties that should play a greater role in enforcement. The level of enforcement of FPA (NVFFA) regulations will briefly be discussed in chapter 5.

#### 4.6.2.5 State and private landowner categories with resource and equipment challenges as prescribed by the National Veld and Forest Fire Act

In order to understand the resource and equipment challenges of state and private landowners it is important to understand the relative importance of the different categories of landowners. From a predetermined list of landowner types commonly found in forestry areas which would require resources and equipment in terms of the Act, including a category for other, all the responses were tallied and the percentage of each landowner category were determined based on the total responses received. These landowner types were then ranked based on the percentage of responses for each landowner category (Tables 4.2 and 4.3).

For state landowners municipalities (24%) ranked the highest, followed be Eskom powerlines (24%). All the listed state category areas listed below are a potential source of fires and therefore require resources and equipment (Table 4.2). Municipalities in particular, as the main custodians of the Act, will be discussed under compliance and enforcement challenges in chapter 5. Categories of private landowners with resource and equipment challenges were identified by the respondents. The results clearly indicate that land claimants, which are often communities and emerging farmers experience the biggest resource and equipment challenges, followed by small sawmills and private conservation areas (Table 4.3).

**Table 4.2 State owned landowner categories commonly found in forestry areas with resource and equipment challenges to meet the legal requirements of the National Veld and Forest Fire Act in the Lowveld and Escarpment and Umpiluzi Fire Protection Association areas**

| State landowner category | Rank LEFPA and UFPA areas | Response percentage |
|---|---|---|
| **Municipalities** | **1** | 26% |
| **Eskom powerline servitudes** | **2** | 24% |
| **Conservation** | **3** | 19% |
| **SANRAL road servitudes** | 4 | 17% |
| **Transnet railway line servitudes** | 5 | 14% |

**Table 4.3 Private landowner categories found in forestry areas with resource and equipment challenges to meet the legal requirements of the National Veld and Forest Fire Act, in the Lowveld and Escarpment FPA and Umpiluzi FPA areas**

| Private landowner category | Rank LEFPA and UFPA areas | Response percentage |
|---|---|---|
| **Land claimants and emerging farmers** | **1** | 31% |
| **Small sawmills** | **2** | 22% |
| **Private conservation areas** | **3** | 18% |
| **Agriculture** | 4 | 16% |
| **Forestry (excluding large companies)** | 5 | 12% |
| **Other (Specify)** | | 0% |

When respondents from both areas were asked what the resource and equipment challenges are for state landowners and private landowners, they identified similar challenges for both groups: Firstly, both state landowners and private landowners lack the financial resources to acquire firefighting equipment and employ trained personnel. Secondly, both state landowners and private landowners experience a lack of skills, knowledge and managerial capacity for veld and forest fire prevention. Finally, there is a lack of understanding of the roles and responsibilities of state landowners and private landowners, their obligations and the potential consequences of non-compliance with the NVFFA.

## 4.7 Ranking of the top five fire prevention challenges by the respondents

All respondents were provided with 21 potential fire prevention challenges and asked to rank their top five challenges. The weighted and unweighted rankings were calculated (Table 4.4). The

method of calculation of the weighted and unweighted response rankings were explained in chapter 3 (section 3.6.1).

**Table 4.4 Weighted and unweighted ranking of the top five fire prevention challenges for all respondents**

| Top five fire prevention challenges | Fire prevention element | Weighted rank both areas | Unweighted rank both areas |
|---|---|---|---|
| Lack of fire awareness | **Education** | **1** | **2** |
| Lack of enforcement of FPA rules and regulations and the National Veld and Forest Fire Act | **Compliance and enforcement** | **2** | **1** |
| Number of fires originating from communities, which include informal settlements | **Fire causes and locations** | **3** | **3** |
| Burning for cattle grazing by communities | **Fire causes and locations** | **4** | **4** |
| Lack of resources and equipment for privately owned land | **Compliance and enforcement** | **5** | **3** |
| Lack of regional strategic fuel load reduction | **Engineering** | | **4** |

It is interesting to note that the all the top five fire prevention challenges in the weighted rankings are also present in the unweighted top five rankings and that the rankings are similar except for rankings one and two which are reversed. Another important difference is that regional strategic fuel load reduction only appears in the unweighted rankings. An unexpected result is the that the lack of resources and equipment on privately owned land and not state owned land appears in both the weighted and unweighted top five fire prevention challenge rankings in spite of 76% of respondents agreeing that the state has resource and equipment challenges. The literature review only highlighted state landowner resource and equipment challenges. Private landowners were therefore not included in the research questionnaire. A reason for this may be that land claimants and emerging farmers, included under privately owned land, possibly should have been included under state owned land because the state, as land custodians, would be expected to facilitate support.

## 4.8 Conclusion

In chapter 4 the fire prevention challenges were discussed under the main elements, viz., identification of fire causes and their sources of ignition, education, engineering and compliance and enforcement. There is however currently a lack of knowledge of fire causes and locations in Mpumalanga which is the first aspect which would need to be addressed to develop the fire

prevention strategy. The anthropogenic nature of fires, the high number of fires originating in communities and socio-economic challenges in these communities are among the main root causes of fires evident in the research results  Addressing the needs of the communities, combined with increased fire awareness will be discussed in chapter 5.

