The Knysna Fires of 2017: Learning from this disaster

A collaborative research report between Santam, the University of Stellenbosch and CSIR

Supported by the Western Cape Disaster Management Centre

Santam

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Research Alliance for Disaster and Risk Reduction

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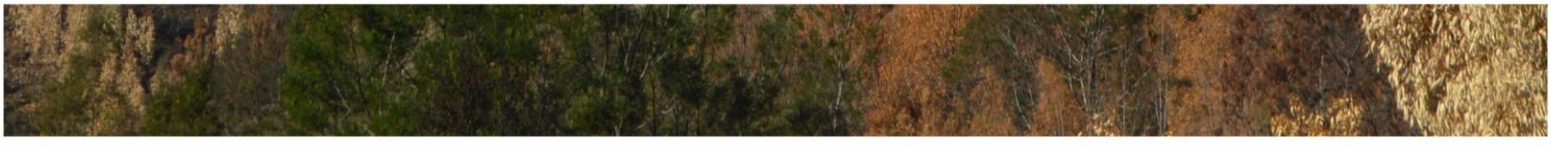
DISASTER MANAGEMENT



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FOREWORD FROM SANTAM

Disaster risk, natural and man-made, is something that is part and parcel of the world we live in. In our times we are also increasingly experiencing the impacts of climate change, with scientists predicting that it will result in the increase of extreme weather events, which will intensify the impact of disaster events, if we are unable to decarbonise our economies over the 2030 pathway as envisaged by the global Paris Agreement.

From a South African perspective, we cannot speak of disaster risk and not mention the Southern Cape (Knysna) fires of 2017, with their R2 billion cost to the South African insurance industry. This is but one disaster in South Africa, alongside the protracted drought in many parts of the country, which has caused much damage and suffering.

These disasters present a major threat to the lives and livelihood of citizens as well as to the sustainability of businesses and specifically, the insurance industry. Understanding the risks posed by volatile climate conditions and mitigating these risks effectively is therefore crucial for the insurance industry and all spheres of government.

It is in this context that the findings and recommendations of the Southern Cape Fires Research are published. We are appreciative of the collaboration between the CSIR, Stellenbosch University, the Disaster Resilience Forum and Santam to produce this research. It will go a long way in providing a better understanding of the conditions that prevailed prior to and during the Southern Cape fires. More importantly, it also provides recommendations on how we can all use the lessons from this tragedy to mitigate against future fire risks. It is Santam's belief that this report will also act as a guide to the insurance industry on how we can provide proactive support to mitigation actions for municipalities and other spheres of government.

As a leading short-term insurance provider, Santam plays a leading role through investing in risk resilience research. This is aligned with one of Santam's four Sustainability Focus Areas: Resilience through Shared Value Partnerships. One way Santam contributes to risk resilience is through our Partnership for Risk and Resilience (P4RR) Initiative, which equips some of the country's most vulnerable communities through disaster management training and resources. We have also released our Climate Change Position statement, which highlights our commitment to understand and manage climate-related risks.

This research challenges different stakeholders to play different roles in contributing towards mitigation measures. This will serve the United Nations Sustainable Development Goal 17, which seeks to strengthen partnerships to support and achieve the targets of the 2030 Agenda and solve these shared risks for a more resilient future. The ability to deal with the uncertainty of disasters is everybody's business. To this end, we need to pool our resources, energy and expertise across sectors in pursuit of a safer, more resilient society. Santam commits itself to be a 'Good and Proper' catalyst toward enabling this.

Lizé Lambrechts

April, 2019

FOREWORD

NATIONAL DISASTER MANAGEMENT CENTRE, DEPARTMENT OF COOPERATIVE GOVERNANCE

The reality of increasing numbers of occurrences, the magnitude and severity of various hazards incidents has become a common feature of the global and the South African landscape with resultant development setbacks. These incidents are predominately weather related with their impacts mainly dependant on levels of vulnerability in terms of social, economic, environmental and institutional perspectives. The key incidents range from veldfires, thunderstorms, drought, heatwaves, pests and diseases, to mention a few.

The 2017 Knysna veldfire disaster has demonstrated our country's vulnerability to fires associated with periods of drought, heatwaves, low atmospheric humidity and strong winds, which are often difficult to control. While these fires have resulted in massive losses of both private and public assets, they also taught us important lessons on the need to mobilise available resources from both public and private sectors for a common course: Integrated Veldfire Management. Accordingly, it has revealed the urgent need to improve the country's multi-sectoral and multi-disciplinary capability to manage disastrous fires. Going forward, this veldfire has truly challenged us to relook into our fire risk management approaches, particularly in the Wildland-Urban Interface, which requires specific and tailor-made measures to fire-proof vulnerable structures, reduce fuel load and establish robust and viable systems to manage emergency evacuation in times of fire occurrences.

As reflected upon in the report, there is empirical evidence that global warming has extended the fire season and increased the number of high and extreme fire danger days. This increased veldfire risk is compounded by increasing exposure of people to veldfires as uncontrolled and unwise urban development extends into fuel load ridden natural vegetation. This is compounded by the increasing rates on alien invasive species, which have become characteristic of our natural environments.

Against this background, I wish to commend Santam for funding the preparation of this cutting-edge report. While I am mindful that the primary focus of this report was on Knysna, I hope that the findings and lessons from this study will be applicable and beneficial to many places that experience veldfires in their natural vegetation across South Africa. Furthermore, I am confident that these findings will (a) assist authorities and communities to improve their veldfire risk reduction and preparedness measures so as to reduce impacts in future fires (veld and structural fires); (b) highlight possible opportunities for the insurance industry to support fire risk reduction initiatives; and (c) through the understanding gained, heighten our implementation of integrated veld and structural fire management measures.

Evidently, this report has also reaffirmed the importance of harmonising legal and institutional mandates in order to ensure clarification of roles and responsibilities of all relevant role-players involved in integrated veldfire management. It is also evident from this report that there is a need to improve joint planning and coordination in order to minimise duplication and fragmentation in the implementation of integrated veldfire management in our country. Undoubtedly, this requires heightened partnerships between government and other social partners, including insurance companies, to build the requisite capabilities to effectively manage veldfires and other risks.

I wish to encourage all readers to harvest maximum wisdom herein and wish all and sundry the best of luck as you give effect to the recommendations of the report.

Dr Mmaphaka Tau
Deputy Director-General (Head): National Disaster Management Centre

LIST OF ACRONYMS

ACSA	Airports Company of South Africa
AFIS	Advanced Fire Information System
CFFDRS	Canadian Forest Fire Danger Rating System
CSIR	Council for Scientific and Industrial Research
DF	Drought Factor
DSR	Daily Severity Rating
DEADP	Department of Environmental Affairs and Development Planning
FBSA	Fire Brigade Services Act
FireSUN	Stellenbosch University's Fire Engineering Research Unit
FMU	Fire Management Unit
FPA	Fire Protection Association
FWI	Fire Weather Index
GEF	Global Environmental Facility
GIS	Geographic Information System
GPS	Global Positioning System
GRDM	Garden Route District Municipality
GRRI	Garden Route Rebuild Initiative
HIZ	Home Ignition Zone
IAP	Invasive alien plant
ICS	Integrated command system
ICT	Information and communication technology
ICTIF	International Centre of Fire Statistics
IFM	Integrated fire management
LFDI	Lowveld Fire Danger Index
NDMC	National Disaster Management Centre
NFDRS	National Fire Danger Rating System
NGO	Non-governmental organisation
NRE	CSIR's Natural Resources and the Environment Operating Unit
NSRI	National Sea Rescue Institute
NVFFA	National Veld and Forest Fire Act
P4RR	Partnership for Risk and Resilience
RADAR	Research Alliance for Disaster and Risk Reduction
SANDF	South African National Defence Force
SANParks	South African National Parks
SAPS	South African Police Service
SARCS	South African Red Cross Society
SCFPA	Southern Cape Fire Protection Association
SDF	Spatial Development Framework
SMS	Short Message Service
VWM	Vulcan Wildfire Management
WCDMC	Western Cape Disaster Management Centre
WCDoA	Western Cape Department of Agriculture
WCDSD	Western Cape Department of Social Development
WoF	Working on Fire
WUI	Wildland-Urban Interface and / or Intermix

ACKNOWLEDGEMENTS

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In addition, we would like to thank the various organisations that have funded and supported the research that underpins this report. This includes the Global Environmental Facility (GEF)-funded FynbosFire project, the Department of Agriculture, Fisheries and Forestry which funded the first in-depth fire risk assessment for the country in 2010, the Natural Resource Management programmes of the Department of Environmental Affairs who have supported the development of the Advanced Fire Information System (AFIS), the CSIR for funding much of the research done by the Meraka Institute, and the South African Forestry Research Institute for supporting research on fynbos fire ecology. Greg Forsyth and David Le Maitre would like to acknowledge the role played by the late Dr Fred Kruger in guiding and mentoring them in much of this research.

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1. INTRODUCTION

The Knysna fires were arguably the worst wildfire disaster in South Africa's history. The social and economic impacts will be felt by Knysna and its inhabitants for years to come. It is critical that those responsible for fire management in rural and urban environments, as well as citizens, learn from this experience and become far better prepared to deal with wildfires in the future. Wildfires will continue to occur but there is a lot that can and must be done to avoid further disasters of this magnitude.

The Knysna fires were a perfect storm. A range of meteorological, bio-physical and institutional factors came together to create the disaster. But the underlying risk drivers are replicated throughout the Western Cape, and in other provinces, creating the potential for similar wildfires elsewhere - as evidenced by extensive wildfires in Hessequa, Mossel Bay, George and Knysna Municipalities in November 2018 and the Overberg in January 2019. The purpose of this report is to identify the lessons and how they can be applied to reduce risk and strengthen preparedness for future fires when they occur. The focus is on the Knysna Fires, but the findings are applicable to the Southern Cape and to many other places in South Africa that experience wildfires in their natural vegetation (CSIR 2019).

These lessons need to be shared with key decision-makers and stakeholder groups so that they can address the factors that have led to the current situation. The Knysna Fires Learning Forum, convened by Santam, is one way of facilitating information-sharing, fruitful discussions and plans and actions aimed at translating the lessons learnt through these fires into more effective management of fire risk. Hopefully this study will give birth to more fire learning forums.