Fuel management is fundamental to any fire prevention strategy and is normally the very first issue in fire prevention which is addressed. Apart from strategic regional inter organisation fuel reduction plans, there is probably not a great deal that can be done to improve fuel load management practice as currently applied. A big opportunity exists however for using forest biomass for bio energy and electricity generation as an alternative to burning or mechanical fuel load management.

Under the compliance and enforcement the issues regarding low FPA membership, lack compliance of municipalities and SOE's to the NVFFA as prescribed by local FPA rules and regulations. Compliance, enforcement and FPA Membership will be discussed following the recent *National Veld and Forest Fire Act amendment Bill of 2021* which addresses some of the compliance and enforcement challenges raised in the dissertation.

# CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

The aim of this study was to identify and evaluate fire prevention challenges and opportunities based on the perceptions of commercial forestry managers in rural Mpumalanga, South Africa. Understanding forestry managers' perceptions of fire prevention challenges and opportunities could assist in determining whether their perceptions are driving current fire prevention practice and assist in identifying opportunities to improve current fire prevention practice. The most important results are discussed under the main fire prevention headings of fire causes and their locations, education and awareness, engineering options for fire prevention and compliance and enforcement. The respondents' ranking of the 21 identified fire prevention challenges are also discussed in relation to the evaluated results. Lastly, recommendations for further research, based on the research results are highlighted.

## 5.2 Fire causes and locations

### 5.2.1 Analysis of fire causes and their locations

The majority of respondents agreed that there is a lack of knowledge of fire causes and their locations. This evaluation is corroborated by 2017 DAFF data that the percentage of fires with unknown causes are 97% and 25% for the Lowveld and Escarpment FPA and Umpiluzi FPA areas respectively (Department of Agriculture Forestry and Fisheries, 2018). There was a high level of disagreement by respondents on whether fire causes and locations should be reported and analysed at plantation level, organisational level, FPA level or National level or a combination of the reporting levels (section 4.3.1). Both FPA managers were of the opinion that not all fires are reported to the FPAs by their members (Ludick, 2020f; Scheepers, 2020d). The fact that non FPA members would not report their fires to the FPAs should also be considered. To resolve these challenges a number of opportunities and recommendations were identified.

It is impossible to develop an effective fire prevention risk management strategy if the majority of the fire causes and their locations are not known. A comprehensive analysis of fire causes and their locations presents a huge opportunity to improve current fire prevention practice. The collation of data and analysis should be driven at FPA level, by larger forestry organisation members in particular, but reporting is important at all levels because all the forestry role players from plantation to National level have a different role to play in developing a fire prevention strategy. It is further recommended that the FPAs should use and analyse the fire alarm spatial data generated by the EVS and Firehawk camera fire detection centres, covering most of the Lowveld and Escarpment FPA and Umpiluzi FPA study areas (section 2.4). This will at least

ensure that the exact locations of most fire ignition points in forestry areas are included in the analysis. Suspected fire causes can then be added by members or inferred based in their locations.

### 5.2.2 The levels and reporting accuracy of arson as a cause of fires in forestry areas

In both FPA areas, almost all respondents, agreed that arson fires are a serious fire prevention challenge in forestry (section 4.3.2.1). Respondents from both areas agreed that arson fires were not correctly reported as arson fires while fewer Umpiluzi FPA respondents believed that arson fires are correctly reported (section 4.3.2.2). This evaluation is corroborated by DAFF data where, in Lowveld and Escarpment FPA , only 1% of fires were reported as arson, combined with the high number of fires with unknown causes (Department of Agriculture Forestry and Fisheries, 2018). A lack of police action and difficulty in proving arson are the most important reasons for not reporting arson fires to the police in both areas (section 4.3.2.3). None of the respondents were aware of any successful convictions for arson fires throughout their careers. Recent proposed amendments to the NVFFA could decrease the number of arson fires by improving compliance and enforcement. This will be discussed further (section 5.5.4). The presence of communities may contribute greatly to arson fire numbers (section 4.3.2.1). Recommendations and opportunities to reduce the numbers of arson fires will be discussed in the following section.

### 5.2.3 The presence of communities as a fire source

Almost all respondents felt that fires originated from communities and informal settlements (section 4.3.3.2), while respondents were almost unanimous in that they have communities within or bordering on their landholdings (section 4.3.3.1). Socio-economic factors were identified as the main reason why communities start fires. The challenges of arson fires in communities, their socio-economic challenges and resource needs and the fact that there have been no successful convictions for arson fires that any respondents can recall provides a cue for what the opportunities and recommendations to reduce arson fires should be.

Engaging communities, understanding their needs, assisting where possible and maintaining sound community relations are some of the biggest opportunities to reduce fires in forestry areas. The most obvious examples would be the provision of water, sourcing of employees from local communities when required and allowing community cattle grazing on forestry land subject to certain conditions. Controlled community grazing could reduce grass fuel loads and indirectly reduce the number of arson fires by providing a sustainable income.