2. THE RESEARCH

As a first step in identifying lessons and enhancing learning, Santam commissioned three linked research projects aimed at improving the understanding of the pre-fire situation, the fire incident itself and the post-fire recovery efforts. The goal of this was to:

1. Assist authorities and communities to be better prepared for future wildfires to reduce impacts;
2. Identify how the insurance industry can support fire reduction initiatives at an appropriate level;
3. Through the understanding gained, prevent the harmful consequences of wildfires through improved implementation of integrated fire management, including mitigation interventions and supportive institutional arrangements.

This research was conducted by the Council for Scientific and Industrial Research's (CSIR's) Natural Resources and the Environment Operating Unit (NRE) and Meraka Institute, the Research Alliance for Disaster and Risk Reduction (RADAR) at Stellenbosch University, and Stellenbosch University's Fire Engineering Research Unit (FireSUN).

The three research projects were designed to document and develop an understanding of:

- The fire behaviour and its causes or drivers (CSIR);
- The human and institutional risk drivers that increased the impact of the fires (SU/CSIR);
- The unfolding incident, including the timeline of the incident and the actions taken by institutional role-players and members of the public (CSIR/SU);
- The impacts of the event, including social impacts and financial costs due to infrastructural damage and property losses (SU/CSIR);
- Post-fire recovery measures (SU/CSIR); and
- The potential for similarly damaging wildfires to occur elsewhere in South Africa (CSIR).

This report synthesises the core findings of three technical reports on the various aspects of the fires. It examines:

- fire in South Africa;
- the emergence of mega-fires and whether they are increasing;
- the processes driving fire-risk in the area, including the issue of prescribed burning;
- the progress of the fires;
- the performance of the fire danger reporting system;
- the official and public response and humanitarian efforts;
- post-fire rehabilitation and recovery efforts; and
- the costs associated with the event and the impacts on affected communities.

This report draws together the lessons learned and makes recommendations on how the authorities and members of the public can reduce the risk of severe wildfires. It also identifies ways that the insurance industry specifically can support both risk reduction and those affected by wildfires (and other disasters).

The material in this document is drawn from the research contained in three technical reports each covering different aspects of the June 2017 Knysna fires:

Forsyth, G.G., Le Maitre, D.C. and R. van den Dool 2019. The Knysna Fires of 2017: Placing the fires in context, fire risk in the wildland urban intermix, the progression of the fires and post-fire environmental measures. CSIR Report: CSIR/NRE/ECOS/ER/2019/0013/A.

Pharoah, R., Fortune, G, Lendrum, D., Schoonwinkel, P. and Cornellisen, L. 2019. Feeling the Heat: Post-event review of the June 2017 Knysna Fires. Research Alliance for Disaster and Risk Reduction (RADAR), Stellenbosch University.

Walls, R.S., Moran, A., van Straten, A. and Sander, Z. 2019. The Knysna Fires of 2017: Learning from this disaster – Technical Report: Analysis and lessons learnt from the homes and structures which were damaged or destroyed in the incident. Fire Engineering Research Unit (FireSUN), Stellenbosch University.

Electronic copies of these reports can be obtained from the CSIR, RADAR and FireSUN.

3. FIRE IN NATURAL VEGETATION IN SOUTH AFRICA - VELDFIRES

Most of the natural vegetation types of South Africa evolved with fire, burn regularly and require fires to keep them vigorous and healthy. Fire-adapted vegetation ranges from the Highveld grassland to the coastal grasslands in Zululand, from the savannas of the Lowveld to the Kalahari, and the grassy Nama Karoo to the Fynbos. Fires in many South African vegetation types are therefore both necessary and inevitable. The question is "**When**?" not "**If**?" there will be fires. This means that fire management practices must seek to reconcile the ecological requirement for fire with the protection of human lives – a delicate balance that is at the heart of veld-fire policy and legislation.

The Knysna area is situated in the Fynbos, a flammable vegetation type which forms a mosaic with dune thicket (which can also burn) and the indigenous forest (which rarely burns except under extreme fire conditions). People have transformed the Knysna landscapes, establishing settlements and infrastructure that have encroached into this flammable landscape with little consideration of wildfire and the risks it brings. Some changes have increased the quantity of fuels for those fires by converting extensive areas to tree plantations, allowing invading alien tree species to spread largely unchecked, and by excluding and suppressing fires. This situation of increased fire risk around human settlements is not unique to the Knysna area; it is found throughout the wetter parts of South Africa.

Key point:

Fires in many South African vegetation types, including fynbos, are both necessary and expected.

4. MEGA-FIRES

The occurrence of large wildfires led fire scientists and managers to create the term "mega-fires" in the early 2000s. Originally, it was used for fires, or combinations of fires, that burnt more than a million acres, but the term has become more widely used to refer to large fires, as well as to damaging fires even though they may be relatively small. Mega-fires are frequently associated with periods of drought, heatwaves, low atmospheric humidity and strong winds, which create conditions that make fires difficult to control. In many cases, these fires are associated with high fuel loads, often due to decades of fire suppression (e.g. western North America), extensive plantations of flammable species (e.g. Portugal), or vegetation that requires fires and naturally has long intervals between fires in which to accumulate fuels (e.g. eucalypt forests in Victoria, Australia, and Fynbos). Mega-fires also frequently begin as multiple fires, often due to multiple lightning strikes or ignitions, and then coalesce. Human actions and activities have also caused many of these fires, whether accidentally or deliberately.

The Knysna and the George-Karatara fires exhibit all the characteristics of mega-fires. Mega-fires, particularly those with severe impacts, have gained a lot of attention from managers, policy-makers and scientists who are trying to better understand the causes and identify effective solutions. Among those is a key characteristic of fynbos - it can burn at a younger age than is ecologically desirable, so that a key motivation for prescribing burning, namely that a landscape-level mosaic of patches of

different ages with an average age close to the ecological optimum, is often not achievable in practice. This does not mean that prescribed burning should be stopped, or that prescribed fires should be as frequent as possible, because both of those options will have undesirable consequences for vegetation and fire management. Experience has also shown that neither of them will always be effective in stopping wildfires. Experience elsewhere in the world shows that the most effective way to use prescribed burning is to combine it with intensive fuel reduction in the Wildland-Urban Interface or Intermix[1] (WUI), fire-proofing vulnerable infrastructure, and well-planned emergency measures such as evacuation. The lack of systematic fuel reduction measures in the WUI over many years is the direct or indirect cause of the loss of many of the structures in the Knysna fires.

Many countries are experiencing damaging wildfires, in some cases setting new records for the associated economic losses and often with a high loss of human lives. However, there is no evidence yet that there is a worldwide upwards trend in the area burnt or in the impacts of the fires, except in the northern parts of the globe. There is good evidence though that fire behaviour is changing – fires are becoming more difficult or impossible to control.

Key point:

The risk of fires and 'mega-fires' is increasing. Climate change is extending the fire season in Southern Africa, and owing to rising temperatures and the increasing number of high and extreme fire-danger days. Although there is not yet a clear upward trend in fire frequencies locally or globally, there is evidence that fires are becoming more difficult or impossible to control.

5. ARE FIRES INCREASING IN SOUTH AFRICA?

An assessment of the burnt areas since 2001, and of other fire records in South Africa, shows no evidence of a trend over time. In the grass-fuelled fire-ecotypes of South Africa there is marked fluctuation between years, which appears to be coupled to rainfall variations (Figure 1).

There is also no evidence of a trend in the areas burnt in the fynbos, either from satellite data or from fire records (Figure 2). A very large area of the fynbos biome was burnt in 2017: total burnt area was 558 000 ha, about twice the mean from 2001-2018; CapeNature recorded 229 000 ha, also about twice the mean for the same period. However, reliable CapeNature records go back to the 1980s and show that a similar area burnt in 1999 and again in 2000, so 2017 is not necessarily exceptional.

However, research has shown that the number of high and extreme fire danger days and length of the fire season is increasing. The primary driver for this is global warming. Rainfall is also becoming more variable between seasons and years. Wet years increase plant growth which then becomes fuel and increases the fire hazard during dry years, which often have long periods of high and extreme fire danger. Air temperatures are rising steadily and relatively rapidly in southern Africa compared with the rest of the world. This results in longer periods of low fuel moisture and increased fire hazard.

[1] Wildland-Urban Interface or Intermix. The interface focuses on a boundary between developed and natural veld (wildland) whereas the Intermix recognises that this is often not a hard boundary but a mixture of homes or other structures and wildland fuels.

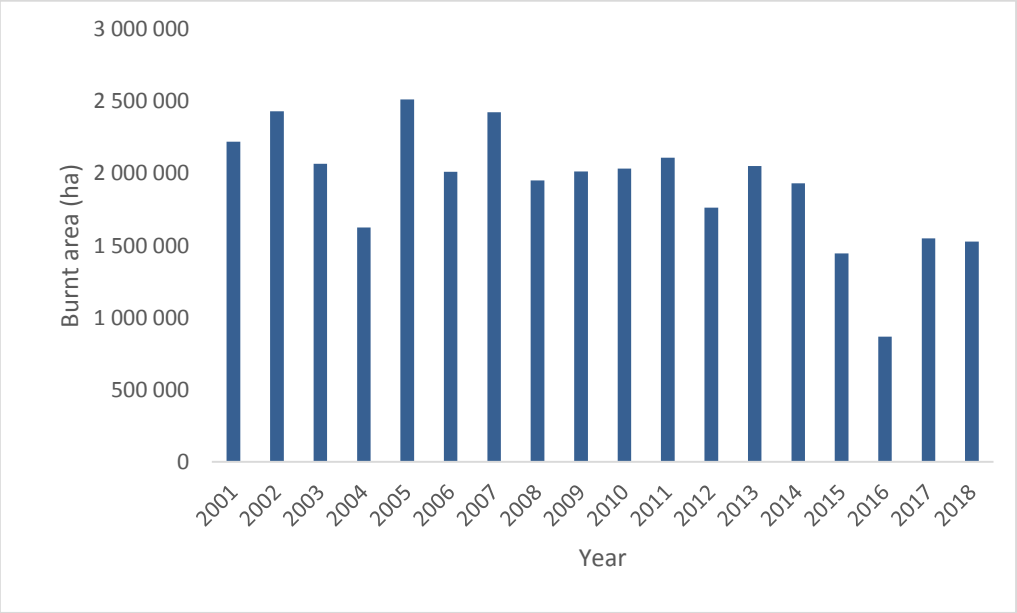

Figure 1: Satellite data on the area burnt each year in the high rainfall grasslands of South Africa from the Advanced Fire Information System (AFIS) database maintained by the Meraka Institute, CSIR.

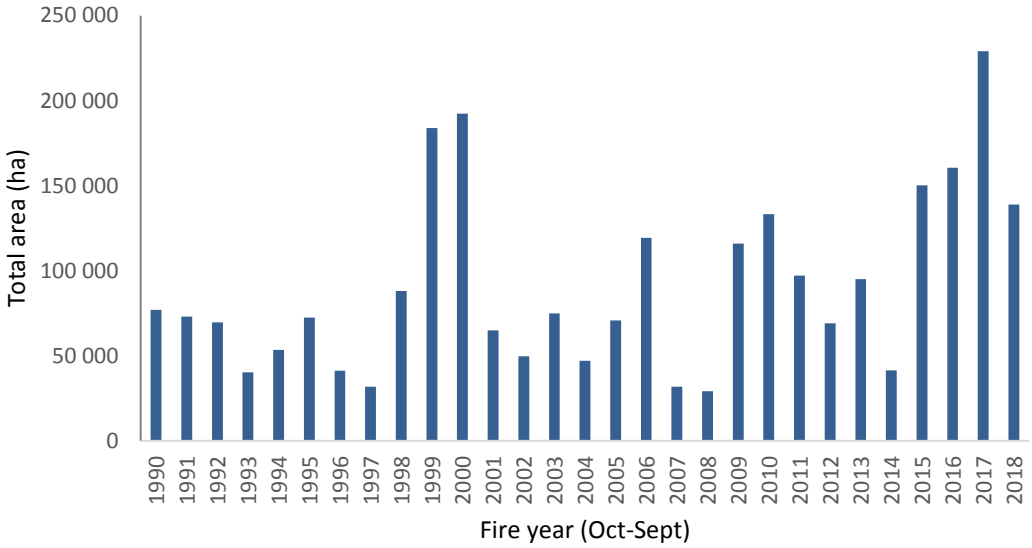

Figure 2: CapeNature records of the area burnt each year in the fynbos, mainly in their nature reserves. Data downloaded from the Biodiversity GIS website maintained by the South African National Biodiversity Institute.

This is creating more frequent and longer periods of hot, dry conditions which lead to high and extreme fire danger and greater fire risk. This increased fire risk is coupled with: (a) increasing exposure of people to wildfires as uncontrolled and unwise urban development extends into flammable natural vegetation; and (b) the growing population increases the likelihood of human activities starting fires. In short, fire risks are increasing and unless we do something to address this, we will continue to experience damaging wildfires.

Key point:

A growing population and expansion of the urban footprint into flammable natural vegetation is increasing both the likelihood of fires and the number of people in harm's way.

Lessons: Increased risk of wildfires in the future

Without change, we are likely to see more 'mega-fires' in the Western Cape and elsewhere in South Africa, and associated deaths and destruction. While the changes associated with climate change are unavoidable, we can and should take steps to reduce the frequency and magnitude of damaging wildfires. This will require balancing the ecological need for fire with the protection of human lives. It will also require that the authorities, exposed communities and landowners take steps to reduce the severity of fires and their impact.

6. THE KNYSNA FIRES – A PERFECT STORM

The Knysna fires occurred at the intersection of an array of hydro-meteorological, bio-physical, institutional and developmental factors, which are in turn linked to ecological, legislative and institutional dynamics. This research also highlighted critical capacity constraints affecting both fire-risk reduction and fire-response operations. Although this combination of factors came together to drive a fire of rare severity and magnitude, a similar combination of factors could occur anywhere within the Garden Route or elsewhere in South Africa. Therefore, identifying, understanding, and addressing these factors is critical to reducing the risk of such fires in the future.

6.1 Hydro-meteorological conditions

The Knysna fires occurred during circumstances that are associated with similar wildfires worldwide: dry conditions created by an extended and severe drought, hot and dry weather with low atmospheric humidity, and very strong winds that shifted abruptly in direction and strength. The 18-month running mean drought index shows that the drought was the most severe on record (Figure 3) but, although the fire danger index had high values, there were occasions during the past 70 years when the fire indexes reached the same or higher levels (e.g. 2001, 2002) (Figure 4).

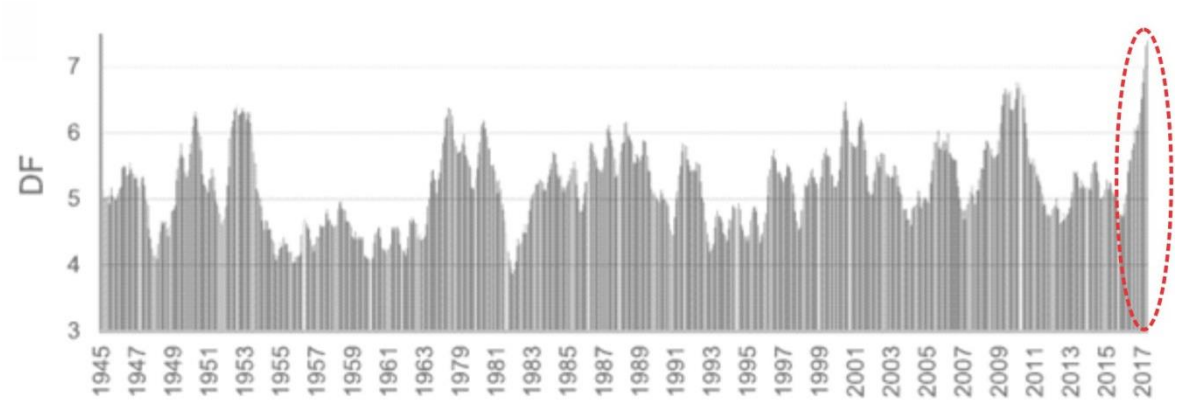

Figure 3: The 18-month running mean of the McArthur Drought Factor (DF). From the study by Kraaij *et al.* (2018)[2]. The ellipse indicates the period leading up to the June 2017 fires.

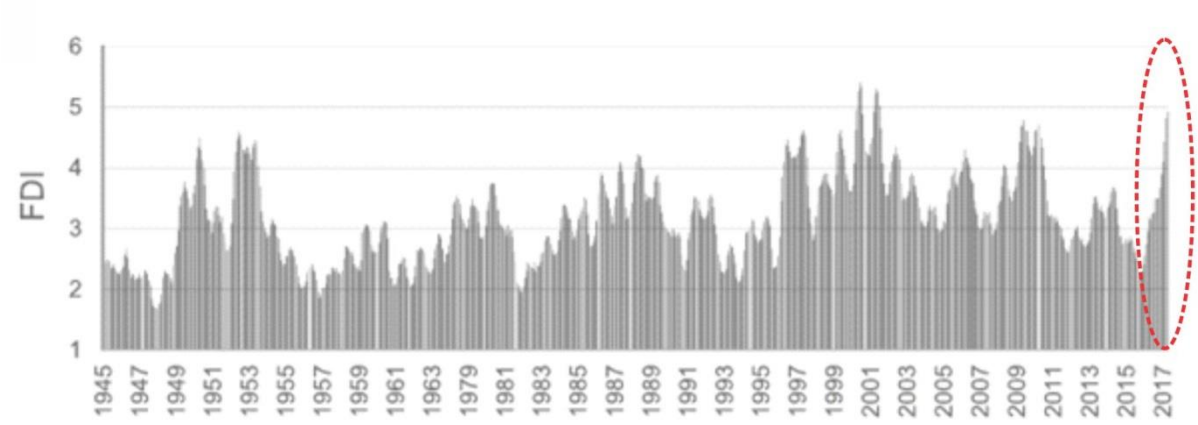

Figure 4: The 18-month running mean of the McArthur Fire Danger Index from the study by Kraaij *et al.* (2018). The ellipse indicates the period leading up to the June 2017 fires.

6.2 Exposure of communities, assets and infrastructure to the Knysna fires

Land cover played an important role in increasing the magnitude and severity of the fires. About 33% of the area burnt was natural or lightly invaded vegetation (primarily fynbos), 35% was under commercial forest plantations (pines, eucalypts), and 17% was heavily invaded by alien plant species (mainly wattles and pines). Both plantations and invaded areas had more biomass, and more of their biomass was burnt in the fire than in the natural fynbos, making the fires in this vegetation more intense and severe. The invading trees are also much taller than the fynbos, so when they burn, the fires are much more difficult to control, especially given the extreme weather conditions that can result in canopy fires. The area is also characterised by hills and ridges with steep slopes, which alter fire behaviour and can result in rapid spread uphill, making the firefighters' task much harder. The result was that the fires spread extremely rapidly and overwhelmed the firefighters, so they had to try to contain the fires where they could, and focus on saving valuable infrastructure and people's lives. The situation was also

[2] Kraaij, T., Baard, J. A., Arndt, J., Vhengani, L. & Van Wilgen, B. W. An assessment of climate, weather, and fuel factors influencing a large, destructive wildfire in the Knysna region, South Africa. *Fire Ecol.* 14, 1–12 (2018).

aggravated by the fact that there were two main fires in this area, as well as fires elsewhere in the Western Cape at the same time, which divided the firefighters' attention and efforts.

Many of the dwellings and assets destroyed were located in high-risk areas. The plantations and densely invaded areas were concentrated on the lower mountain slopes and coastal platform, which is where most settlements were too, creating a combination of valuable infrastructure and high fuel loads and setting the scene for a disaster. Many dwellings were also located on slopes. About 30% of the nearly 939 of the houses that were lost were situated on or near land with a slope >15 degrees, and slopes enhance fire spread and intensity (Table 1). If the slopes also had vegetation types with a high fuel load, this could have contributed to the loss of these houses, either through heat radiated by the fire or through embers blown up against the house, other flammable material near the house, into the gutters, or under the eaves and into the roof space[3].

Table 1: Slope classes within a circular buffer around the GPS point marking the location of houses.

Slopes	**Degrees**	**Buffer width (m)**	
		% within 30 m	**% within 90 m**
Mild	< 5	18.2	18.2
Moderate	5 - 15	55.4	52.0
Steep	15 - 25	22.9	24.1
Very Steep	> 25	3.5	5.7
		100	100

The analysis indicates that about 84% of the houses had high or extreme fuels loads within 30 m and 94% within 90 m, which contributed to the losses (Figure 5). About 42% of these buffer areas were classified as urban residential (dense trees/bush), and 27.3% (72.2 ha) as thicket/dense bush (Figure 6). This indicates that many of these houses are likely to have been exposed to intense heat from the fires, or ember attack, or both. The thicket/dense bush vegetation is likely to have been invaded by alien plants, which could have modified its flammability and increased the fire hazard.