## 5.3 Education and the role of fire awareness

### 5.3.1 The effectiveness of fire awareness campaigns

Most respondents agreed that the current levels of fire awareness campaigns are ineffective in reducing the number of fires. Notably, based on the Umpiluzi FPA response levels, fire awareness seems to be more of a challenge in the Umpiluzi FPA than the Lowveld and Escarpment FPA area. This disparity is largely because all the Umpiluzi FPA respondents indicated that they have communities living in and around their landholdings. This result was corroborated by van Heerden (2021) who stated that there are more communities living within or around forestry areas in the Umpiluzi FPA area than in Lowveld and Escarpment FPA . It is therefore clear that communities are a major source of fires in forestry areas. There is therefore an opportunity to focus fire awareness campaigns by FPAs on communities. This focus can be narrowed further by concentrating on high fire risk areas as indicated by fire location data identified by the camera fire detection centres (section 5.2.1).

## 5.4 Engineering options for fire prevention

### 5.4.1 Regional strategic fuel load reduction

The majority of respondents felt that fire risk is not mitigated by managing fuel loads on a strategic regional basis (section 4.5.1.1). It is recommended that a regional fuel load reduction initiative is driven by the large forestry organisations at FPA level, involving the co-operation between forestry landowners on a regional landscape basis rather than focusing only on fuel management by individual organisations. Regional fuel load management is a big opportunity relative to trying to increase the levels of fuel load management in standing and clearfelled compartments, with potential greater benefits than improving individual fuel management programmes.

### 5.4.2 The opportunity to remove forestry residue biomass as a raw material for bio-energy generation to reduce fuel loads in forestry

All respondents from both areas indicated that they burn harvesting residue after clearfelling. Only two respondents from different organisations indicated that between less than 10% of timber residue in their organisations is used as biomass for the bio-energy market.

Lundqvist (2020:41) found that only 8% of South Africa's energy is produced from bio-energy sources mostly for heating and cooking purposes, while South Africa's available biomass could replace 15% of the energy produced by coal. Furthermore, most of these sources are located in the north eastern parts of South Africa, which includes the study area. A study by Ross (2004:80) found that mean residual fuel loads after clearfelling in Mpumalanga *Pinus patula* compartments,

including the plantation litter layer and the harvesting residue for sawtimber and pulpwood plantations, were 62.2 t $ha^{-1}$ and 61.2 t $ha^{-1}$ respectively.

The controlled use of harvesting residue for biomass as an alternative to burning could therefore reduce fire fuel loads and improve soil nutrient retention. Such use could also reduce carbon emissions, which has an economic value, and provide an opportunity to offset the costs of fuel management in plantations, if the financial returns are sufficient. Savings in electricity costs and electricity availability could also make this option more viable. Given the large volumes of available biomass, it would be interesting to investigate why the current utilisation of forestry biomass for energy generation is so low. The main reasons for the low use of forest biomass for the production of bio-energy is so low is due to the delay in the awarding of bids to allow for the selling of surplus electricity into the bid, as well as the high start up costs (Pretorius, 2022). This is however beyond the scope of this dissertation and would require further research.

## 5.5 Compliance and enforcement

### 5.5.1 Low levels of fire protection association membership

If landowners are not FPA members, they are not subject to the local FPA rules and regulations. The perception that FPA membership is low for state and privately owned land was supported by the majority of all respondents. Furthermore, FPA reports from both FPAs indicated that there is poor participation and support from government (municipalities) and SOE's at FPA level (Lowveld and Escarpment Fire Protection Association, 2020c; Ludick, 2020c).

The government has recently partially addressed this challenge in Clause 3 of the *National Veld and Forest Fire Amendment Bill of 2021* (the Amendment Bill) which compels municipalities, SOE's and other state landowners to become FPA members (Department of Forestry Fisheries and Environment, 2021). Whether the Amendment Bill is successful or not will however depend on whether municipalities as the custodians of the NVFFA and SOE's actively participate in FPA activities.

### 5.5.2 Compliance with the National Veld and Forest Fire Act 101 of 1998 as determined by the fire prevention associations rules and regulations

Firstly, most of Lowveld and Escarpment FPA and Umpiluzi FPA respondents felt that state landowners do not comply with FPA resource, equipment and personnel requirements. Secondly, the majority of respondents agreed that state and private landowners are non-compliant to burning prohibition requirements (sections 4.6.2.1 and 4.6.2.2). The respondents felt that non-compliance is mostly by non-FPA members, which includes state landowners, communities, land claimants and absent landowners. Respondents felt there was a lack of understanding by these

landowners about their responsibilities and the consequences of non-compliance with the NVFFA. These challenges should be resolved though enforcement of FPA rules and regulations and the successful implementation of the NVFFA Amendment Bill.