[3] A phenomenon known as ember attack.

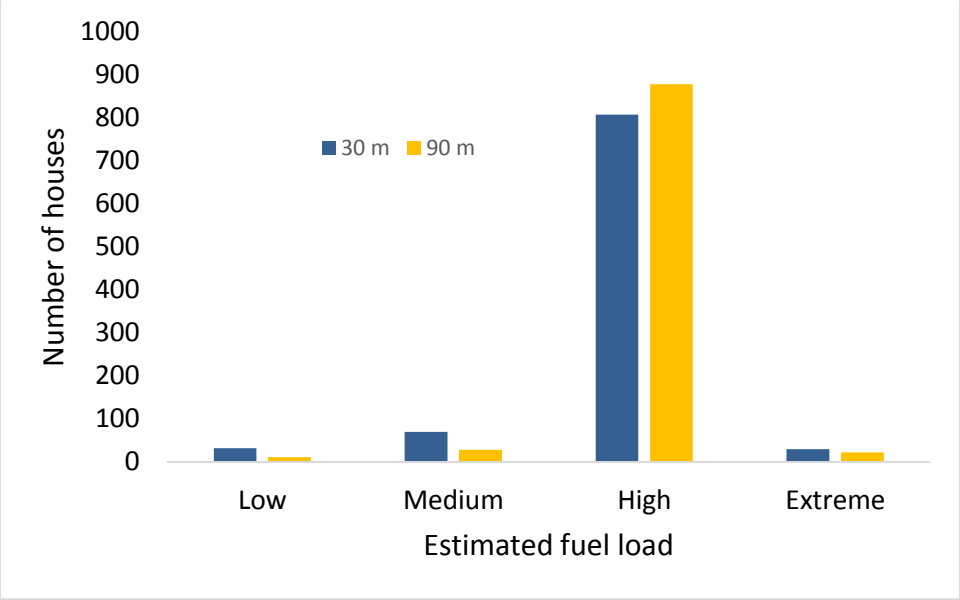

Figure 5: Estimated fuel loads within a 30 or 90 m radius buffer around each destroyed or damaged house.

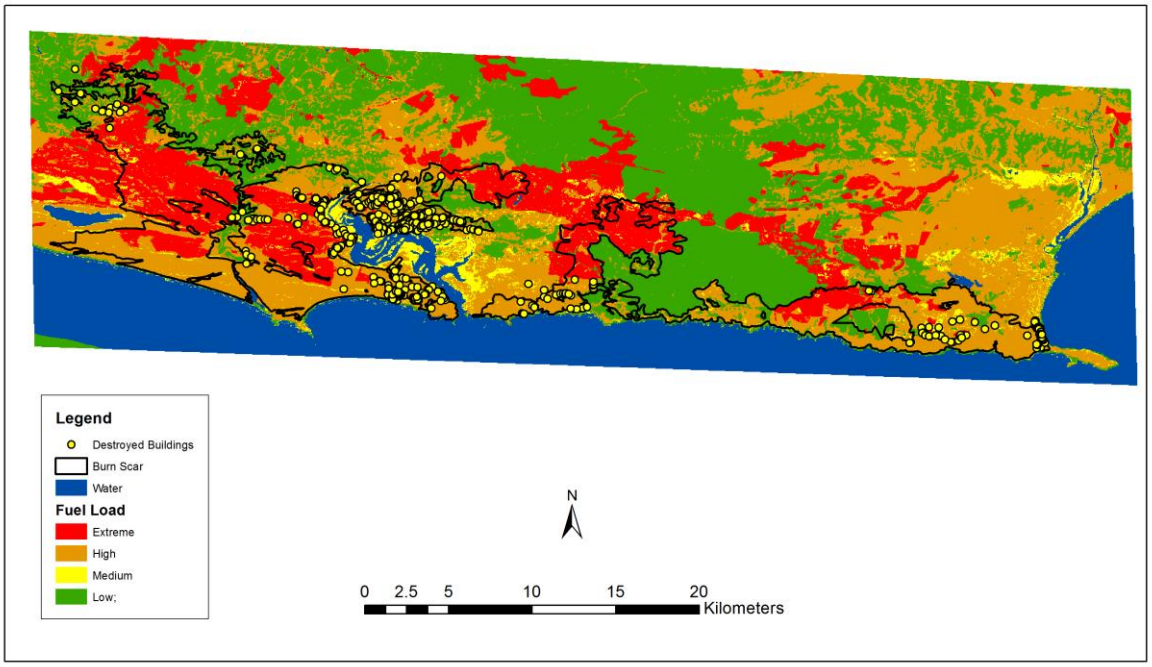

Figure 6: Estimated fuel loads based on the 2013-14 national land cover classes showing that many areas that escaped the fire have high or extreme fuel loads and are still a significant hazard.

Being close to nature is a major drawcard in the Garden Route. Photographs taken before the fires show that housing throughout the Garden Route is nestled amongst forest and other vegetation (Figure 7), increasing the risk of fire damage with many houses and other structures. This was a critical ingredient in destruction caused by the Knysna fires (Figure 8).

Figure 7: Chalets on a steep slope surrounded by Eucalyptus trees in the vicinity of the Knysna Lagoon about three years prior to the Knysna Fires of 2017 (Image taken in July 2014 by G. Forsyth, CSIR).

Figure 8: Remnants of destroyed chalets on a steep slope surrounded by Eucalyptus trees in the vicinity of the Knysna Lagoon post the Knysna Fires of 2017 (Image taken in July 2017 by G. Forsyth, CSIR).

Key points:

Topography and dominant vegetation types, particularly invasive alien plants (IAPs) and commercial forests, have high fuel loads that helped to make the fires more intense and severe. Settlement patterns increased the destructiveness of the fires. Dwellings that were damaged or destroyed were concentrated in areas that were densely invaded with IAPs and commercial forests, and many were located on slopes, which increase the speed of fire spread.

These findings clearly highlight the need for more effective fuel reduction in the WUI and the application of measures aimed at protecting structures, including houses, from fires (and reducing the probability of ignitions and the consequent losses).

6.3 Surrounding vegetation

Analysis of the environment immediately around damaged and destroyed homes confirms that the landscape around houses played a critical role in whether homes survived the fires. Homes were classified according to the likely mechanism of fire spread:

a) **Uninterrupted vegetation fire or ember ignition:** structures that were potentially ignited by uninterrupted fire spread through continuous vegetative fuels right up to the structure;
b) **Vegetation fire or ember ignition:** structures with sufficient burnt vegetation surrounding them to cause ignition but which could not have ignited through continuous fire spread, due to the presence of fuel breaks such as roads, grasslands with short grass, fire breaks, etc.;
c) **Ember ignition only:** structures that were ignited by embers directly, which caused little to no damage to vegetation surrounding them (firebrands can be carried many kilometres ahead of a fire front and ember attack can always occur, and hence is part of all these mechanisms of spread);
d) **Structure-to-structure or ember ignition:** Structures that were ignited by adjacent burning structures; this typically occurs in suburbs, and for homes located at least one row of structures inside a suburb.

As shown in Table 2, 74% of the homes destroyed or severely damaged had vegetation which provided pathways for the fire to reach them. About 43% of homes had vegetation in their immediate vicinity but there were some breaks in the coverage, meaning that the fire jumped roads or fire breaks, through spotting or intense heat radiation causing ignition over a distance. Another 31% of the homes destroyed had a continuous path of vegetation leading up to them, exposing them to the fire front directly. Only around 17% of homes destroyed had limited vegetation around them, or no vegetation present, indicating that they were most probably ignited directly by embers. Around 9% of homes were ignited from adjacent structures or homes.

Table 2: Fire spread mechanism leading to homes / structures being destroyed / severely damaged

Fire spread mechanism	No. homes	% Total
Vegetation Fire or Ember Ignition	380-420	43%
Uninterrupted Vegetation Fire or Ember Ignition	270-300	31%
Ember Ignition	140-180	17%
Structure-to-Structure or Ember Ignition	70-100 (up to ± 150)	9%

A summary of the vegetation cover surrounding homes (Table 3) shows that 46% had vegetation with some interruptions, 28% had significant vegetation around them, while a further 22% had low or limited vegetation within 10 m of the structure. Of all the homes destroyed, only six had very limited vegetation within 30 m of them, whilst 38 homes (just 4%) had almost no vegetation surrounding them. These latter two categories would have most probably been ignited by embers and not by vegetation carrying the fire to the home.

Table 3: Vegetation surrounding destroyed / severely damaged homes & structures

Vegetation	No. homes	% Total
Interrupted Vegetation	423	46%
Uninterrupted Vegetation	262	28%
Low / Limited Vegetation within 10 m	200	22%
Low / Limited Vegetation within 30 m	6	1%
No Vegetation	38	4%

Key points:

Having tree or shrub vegetation near dwellings increases the chances of them being damaged or destroyed. Homes that have cleared space or short vegetation around them are much less likely to be damaged or destroyed.

6.4 Susceptibility of homes to fire

Determining the role of building materials in home ignitions is less clear-cut. Table 4 and Table 5 summarise the main construction materials used for the walls and roofs of the homes that were destroyed or severely damaged. The data shows that homes constructed from many different materials were destroyed, meaning that no home is impermeable. Around 23% of the dwellings were timber structures (Table 4). By South African standards, the Garden Route area has a higher than normal prevalence of timber structures, which may have influenced the fire spread rate on the outskirts of the town, where timber homes were interspersed amongst thick forests. However, the majority of the structures damaged or destroyed were not constructed of timber.

Table 4: Wall types of homes that were destroyed / severely damaged

Wall type	No. homes	% Total
Masonry	400-410	44%
Unknown	228	25%
Timber	210-220	23%
Informal	78	8%
Steel sheeting	4	0%

Table 5: Roof type of homes that were destroyed / severely damaged

Roof Type	No. homes	% Total
Unknown	290	31%
Tiles	260-270	28%
Steel Sheeting	200-210	22%
Informal	78	8%
Thatch	36	4%
Timber	25-30	3%
Concrete	30	3%

Critically, the results indicate that the presence of masonry walls and steel sheeting, or even a concrete roof, does not necessarily guarantee the survival of a home. This is because all homes have windows, air vents, chimneys and other weak points through which the contents of homes can be ignited. A window subjected to high temperatures can quickly crack and fall out, leading to the curtains catching fire. The survivability of a home is highly dependent on characteristics of the Home Ignition Zone (HIZ) (Cohen, 2010), which is typically considered the 30 metres surrounding a home. Risk reduction measures in this area can significantly improve the chance of a home surviving a wildland fire. For example, a timber home with limited amounts of combustibles and good wildfire preparedness may be more likely to survive than a masonry home with a concrete roof that is surrounded by thick, dry vegetation. Having combustible materials around homes (especially combustible vegetation, but also wooden decks, piles of firewood, canvas items, etc.) substantially reduces the chance of a home surviving a wildland fire.

International research shows that roofs (and associated features such as eaves, gutters, vents and chimneys) are the most susceptible to ember attack. Hence, it is important to ensure that roofs are not combustible. In the Knysna area, the 36 structures with thatch roofs would have been more susceptible to fire (unless specific protection products are used along with roof mounted sprinklers) (Table 5, shown previously).

Fundamental fire physics and wildland fire behaviour

Fire requires (a) heat, (b) oxygen, and (c) fuel. Fire, or combustion, is governed by the laws of physics, and homes or vegetation will only burn where specific conditions are satisfied. An understanding of fire behaviour can demystify many fire phenomena. It is important to note that fuel consists of any combustible materials. People sometimes only think of vegetation as fuel, but once a home catches alight it too is fuel and will cause the fire to spread. Heat is transferred through *conduction*, *convection* or *radiation*. Fire spread can also occur through *flame impingement*, which is where flames come into contact with fuels (and at some level is a combination of combustion, convection and radiation). The presence of burning embers that are carried by the wind significantly influences both the rate of fire spread, and also how many homes are destroyed during fires. These flaming embers are referred to as *firebrands*, *spotting* or *ember attack*, and are shown in Figure 9. They are typically burning leaves, twigs, barks and other small materials (or items from homes that are burning). It has been shown that in many fires, ember attack is the mechanism responsible for destroying the majority of homes, and played a significant role in the Knysna fires incident.

Figure 9: Common sources of home ignition. Burning vegetation can cause intense radiation onto homes (along with flame impingement and hot convective gases)(Left). Firebrand / ember attack from lofted burning material being carried onto homes and causing them to ignite (Right).
(Images from the Western Cape #WildfireReady project, produced by Vulcan Wildfire Management)

Figure 10 shows aerial images of various areas immediately after the Knysna fires disaster, which have been included because they highlight various important factors. In (a) and (b), the images show a housing estate in Knysna which was unaffected when houses on all sides were destroyed. In this area, the amount of vegetation was very limited, and the construction materials of the homes were typically not flammable. Image (c) is from Brenton-on-Sea where several homes near the beach were destroyed. The majority of structures destroyed in (c) were timber, many with thatch roofs. Firebrands must have been carried around 100-200 m for these structures to be affected, some of them being destroyed. In (d), the homes were at the top of a slope and would have been exposed to fast-moving and extreme fires, as fire burns faster uphill. In general it is difficult to change the influence of slopes in a region, but these should be considered when determining fire risk, and which homes require additional fuel reduction and fire resilience measures.

Risk reduction is a collective responsibility. If homes on the edge of a suburb or vegetated areas are more resilient they can form a shield to protect the rows of homes behind them. Conversely, once a home catches fire, it may increase the fire exposure of the homes around it, meaning that they too could burn down. Hence, communities rather than isolated individuals need to become fire resilient.

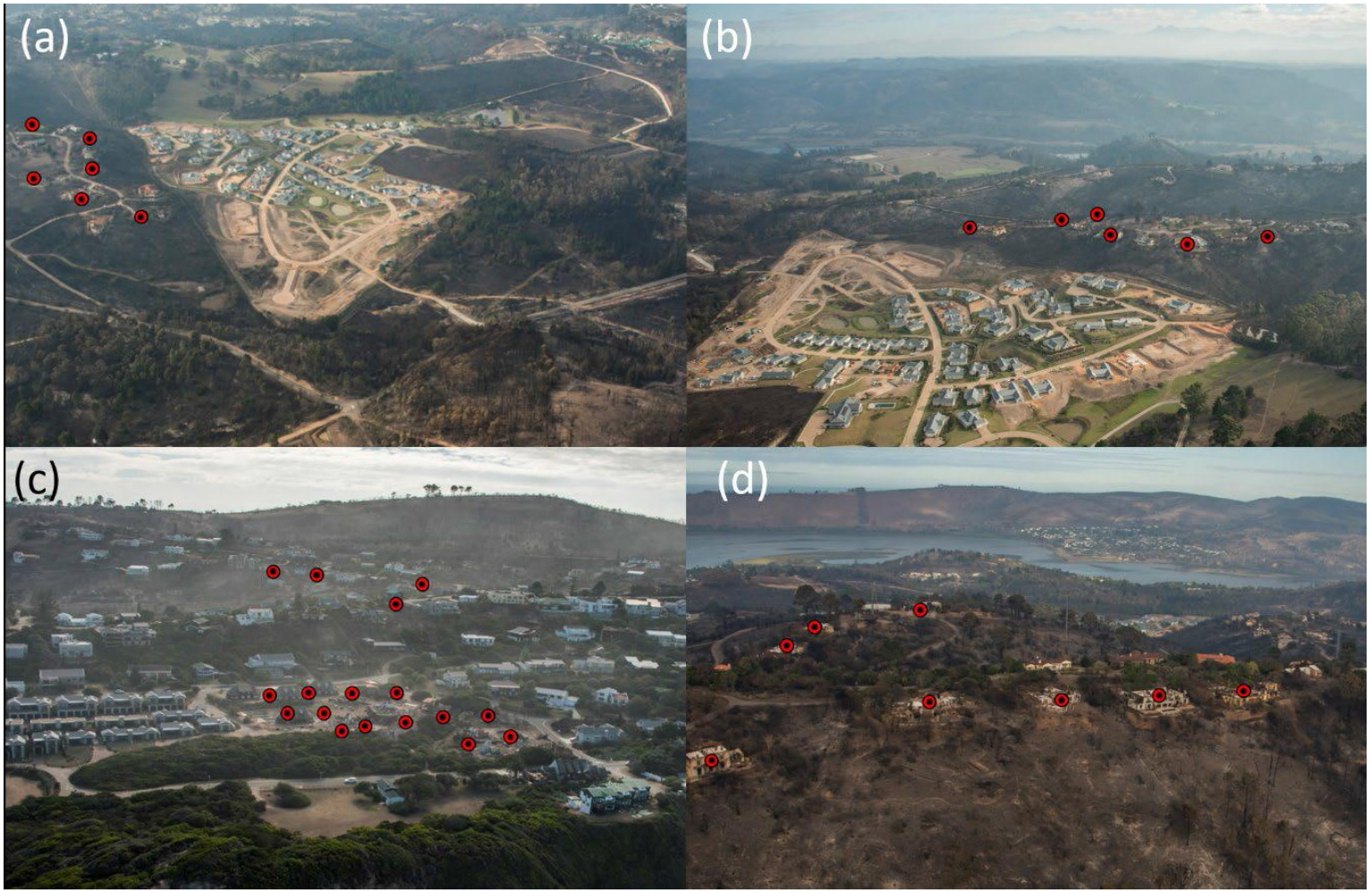

Figure 10: Aerial images of locations affected after the Knysna fires disaster, with destroyed / severely damaged homes shown by the red dots. These figures highlight: (a & b) a new housing estate where the estate was virtually unaffected due to good defensible space and low amounts of combustible material, (c) homes / chalets in Brenton-on-Sea that were destroyed, probably due to ember attack / spotting, and (d) homes at the top of a hill that were destroyed.
(Images courtesy of Vulcan Wildfire Management)

Making homes more resistant to fire

This research highlights the importance of preparing for wildfires. Given how quickly wildfires can spread in severe weather, and the large number of homes that can be simultaneously affected, it is impossible for fire brigades to protect all homes. Hence, home owners need to take responsibility for improving fire safety around their homes. Although any type of home can be destroyed, there are still significant improvements that can be made to improve their chance of survival. These include:

- Selecting more fire-resistant home construction materials. This is especially important for roofs. Roofs, eaves, gutters and similar items can be designed to reduce the chance of homes being ignited by flaming embers or spotting.
- Care must be taken with the selection and testing of roof cladding systems; some materials have been shown to be susceptible to fire and require additional protection.
- Regular maintenance, such as removing dry lead litter from gutters. Ensuring that there are not places for embers to build up around decks also reduces the risk of homes catching fire.
- Careful selection of vegetation and garden layout. Planting plants that are not readily combustible and having short lawns reduce the fuel loads.
- Creating defensible space around homes also makes it easier to fight fires.

Key points:

The features of the Home Ignition Zone (HIZ) are critical in determining whether a home survives fire. Simple ways of improving the chances of a home surviving include:

- Moving fuel sources away from homes and ensuring that gutters and roofs are kept clear of flammable leaves and debris.
- Choosing materials that are more resistant to fire. Roofing is particularly important, and homeowners should ideally avoid highly flammable materials, such as thatch, or take precautions to make them more fire-resistant.

Reducing risk effectively requires collective action by all those living in exposed communities.

The insurance industry can help to support risk reduction by:

- Encouraging the use of more fire-resistant materials.
- Advocating the inclusion of fire-resistance measures in the National Building Regulations, and municipal by-laws that promote risk reduction in the WUI.
- Sponsoring HIZ awareness-training for building inspectors and fire safety officers.

6.5 Inconsistent land management practices

In addition to highlighting the critical role of homeowners in reducing risk, this research underscores the importance of public and private landowners playing their part to reduce risk. Poor land management, particularly insufficient control of invasive alien vegetation or allowing moribund brush to develop in indigenous fynbos, results in the accumulation of fuel in the landscape. Our interviews flagged several issues:

- Poor management by some private landowners, especially where land is visited only occasionally, properties are very large, or topography makes parts inaccessible;
- Inadequately managed road reserves and electrical servitudes;
- Uneven maintenance on land belonging to governmental entities;
- Sometimes inadequate management by forestry companies; and
- The accumulation of fuel on vacant residential plots and public land along the WUI.

Landowners, particularly private owners, often do not understand the risk of fires or what they can do reduce their likelihood and impact. Prior to the fires, many people did not see wildfires as a significant threat and were unaware of the dangerous conditions they were living in. Where people are aware of their responsibilities, the expense of creating and maintaining firebreaks or controlling alien vegetation can be prohibitive. If they belong to a Fire Protection Association (FPA), this can unlock assistance and resources that can make it more affordable.