### 5.5.3 Lack of enforcement and low penalties for non-compliance to the National Veld and Forest Fire Act as prescribed by the local FPA rules and regulations

Almost all respondents agreed that the enforcement of the NVFFA is insufficient and that the maximum penalties of R5 000 are too low to act as an effective non-compliance deterrent (sections 4.6.2.3 and 4.6.2.4). According to the two FPA managers, only two municipalities out of fifteen have had FPA regulations promulgated in their municipal by-laws and therefore FPA regulations cannot be enforced by the FPAs on non-FPA members (Ludick, 2020b; Scheepers, 2020c). *The NVFFA Amendment Bill* aims to address this by encouraging local government to put municipal by-laws in place to ensure that all landowners comply with the provisions of the NVFFA (Department of Forestry, Fisheries and Environment, 2021). There are currently insufficient trained law enforcement officers in the two FPAs to enforce FPA regulations (Ludick, 2020b; Scheepers, 2020c). Clause 6 of the Amendment Bill has added peace officers and traditional leaders, in addition to forest officers and police officers, to enforce the NVFFA on condition that they are trained.

### 5.5.4 Concluding remarks on compliance and enforcement

The *NVFFA Amendment Bill*, which was published after this research was concluded, confirms that government is aware of the compliance and enforcement challenges identified in the research. The resolution of these challenges will be successful if the Bill is enacted by parliament and its requirements successfully implemented at local government level, with meaningful enforcement by the proposed law enforcement officers and courts.

## 5.6 The top fire prevention challenges identified by respondents

Four of the top five weighted and unweighted fire prevention rankings (section 4.7) listed by the respondents were also confirmed responses by respondents, apart from the unexpected exception of resource and equipment challenges by private landowners which were not included in the discussion on fire prevention challenges and opportunities. A notable omission, identified in the research results as an important challenge, is the lack of analysis of fire causes and their locations, which should be the first step to develop an effective fire prevention strategy. This aspect of fire prevention was not ranked in the top five fire prevention challenges by the respondents.

## 5.7 Conclusion

The top five weighted fire prevention challenges identified by respondents were lack of fire awareness, lack of enforcement of FPA rules and regulations (NVFFA), the number of fires originating from communities, burning for cattle grazing by communities and a lack of resource and equipment available to private landowners, particularly land claimants, emerging farmers and small sawmills. The unweighted response options were similar to these, but included regional strategic fuel load reduction.

The following opportunities were identified to improve fire prevention:

- The analysis of fire causes and locations at Fire Protection Association level to develop an effective fire prevention strategy;
- Support of high fire risk communities, who pose a fire risk to commercial forestry, through Corporate Social Investment (CSI) projects, by understanding and meeting the resource needs of such communities, where possible;
- Fire awareness campaigns focussing on high fire risk communities;
- The expansion of current fire fuel load management to a regional (landscape) level;
- Increased utilisation of forest residue for bio-energy to reduce fire fuel loads; and
- The successful implementation of the proposed *National Veld and Forest Fire Amendment Bill of 2021* by local government, compelling state landowners to become Fire Protection Association members, incorporating FPA regulations into municipal bylaws and training of municipal law enforcement officers in the Fire Protection Associations to improve the compliance and enforcement of the FPA regulations.

This study assumed that the commercial forestry managers' perceptions of fire prevention challenges drive current fire prevention practice in commercial forestry. The research results indicate that commercial forestry managers largely agree with the fire prevention challenges identified in the literature review. This result suggests that current fire prevention practice is not driven by a lack of knowledge about what the main fire prevention challenges are. The key to improving fire prevention practice is therefore to prioritise fire prevention, starting with the identification of fire causes and locations. This should be followed by addressing the key fire prevention challenges and implementing the recommendations included in this study. It should however be noted that a study, in savanna areas of South Africa found that the number and intensity of fires was driven by rainfall rather than fire management polices (van Wilgen *et al*., 2004:1533). It is acknowledged that although the focus should be on fire prevention in areas where anthropogenic fires are predominant, other factors also play a role in the number and intensity of fires.

## 5.8 Opportunities for future research

The commercial forestry managers, with a high level of forestry experience, perceived 89% community fires to be caused by socio-economic factors. It would, however, be useful to do a detailed socio-economic study of high fire risk communities, who pose a high fire risk to commercial forestry, to determine what could be done by forestry organisations to alleviate socio-economic challenges in order to reduce forest fires originating from such communities.

The high levels of available forest residue biomass and its low utilisation as a bio-energy source was identified in the research as a potential fuel reduction opportunity. There is a need to investigate the impediments and provide recommendations to facilitate greater use of this wasted resource to improve fire prevention, as well as environmental sustainability.

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# ANNEXURE A

## Annexure A

## Questionnaire to understand the perceptions of managers directly involved with fire management on fire management challenges, focussing specifically on fire prevention in commercial forestry in rural Mpumalanga.

### Introduction

I am busy with my Masters degree in Environmental Management at North West University. The focus of my research is on the perception of fire management challenges, specifically related to fire prevention, in commercial forestry in rural Mpumalanga.