Other important barriers to effective land management include:

- Gaps in the legal provisions available to support risk reduction

Belonging to an FPA is voluntary and FPAs cannot force members to undertake risk reducing activities. This hampers strategic actions to reduce risk. The National Veld and Forest Fire Act (NVFFA), which underpins fire risk reduction, emphasises landowners' responsibility to create and manage firebreaks and does not oblige them to ensure land is free from alien vegetation or undertake prescribed burns – although most FPAs promote this expanded range of activities.

- Disincentives to undertake activities

Landowners are legally liable if prescribed burns on their property spread and damage surrounding properties. The 'caller pays' principle means that landowners or the implementing agent must also cover the cost of firefighting resources should this happen. It is also time-consuming to obtain permits to conduct controlled burns and preparations are costly. All these discourage prescribed burning. The insurance industry could help to address this by extending cover to landowners wanting to undertake burns.

Prescribed burning – A complicated issue

Fires in fynbos, grasslands and savannas are inevitable and prescribed burning is an effective way of managing fuel, and thus the fire behaviour. Prescribed burning in fynbos cannot always prevent wildfires from spreading, especially wildfires burning under conditions like those experienced during recent damaging fires. But it can reduce fuel loads and make the fires easier to control, especially if the wind drops and when air temperatures decrease. There is always a risk that prescribed fires will

get out of control, but the alternative is to allow fuels to accumulate until the inevitable wildfire occurs. Allowing this to happen means we will always be stuck in reactive mode rather than being pro-active and able to make choices. Prescribed burning in the landscape needs to be complemented by fuel reduction in the WUI. This includes the use of fire breaks, created by burning, brush-cutting or encouraging vegetation with low flammability.

The core problem is that risk aversion and complicated and lengthy approval processes have made it nearly impossible to use prescribed burning in practice, or even to burn firebreaks in the WUI. There already are very few days that are suitable for prescribed burning and climate change is going to reduce those even more and make them less predictable. We have to find ways of making it easier to utilise the few opportunities there are and to use them effectively to manage the fire hazard to human settlements, critical infrastructure and valuable assets.

- Unclear roles and responsibilities

Fringe areas like the WUI often fall in a jurisdictional grey area and it is frequently unclear who is responsible for promoting and facilitating risk reduction activities. The NVFFA applies to land outside of the urban footprint, and FPAs are not typically active in urban areas. There is also a jurisdictional division between fire and rescue services in urban and rural areas. The Municipal Structures Act of 1998 makes district municipalities responsible for fighting fires outside of urban areas, while the Fire Brigade Services Act (FBSA) of 1987 makes municipal firefighters responsible for responding to fires within urban areas. The weighting of risk reduction and response in these areas is also challenging as the NVFFA focuses strongly on fire prevention, while the FBSA emphasises response; although the Act is currently under review and is expected to become more prevention-oriented.

- Inadequate leadership and coordination

There are many different role-players involved in managing land effectively, but it is unclear how the different stakeholders should work together to reduce risk at a landscape scale – and most importantly, which entity should coordinate and lead activities. Landowners in the Garden Route include several different national and provincial government departments, CapeNature, SANParks, municipalities, the Forestry Industry, farmers and other private owners. There are also voluntary associations such as the Southern Cape Fire Protection Association (SCFPA) and Fire Management Units (FMUs), municipal- and district-level fire and rescue services, as well as disaster management authorities at these scales. FPAs, which bring landowners together to share resources and plan mutually beneficial fire breaks, are best placed to provide such leadership.

- Capacity and resource constraints

There is also often limited capacity to undertake and enforce measures to reduce risk. Local, provincial and national government sometimes lack the resources to manage their land. Resource pressures within the forestry industry have also eroded management capacity (Stehle, 2018). The resources of institutions such as the SCFPA, which is tasked with promoting and facilitating risk reduction and building landowners' capacity to prevent and respond to fires, are also stretched thin – especially as it manages Working on Fire (WoF) and undertakes controlled burns. The SCFPA has just eight staff and 13 base managers serving 5 000 members in George, Knysna and Plettenberg Bay, as well as parts of Uniondale, Mossel Bay and Oudtshoorn Municipalities. The insurance industry (and private sector more generally) could help to build FPA capacity.

Key points:

Improved management of land is critical to reduce the threat of damaging wildfires. Inadequate understanding of risk by landowners, sometimes inadequate capacity to undertake activities, and government's limited capacity to enforce owners' legal responsibilities, as well as the cost of interventions, currently prevent strategic land management. Getting landowners involved in risk reduction is essential. This requires incentivising action and building enforcement capacities. The insurance industry could support risk reduction by encouraging policy-holders to manage their land more effectively and requiring them to join their local Fire Protection Association (FPA).

The Southern Cape FPA and other FPAs can play an important role promoting risk reduction, and coordinating the activities of landowners, but they are critically under-resourced. The insurance industry (and private sector more generally) could help to build FPA capacity.

Strategic prescribed burning is an important environmental management tool. However, the prospect of financial liability should a prescribed burn get out of control is a significant deterrent, thereby increasing the risk of damaging fires. The insurance industry could help to address this by extending cover to landowners wanting to undertake prescribed burning.

Prescribed burning needs to be complemented by fuel reduction in the WUI. This includes the use of fire breaks, created by burning, brush-cutting or encouraging vegetation with low flammability.

6.6 Prevention and response capacities

Capacity to fight fires (or engage in prevention activities) is also constrained – although WoF, Fire Management Units (FMUs) and volunteers serve as important supplementary resources. The Garden Route District Municipality's (GRDM's) Fire and Rescue Service has a total of 40 permanent staff and 18 volunteers, with resources strategically distributed across three municipalities: George (George), Hessequa (Riversdale) and Kannaland (Ladismith) (Figure 11). There are normally three firefighters and one volunteer on duty per shift in Hessequa and Kannaland, and six in George. In total, the District has six skid units[4], two bushfire trucks, two tankers, one rescue unit and two hazmat resources – to serve an area of over 23 000 km^2.

It might also take several hours for GRDM personnel to reach towns in the district. Figure 11 approximates the distances that firefighting personnel in each of the three hubs would need to travel to reach key towns in neighbouring local municipalities within the District. The closest distance is between George and Knysna, where it would take at least 35 minutes for GRDM firefighters and equipment dispatched from George to reach Knysna. The furthest apart are Ladismith and Plettenberg Bay, where it would take over three hours for teams dispatched from Ladismith to reach the latter.

[4] A skid unit, also known as a bakkie sakkie, comprises a portable 500 litre water tank, pump and hoses mounted on a light delivery vehicle

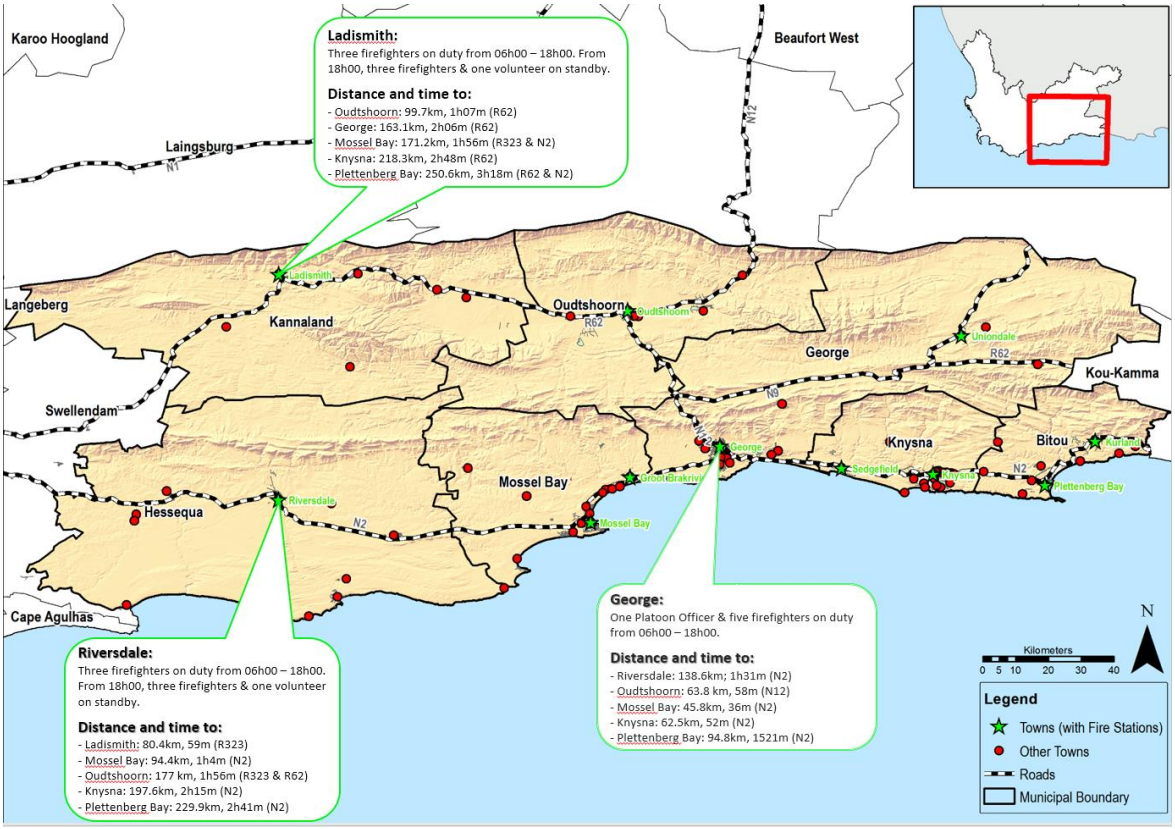

Figure 11: Distances GRDM firefighting personnel in each of the three hubs would need to travel to reach key towns in neighbouring local municipalities within the District.

Municipal fire and rescue services are also under-resourced – although WoF, FMUs and, depending on location, volunteers and other agencies such as CapeNature, SANParks and the South African National Defence Force (SANDF), again provide additional capacity. In absolute numbers, Mossel Bay, George and Knysna have the most municipal firefighters. Bitou Municipality's capacity levels are lower than indicated, as staff and vehicles must also be stationed at Plettenberg Bay's airport. Due to the limited capacity, GRDM firefighters have the mandate to perform all firefighting services in Kannaland.