The forestry industry in Mpumalanga is of economic and social importance. The plantations in Mpumalanga are situated in high rainfall regions, which are also high fire risk areas. The high fire risk in Mpumalanga due to the fact that grassland is the predominant vegetation type in between afforested areas, emphasises the importance of effective fire management practices in these forestry areas. A high frequency and severity of fires can have a negative impact on the long term sustainability of the industry.

Larger forestry organisations are all well equipped with fire suppression resources and trained personnel to control and extinguish forest fires quickly and effectively. The larger forestry areas in Mpumalanga also have well organised FPA's with aerial fire suppression resources, incident command centres and camera fire detection centres. Despite the intense focus on fire management, the number of uncontrolled fires that cause harm and losses is still unacceptably high. It would appear that despite all the resources at the disposal of forestry organisations, the fire prevention element of fire management is being neglected. Due to climate change, fires are expected to increase in most regions of the world in future, also in rural Mpumalanga.

From the above, it is clear that commercial forestry in Mpumalanga faces serious challenges in preventing or at least reducing the number of fires. This needs to be investigated, because the current fire management measures do not appear to be effective. The perceptions of forestry managers of fire prevention challenges and opportunities could assist in reducing the devastating impact of fires and improve current fire management practice in the study area.

This research project aims to answer the following research question: What is the perception of forestry managers of the fire management challenges and opportunities to improve fire management practices in rural Mpumalanga, South Africa?

The study will establish the views of forestry managers of fire prevention challenges, specific to their area of responsibility and location. Understanding the forestry managers' perception of fire management challenges and identifying opportunities may assist in changing current fire management practices to reduce the devastating impact of fires on forestry.

# Annexure A

## Instructions

1. This questionnaire has been sent to the following categories of respondents of large forestry organisations, who are directly involved with fire management within their organisations: Fire Protection Association office bearers (company representatives), Fire Managers of commercial forestry organisations, as well as Area, District or Plantation Managers.
2. The study area is the Lowveld and Escarpment Fire Protection Association and the Umpuluzi Fire Protection Association.
3. Some of the questions are just general questions about your own opinion or experience on subject matters, while others relate to the fire management practices in your organisation.
4. Possible challenges for fire prevention incorporated in the questionnaire were identified in a literature review, as well as from local data. Some of these challenges may not influence or be applicable to your situation, because they are context and location specific.
5. Please reflect on each question from your own perspective. Determine whether it is relevant to your scope of work and in the specific geographic area for which you are responsible. Consider your own organisation, your neighbours and the FPA, whose level of fire management could have a positive or negative impact with regard to fire management in your organisation.
6. Please answer or give your view on all the statements and associated questions. There are no right or wrong answers.
7. Mark your selection(s) with an **X**.
8. If any statement falls outside the scope of your responsibility or you do not have the required information, please select the "Unable to judge" option. If you select "Unable to judge", please move on to the next question.
9. Some statements also have open ended questions, where you will be asked to clarify or motivate your answers.
10. Please also complete the biographical information, which will be used to contextualise, understand and analyse your responses.
11. Please note that once you have submitted the completed questionnaire, you may be contacted for an online interview to clarify some of your responses.
12. Your answers are confidential and any personal information you provide will be kept secure so that it is only available to the researcher. Contact details are only for record-keeping and follow-up purposes, if required.
13. Your participation in this research is completely voluntary and you may stop at any time.

# Annexure A

***Definitions and terminology***

- ***State land*** *refers to municipalities, State Owned Enterprises, Mpumalanga Tourism and Parks Agency, and any other land of which the state is custodians (e.g. land claims)*
- **State Owned Enterprises** (SOE's) refer to ESKOM, TRANSNET, and SANRAL.

***Anonymity and confidentiality:***

**Please note:**

- ***Individual responses will be kept anonymous and will not be linked to participants or the organisation that they represent.***
- ***All electronic data will be converted to an anonymised or pseudo-anonymised form, with only the researcher having ongoing access to the data that is not anonymised. This means that your name, contact details, and the details of the organisation you work for will be kept anonymous in the research.***
- ***Data will be aggregated and analysed collectively for both FPA's combined and/or per FPA.***
- ***Where there are notable differences between the two FPA's, these differences will be analysed separately.***

**By completing this questionnaire, you agree that:**

- **you have read the information above and understand it;**
- **you voluntarily agree to participate in the research;**
- **you understand that your data cannot be withdrawn once submitted.**

# Annexure A

## Biographical Information.

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|---|---|---|---|---|---|---|---|---|---|---|
| Name of Organisation: | | | | | | | | | | |
| Management Unit Name | | | | | | | | | | |
| Management Unit Type | Region | | Area/District | | Plantation | | Other | | | |
| | Other: Specify: | | | | | | | | | |
| Extent of operations: | | Ha | commercial area (plantation area) | | | | | | | |
| | | Ha | non-commercial area (open area) | | | | | | | |
| Do you need to take extra fire prevention and protection measures due to your neighbours failing to take adequate measures? | Yes | No | Description: | | | | | | | |
| FPA membership: | Yes | No | LEFPA | | UFPA | | | | | |
| FPA category | Forestry | | Agriculture | | Conservation | | Other | | | |
| Name of respondent: | | | | | | | | | | |
| Job category: | Fire manager (Functional position within the organisation) | | | | FPA Office Bearer (only organisation representatives) | | | | | |
| | Area/district /plantation manager | | | | Other (Specify)- | | | | | |
| Years of experience in position: | 0-3 years | | 3-6 years | | 6+ years | | | | | |
| Years of experience in organisation: | 0-5 years | | 5-10 years | | 10+ years | | | | | |
| Years of experience in industry: | 0-10 years | | 10-20 years | | 20+ years | | | | | |

Briefly list your responsibilities with regard to fire management.