When personnel numbers are calculated relative to the size of the population in each municipality (as indicated in Statistics South Africa's 2016 Community Survey), the capacity gap becomes striking. Figure 12 shows, the number of municipal firefighters per 1 000 of the municipal population, compared to figures compiled by the International Association of Fire and Rescue Services' Centre of Fire Statistics (ICTIF) in 2018. It shows that levels of staffing per 1 000 of the population in all municipalities in the GRDM are considerably lower than those in countries such as the United States of America, Canada and Britain. Mossel Bay Municipality fares the best, with 0.41 firefighters per 1 000, while George (0.15) and Oudtshoorn (0.18) fare the worst – although George Municipality can also draw on District resources. These figures are substantially lower than in the comparison countries, which range from one professional fire fighter per 1 000 of the population to 0.65.

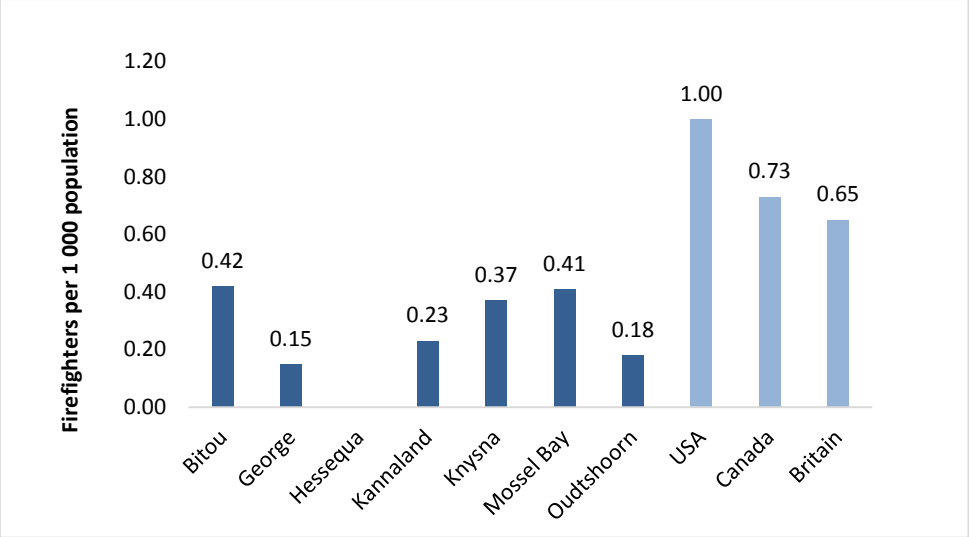

Figure 12: Number of municipal firefighters per 1 000 of the population compared to international examples.

In the absence of adequate permanent resources, volunteers and other sources of support can help to build human resources for fire prevention and response. FMUs, especially, are essential in building capacity to deal with frequent wildfires and can also play a critical role away from the fire line, as they have relationships with landowners and can provide an essential link to the fire services (VWM, 2018). To reap the benefits, however, they need adequate training, and must be provided with protective clothing and the necessary equipment. Other volunteers can also help, but they are not a panacea as they are not a stable resource. Hence, it is critical to develop professional firefighting capacity alongside a volunteer capacity.

Key points:

There are a range of role-players involved in fire prevention and response, with non-governmental stakeholders helping to spread the load on government resources. This notwithstanding, municipal fire and rescue services lack the capacity to perform optimally, particularly at the District level. This is particularly problematic as it is District Municipalities that are mandated to respond to wildfires.

This again suggests a role for the private sector, including the insurance industry. They could play a role in building capacity through corporate social responsibility programmes, particularly with respect to vehicles and equipment.

6.7 Other settlements exposed to similar fire risk

The CSIR's Green Book project is aimed at helping municipalities to manage their natural environmental risks under a changing climate (www.greenbook.co.za). This included a fire risk assessment within a 1 km buffer around 1 596 settlements across South Africa, based on the vegetation characteristics and the occurrence of veldfires. Fire occurrences for 49% of these settlements were classified as "Likely" and 33% as "Possible" - which means that parts of their boundary are regularly exposed to wild fires with sufficient fuel to potentially damage infrastructure at

least once in every 10-15 years. In addition, about half of these settlements have at least 25% of their buffer areas in the high or extreme fuel load classes. In the case of Knysna, more than 85% of the area burnt fell into the high or extreme fuel load classes, a factor which undoubtedly contributed to the difficulty of controlling these fires and, via embers and spotting, to the very rapid spread of the fire.

Key point:

Many settlements in South Africa are exposed to significant fire risks, a situation which needs to be addressed.

Lessons: Reducing the risk of future fires

Several dynamics contributed to the devastation caused by the Knysna fires, which include: very hot and dry conditions; the concentration of assets and housing in high-risk areas; the vulnerability of dwellings; high fuel loads in many areas; and limited capacities to either promote risk reduction or respond to fires. Given that a shift in climatic conditions and urban expansion are inevitable, and existing resource constraints, the emphasis must be on reducing the risk of fires. In addition to the points highlighted above, the research suggests two critical areas for action:

- Reducing risk through integrated fire management

Integrated Fire Management (IFM) is essential. Reducing the risk of serious fires can only be achieved at a landscape level, and requires action across a range of sectors, scales and interest groups. Municipalities have a critical role to play in reducing development in high-risk areas, and Knysna Municipality is already taking steps to do this by re-working its Spatial Development Framework (SDF). Landowners and homeowners also need to play their part, as do developers. The insurance industry can help to reduce the threat of damaging wildfires by incentivising and promoting actions to reduce risk. This can include extending cover to landowners wanting to undertake burns, so as to reduce the cost to landowners should a fire burn out of control.

- Building response capacity

It is important to boost the fire services' capacity to respond to fires, especially given the expected shift to promoting prevention in the amended FBSA. Prevention is critical at both the District and Local Municipal level, but particularly at the District level, as it is the District service that is ultimately mandated to respond to wildfires. Organisations like WoF and the SCFPA and volunteers represent valuable resources, but FPAs and their constituent Fire Management Units (FMUs), in particular, need to be adequately resourced, trained and equipped to play their role. They are also no substitutes for the fire and rescue services. Capacity building must seek to strengthen both municipal and external capabilities.

Through their social responsibility programmes, the insurance industry (and private sector more generally) could help to build governmental and FPA capacity, particularly with respect to vehicles and equipment. Santam's Partnership for Risk and Resilience (P4RR) initiative, which aims to capacitate local government with fire and flood risk management skills and equipment, is a useful example of how insurers could assist in improving local capacity.

7. THE UNFOLDING INCIDENT

The Knysna fires had two main points of origin on the 7th of June 2017, which led to what are known as the Elandskraal and the Kruisfontein fires. There is evidence that the Elandskraal fire was ignited by lightning on the 22nd of March 2017 and smouldered until the 7th of June when it flared-up (Frost *et al.* 2018). The two fires swept from west of Knysna to Plettenberg Bay between the 7th and 11th of June 2017 (Figure 13). There is a report of a third fire, which started near Featherbed Nature Reserve, but due to limited information available our discussions are mainly focussed on the Kruisfontein and Elandskraal fires.

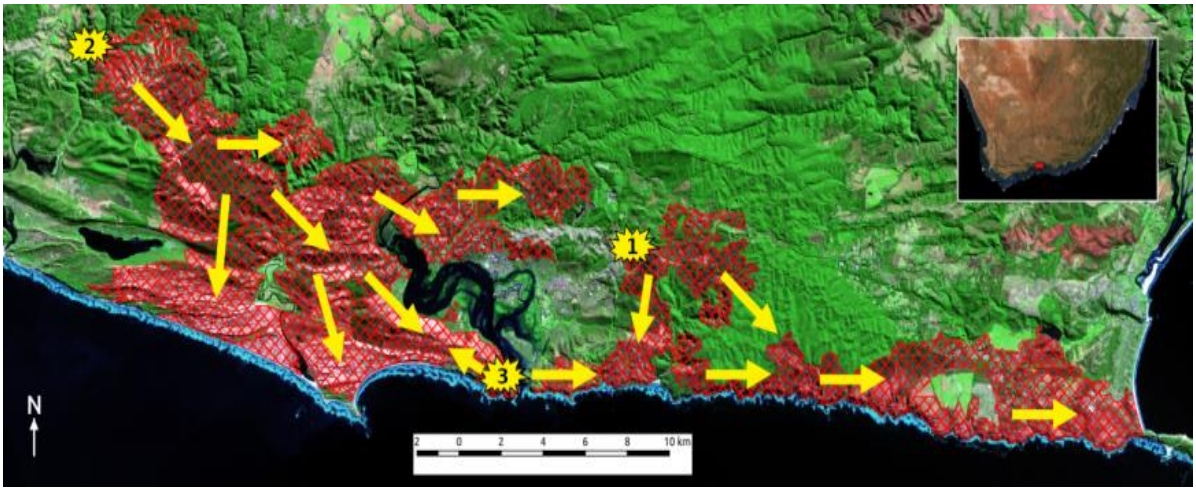

Figure 13: The general pattern of spread of the fires from the ignition points indicated by the yellow icons. The easternmost icon (1) is the origin of the Kruisfontein fire while the westernmost icon (2) is the origin of the Elandskraal fire. There are reports of another fire starting on the West Head (icon 3) before the Elandskraal fire front reached the same area.

Gale-force winds, associated with an intense cold front, created a massive firestorm and severely hampered firefighting operations. Flame heights reached 40 metres high in some places (VWM, 2017). At one stage, the fire is reported to have moved one kilometre every 10 minutes (Garden Route Rebuild Initiative (no date), and a disaster manager estimates that, at its peak, the fire consumed a house every minute. These fires burnt approximately 19 000 ha and mopping up operations continued for weeks afterwards. There were also wildfires elsewhere in the GRDM and in the Tsitsikamma region of the Eastern Cape.

The spread of the fire was not systematically recorded because the firefighters were, understandably, focusing on managing and containing the fire to minimise damage and loss of life. So we have pieced the story together from various sources, including remotely sensed data, reports, interviews and personal observations.

The Kruisfontein fire was first reported at about 03h30 on the 7th of June 2017 and by 06h35 had jumped the N2 between Knysna and Plettenberg Bay. It continued to spread rapidly, helped by spot fires up to 2.6 km ahead of the main fire front. The fire front reached Robberg and the outskirts of Plettenberg Bay by about 24h00, more than 25 km from its starting point.