_____

_____

_____

_____

_____

Date: _____

# Annexure A

## 1. Analysis of fire causes

1.1 The lack of knowledge of fire causes linked to their location is a cause for concern. (Not knowing the fire locations and their causes hampers effective fire prevention.)

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
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1.2 Please explain and motivate your answer?

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1.3 At what level(s) do you think should fire causes and locations be analysed? (You can choose **more than one option**)

| Plantation level | | Company level | | FPA level | | National level | |
|---|---|---|---|---|---|---|---|

1.4 Please explain and motivate your answer?

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1.5 Do you or your organisation report fires to the FPA?

| **YES** | | **NO** | |
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1.6 If you answered "No", why not?

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## Annexure A

1.7 From your personal experience, the current levels of arson fires are a serious fire prevention challenge in commercial forestry areas.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

1.8 Do you think that arson fires are correctly reported as arson fires?

| YES | | NO | |
|---|---|---|---|

1.9 Please explain and motivate your answer **if you answered "NO"?** (**N/A if you answered "YES" - proceed to 1.10)**

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1.10 Do you report arson fires to the police?

| YES | | NO | |
|---|---|---|---|

1.11 Please explain and motivate your answer?

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1.12 Are you aware of any successful convictions for arson fires ?

| YES | | NO | |
|---|---|---|---|

1.13 Do you have any communities or informal settlements living on or adjacent to your land holdings?

| YES | | NO | |
|---|---|---|---|

## Annexure A

1.14 **If you answered "YES" in 1.13**, do you experience that a large number of fires in your area originate from communities or informal settlements? **(If you answered "NO" please answer N/A)**

| | | | | | |
|---|---|---|---|---|---|
| **YES** | | **NO** | | **N/A** | |

1.15 **If applicable (you have a problem with community fires)**, why do you think do the communities and informal settlements start fires?

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1.16 Which of the following reasons for the high levels of fires with unknown causes **reported by the Department of Environment Forestry and Fisheries** are important/legitimate in your opinion? Please rank your choices with 1 being the most important, 2 the second most important and so forth. You do not need to rank those reasons which you feel are not applicable **(Leave them blank if you are not sure or do not know)**

| **Options** | **Reasons.** | |
|---|---|---|
| 1 | The fire causes are not reported to the FPA | |
| 2 | Fires are not reported to the FPA | |
| 3 | The fire causes are reported to the FPA but not analysed or used | |
| 4 | Many fire causes are reported to the FPA as "unknown" | |
| 5 | Other – Please specify below of applicable | |

1.17 Are you aware of any other reasons for the high levels of fires with unknown causes?

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## Annexure A

1.18 There is a high incidence of lightning fires during the summer rainfall season (October to March) in your geographic area of responsibility.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

1.19 Does your organisation experience significant **plantation area losses** due to lightning fires?

| YES | | NO | |
|---|---|---|---|

# 2. Fire Risk

2.1 Fire risk is not mitigated by applying strategic fuel load reduction on a regional basis (in larger areas incorporating different landowners) in high risk areas.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
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| | | | | |

2.2 Are there any other opportunities for applying strategic fuel load reduction on a regional basis in addition to fuel load reduction within the landholdings of your organisation? Please motivate your answer?

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# Annexure A
# 3. Fuel Management

### 3.1 Standing commercial compartments

*The accumulation of fuels in commercial compartments can be managed in five ways.*

*1. Understory burning – depending on species / management objective (e.g. sawtimber, pulp)*

*2. Mechanical means (mulching, disking and chopper rolling)*

*3. Silviculture (weeding)*

*4. Removal (Biomass)*

*5. Other means*

3.1.1 The current levels of fuel management in commercial compartments is ineffective in preventing and mitigating fire damage and should be improved to increase fire prevention effectiveness.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

3.1.2 Do your organisation make use of understory burning in standing commercial compartments? (Mark with an X)

| YES | | NO | |
|---|---|---|---|

3.1.3 If you answered "**NO**", what are the reasons for not using understory burning for fuel management in standing commercial compartments?

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3.1.4 What method(s) does your organisation use to manage fuel loads in **standing** commercial **compartments?**

| Burning | | Mulching | | Disking | | Chopper rolling | | Chemical weeding | | Biomass removal | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Other | | Specify other- | | | | | | | | | |

## Annexure A

3.1.5 Why does your organisation use your chosen method or combination of methods?

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3.1.6 What are the disadvantages of your chosen method(s)?

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3.1.7 What opportunities are there to improve fuel load management in standing commercial compartments?

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**3.2 Fuel management after clearfelling**

*Fuel management after harvesting falls broadly into 4 categories:*

*1. Burning*

*2. Mechanical (mulching, disking and chopper rolling*

*3. Removal. (biomass).*

*4. Other?*

## Annexure A

3.2.1 The current level of fuel management in clearfelled compartments is ineffective in preventing and mitigating fire damage and should be increased.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

3.2.2 Does your organisation burn harvesting residue in compartments after clearfelling?

| YES | | NO | |
|---|---|---|---|

3.2.3 **If you answered "NO"**, what are the reasons for not burning harvesting residue after clearfelling? (**If you answered "YES", mark as N/A and move to question 3.2.4)**

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3.2.4 Loss of long term site productivity should receive more attention than is currently the case when deciding whether to burn harvesting residue in a compartment after clear-felling.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

3.2.5 Please explain or motivate your answer?

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3.2.6 What methods do you use to manage fuel loads in clearfelled compartments?

| Burning | | Mulching | | Disking | | Chopper Rolling | | Biomass removal | |
|---|---|---|---|---|---|---|---|---|---|
| Other | | Specify other- | | | | | | | |

# Annexure A

3.2.7 Why do you use your chosen method or combination of methods?

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3.2.8 What are the disadvantages of your chosen method(s)?

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3.2.9 Is any of your harvesting residue used for the biomass market?

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| **YES** | | **NO** | |

3.2.10 If you answered **"YES"**, approximately what percentage of the harvesting residue is used for the biomass market?

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3.2.11 What opportunities are there to improve fuel load management in clearfelled compartments?

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### 3.3 Burning of open (non-plantation) areas

3.3.1 There are challenges to burning enough open areas in and around forestry landholdings to provide for adequate fire prevention to the plantations.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
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## Annexure A

3.3.2 If you agree with the above statement, please elaborate on or explain the challenges in burning enough open areas for effective fire prevention?

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3.3.3 Firebreaks are not on optimal topographical positions on the landscape to prevent fires spreading.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
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3.3.4 If applicable, what are the main challenges in moving firebreaks to more optimal positions?

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3.3.5 Are there any other opportunities to improve fuel management in open areas?

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## Annexure A

# 4. Cattle Grazing

4.1 A demand for cattle grazing presents a challenge for fire prevention in the geographic area that you are responsible for.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

4.2 Do you allow community cattle grazing if there is a need? **(YES, NO or N/A)**

| YES | | NO | | NA | |
|---|---|---|---|---|---|

4.3 Please clarify what fire prevention challenges relating to cattle grazing on areas under your control does your organisation experience, if applicable?

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4.4 **If applicable**, how do you address these challenges?

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4.5 Do you think that cattle grazing is a viable fuel load reduction method in grasslands?

| YES | | NO | |
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4.6 Please explain or motivate your answer?

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## Annexure A
# 5. Fire Awareness

*Fire awareness activities, to create awareness of the dangers of fires as well as periods of high fire danger, can be conducted on radio stations, in newspapers, websites, signs, communities and schools. Fire awareness is normally conducted by the FPA's.*

5.1 The level of fire awareness by the public and communities in forestry areas is currently **not effective** to prevent and reduce the number high fire frequencies occurring during the fire season.

| Unable to Judge | | Disagree | Neither agree or disagree | | Agree |
|---|---|---|---|---|---|
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5.2. If applicable, why do you think this is the case?

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5.3 What suggestions do you have to improve the level of fire awareness by the public and in the local communities in particular?

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## Annexure A

# 6. Fire Danger Index (FDI)

*The Lowveld Fire Danger Index is used over the whole of South Africa and may not give accurate fire danger predictions in all areas*

6.1 My experience is that the Lowveld FDI does not give an accurate prediction of fire danger for effective fire prevention in certain areas

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
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6.2 If Applicable, are the challenges linked to the Fire Danger Index forecast, the size (resolution) of the forecast area or the accuracy of the Fire Danger Index model itself? Please explain?

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# 7. Fire Protection Association (FPA) Membership

***Note:*** *Different FPA's have different membership categories, which can roughly be divided into*

*1. Forestry*

*2. Agriculture (including mixed forestry and agriculture)*

*3. Conservation*

*4. Other*

7.1 The low level of Fire Protection Association membership of **state** land impacts the effectiveness of fire prevention **in my area of responsibility**.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
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## Annexure A

7.2 Please explain or motivate your answer?

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7.3 The level of membership of the Fire Protection Associations of **private** landowners affects the effectiveness of fire prevention **in my area of responsibility**.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

7.4 Please explain or motivate your answer?

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# 8. Support from municipalities and State owned enterprises (SOE's) in fire prevention activities

8.1 Do you have municipal areas bordering on your plantations? **(If you answered "NO", please skip questions 8.2 and 8.3 and proceed to question 8.4)**

| YES | | NO | |
|---|---|---|---|

8.2 The lack of support from local municipalities is a serious challenge to the effectiveness of your fire prevention activities.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
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## Annexure A

8.3 Please explain or motivate your view? State what support you receive (financial, resources or other) from municipalities? Also, state what support you expect to receive (financial, resources or other) from municipalities?

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8.4 Is there any SOE non-forestry land (Transnet railway lines, Eskom powerlines, SANRAL roads) within or bordering on plantations within your area of responsibility?

| | | | |
|---|---|---|---|
| **YES** | | **NO** | |

8.5 The lack of support from State Owned Enterprises is a serious challenge to the effectiveness of your fire prevention activities. .

| **Unable to Judge** | **Disagree** | **Neither agree or disagree** | **Agree** |
|---|---|---|---|
| | | | |

8.6 Do you claim any burning or firebreak preparation costs from SOE's (e.g. powerlines, railways, roads etc.)? .

| | | | |
|---|---|---|---|
| **YES** | | **NO** | |

8.7 Please explain or motivate your view and what support you receive (financial, resources or other) for fire prevention from State Owned Enterprises? Also, state what support you expect to receive (financial, resources or other) from State Owned Enterprises?

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## Annexure A

# 9. Compliance with the National Veld and Forest Fire Act (No. 101 of 1998) as determined by the rules and requirements of the Fire Protection Association (FPA)

9.1 There is a lack of compliance with the resource and equipment requirements as determined by the rules and equipment requirements (including firefighting equipment, PPE, training and trained personnel available within 30 minutes during the fire season) of the FPA for state owned land.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

9.2 Which categories of State landowners experience resource and equipment challenges that affect your fire prevention activities?

| Municipalities | Eskom | Transnet | SANRAL | Conservation | Other (Specify)- |
|---|---|---|---|---|---|
| | | | | | |

9.3 Please explain what you think the resource and equipment challenges of these entities are?

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9.4 Which categories of private landowners experience resource and equipment challenges?

| | | | | | |
|---|---|---|---|---|---|
| Forestry (excluding large companies) | | Agriculture | | Sawmills | |
| Land claimants and emerging farmers | | Conservation | | | |
| Other (Specify) | | | | | |

## Annexure A

9.5 Please explain what you think the resource and equipment challenges of these landowners are?

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9.6 The compliance of landowners to burning permit and burning prohibition requirements presents a challenge for fire prevention.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

9.7 Please explain or motivate your answer?

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9.8 Your organisation experience a challenge with landowners not preparing firebreaks as required by law

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

## Annexure A

9.9 If you agree, which categories of landowners do not comply with firebreak preparation requirements?

| State owned land | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Municipalities** | | **Eskom** | | **SANRAL** | | **Transnet** | | **Conservation** | |
| **Other (Specify)-** | | | | | | | | | |
| **Private land** | | | | | | | | | |
| **Agriculture** | | **Conservation** | | **Land claimants and emerging farmers** | | | | | |
| **Forestry (Excluding large organisations)** | | | | **Sawmills (Excluding large organisations)** | | | | | |
| **Other (Specify)** | | | | | | | | | |

9.10 The enforcement of compliance to the requirements of the National Veld and Forest Fire Act (including FPA rules and requirements) is inadequate for effective fire prevention.

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

9.11 If you are of the opinion that compliance enforcement is a problem, please explain what you think should be done to improve enforcement?

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9.12 The penalties provided for in the National Veld and Forest Fire Act are an insufficient deterrent to prevent non-compliance with the legal requirements to prevent veld and forest fires. (The current maximum penalty is R5000)

| Unable to Judge | | Disagree | Neither agree or disagree | Agree |
|---|---|---|---|---|
| | | | | |

9.13 Are you aware of any fines that have been issued to parties who have transgressed the legal requirements in the 2020 fire season?

| YES | | NO | |
|---|---|---|---|

## Annexure A

9.14 How many fines are you aware of that were issued during the 2020 fire season? ☐

## Annexure A

# 10. Top five Fire Prevention Challenges

Please rank the 5 fire prevention challenges which you feel are the most important from 1 to 5 in order of importance, where 1 is the most important and 5 least important. **(Only select 5)**

| **Rank the Top 5 fire prevention challenges** | **Rank** |
|---|---|
| Reporting of fire causes and locations | |
| Analysis of fire causes and locations | |
| Number of Arson fires | |
| Number of fires originating from communities and informal settlements | |
| Number of fires with unknown causes | |
| Regional strategic fuel load reduction | |
| Fuel management on plantation and management unit level | |
| Firebreaks not in optimal topographical positions in the landscape | |
| Burning for grazing by communities | |
| Lack of fire awareness | |
| Fire danger index model accuracy | |
| Fire danger index forecast accuracy | |
| Low FPA Membership | |
| Lack of support from municipalities | |
| Lack of support from state owned enterprises | |
| Lack of resources and equipment state owned land | |
| Lack of resources and equipment privately owned land | |
| Non-Compliance with burning prohibition periods and burning permit requirements | |
| Non-compliance with firebreak preparation | |
| Lack of enforcement of FPA rules and regulations and the National Veld and Forest Fire Act | |
| Other (Specify) | |