The flare-up and spread of the Elandskraal fire also was extremely rapid, starting between 05h00 and 05h30 on the 7th of June 2017 and reaching the N2 near the bridge over the Knysna River by 12h00. By 16h00 the Elandskraal fire had reached Timber Village in Knysna and by 17h00 it had reached Knysna Heights. From there it spread more slowly until it had largely surrounded the town.

At about 13h30 on the 7th a fire burning near Featherbed Nature Reserve on the West Head spotted across to the East Head and eventually linked up with the Kruisfontein fire. By the 9th, the fires were estimated to be 85% contained, but a second cold-front, associated again with very strong winds, saw major flare-ups throughout Knysna and Bitou Municipality on the 10th of June. By 17h00 on that day, most fire lines had flared up again and were out of control. In Plettenberg Bay, the fire spread rapidly to the Robberg Peninsula and into the beach area, with more structures lost in Bitou on the 10th than on the 7th of June.

It took almost two weeks to fully gain control of the fires. Thanks partly to some rain, the fires were 70-80% contained by the 11th of June 2017, but mopping up operations continued for several days, and there were flare-ups. The Knysna fires were officially declared over on the 19th of June 2017 – 12 days after they began (WoF, 2018).

7.1 The response to the fires

The timeline and key events are summarised in Figure 14. The fires comprised the largest operational deployment of firefighting resources and personnel in a single incident in South Africa's history. At peak capacity on the 11th of June, there were 1 008 command staff and firefighters active, and 78 fire vehicles and 19 buses in use (Table 6). CapeNature and SANParks, Volunteer Wildfire Services, Enviro Wildfire Services FMUs and the SCFPA and other civilian volunteers assisted, while the SANDF, WoF teams and SCFPA provided aerial support. The SANDF also mobilised a medical team and equipment. The Airports Company of South Africa (ACSA) provided vehicles and personnel. The Western Cape's Disaster Management Centre (WCDMC) formally activated their Provincial Response Plan late in the afternoon of the 7th (VWM, 2017), marshalling resources through mutual aid agreements with other municipalities and districts in the Province.

Table 6: Municipal and district firefighting resources deployed between 7th and 11th June 2017.

Dates	Command staff	Firefighters	Fire vehicles	Buses
7 June	48	632	60	12
8 June	49	633	62	12
9 June	50	650	62	14
10 June	84	871	79	17
11 June	88	920	78	19

Thousands of people were evacuated over the course of the incident. The numbers vary according to source, but the WCDMC estimates that between 7 000 and 8 000 people were evacuated on the 7th of June, and by the 9th between 3 000 and 4 000 people remained displaced (WCDMC, 2017).

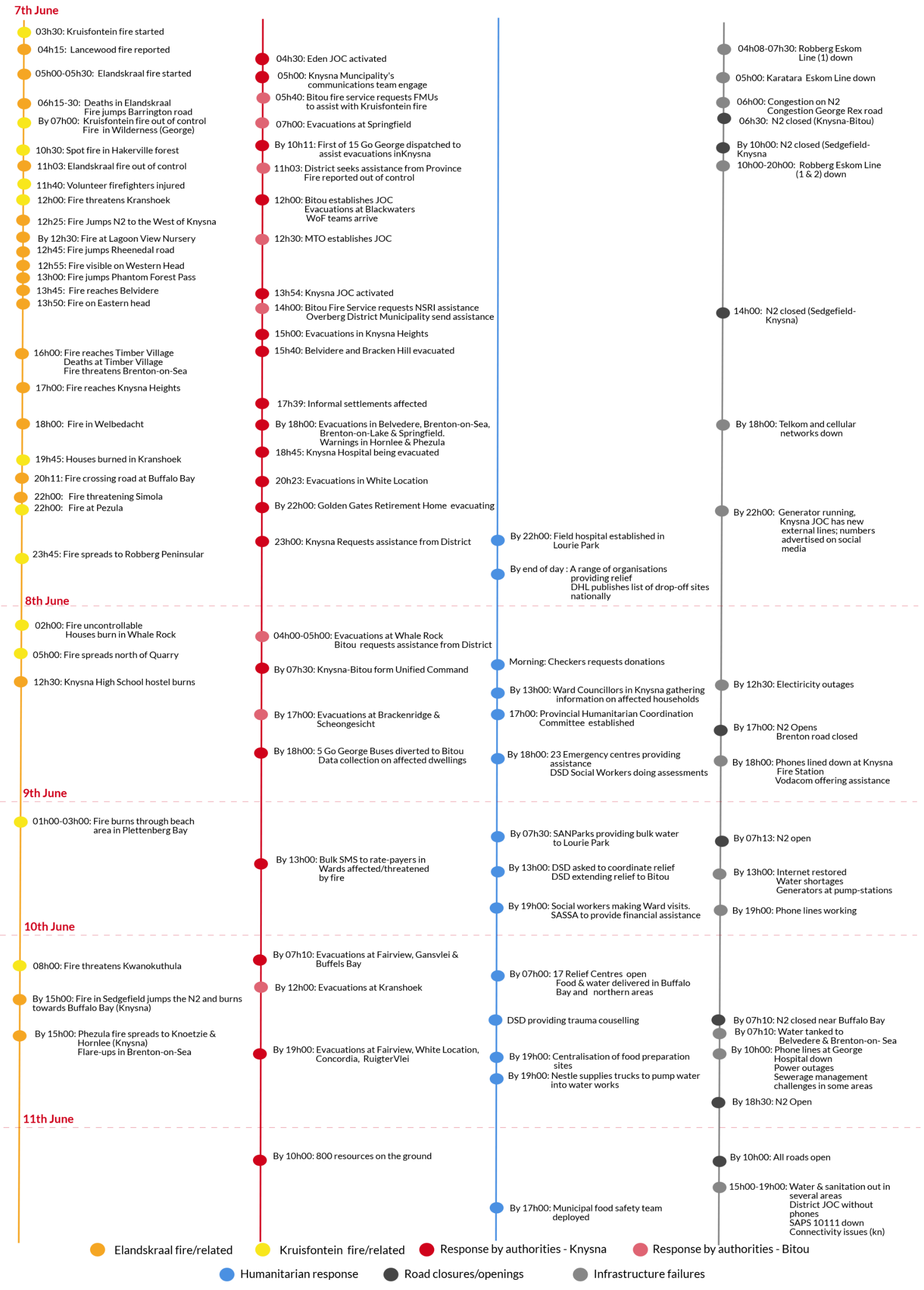

Figure 14: Summary of the incident timeline. The orange and yellow markers show milestones in the spread of the fire, the red and light red the response by the authorities, the green the humanitarian response and the charcoal and grey road closures and infrastructure failures. The timeline underscores the many moving parts and role-players involved and the overall complexity of the incident.

Many also went to stay with friends and family or to hotels, and members of the local community opened their homes while others were evacuated to 21 Emergency Centres established in and around Knysna and Plettenberg Bay. Several retirement villages and frail care facilities were evacuated, along with Knysna's Provincial Hospital and Community Day Centre.

The most complex evacuations were from Brenton-on-Sea and Belvidere in Knysna, where the closure of the only access road forced people to evacuate along the beach to Buffalo Bay and across the Knysna Lagoon. Evacuees from Belvidere were ferried across Knysna, while people from Brenton-on-Lake and Brenton-on-Sea were evacuated along the beach to Buffalo Bay. Members of the public and a range of organisations assisted with evacuations, including Gift of the Givers, the National Sea Rescue Institute (NSRI), SANParks, WoF, security companies, 4x4 Clubs and neighbourhood watch organisations.

Numerous organisations mobilised to assist those affected. Non-governmental organisations (NGOs) and members of the public living in the Garden Route mobilised to provide shelter and relief to people displaced by the fire. Government institutions mobilised to provide humanitarian assistance and trauma counselling, while various companies provided meals, financial and in-kind donations and logistical support. Public interest in the fires and calls for donations by corporates, NGOs and members of the public resulted in a massive quantity of food and relief items pouring in the Knysna, and to a lesser extent, Plettenberg Bay. It is impossible to quantify precisely the number of items received, as there were so many different organisations collecting donations, and record keeping was initially poor. However, it is estimated that as much as 27 000 tons of food, clothing, blankets and other items were received in Knysna.

7.2 Utmost complexity: Challenges associated with the response

The response environment was immensely complex and challenging. The fires were extremely intense and spread rapidly, making firefighting difficult. Those responding to the fires, on the frontline and elsewhere, also had to navigate a range of challenges. These included:

- **Infrastructure**: power failures and the loss of landline and most cellular network coverage. The use of different radio types and frequencies also created difficulties for responders.
- **Road closures**: the partial and total closure of access and other roads, including the N2 between Knysna and Sedgefield and Plettenberg Bay, the road to Brenton-on-Sea and Belvidere.
- **Inadequate and uneven resources**: sometimes inadequate equipment, clothing and vehicles to fight the fire optimally.
- **Self-dispatching by volunteers**: large numbers of well-intentioned but inadequately trained, equipped and prepared volunteers.
- **A flood of donations**: tons of in-kind donations and financial resources.
- **Relief**: a lack of synergy between the many organisations that mobilised to provide relief to those affected by the fires. Organisations applied differing eligibility criteria and standards of relief also varied.
- **Information overload**: Emergency Call Centres and communications teams were inundated with calls and messages and struggled to cope.
- **Social media**: Initially confusing official communication and deliberate and accidental miscommunication by the public.

- **Fragmentation of initial Command and Control efforts:** Confusion also undermined responders' situational awareness. This prevented the formation of a shared understanding of the operational situation and delayed the activation of the Provincial Response Plan.

The simultaneous loss of communication and electricity infrastructure and the limited equipment and resources proved particularly challenging. The interruption of cellular and landline communications and the use of different radio types and frequencies made fighting the fires more dangerous and coordination of the fire and disaster response more difficult. Power outages also presented difficulties for the firefighting operations and disaster management, as well as Knysna Municipality's efforts to keep pump stations and water treatment plants operating. Many front-line responders, including municipal and district firefighters, sometimes lacked the appropriate equipment, protective clothing and suitable vehicles for fighting wildfires or meeting the unique challenges associated with supressing fires on the WUI (VWM, 2018). The was also no dedicated facility for the command centre, which was ultimately established in the Municipal Manager's office as this was the largest space available.

Lessons: A complex and demanding incident

The response environment during the fires was extremely demanding. There were a huge number of moving parts and several unanticipated challenges. The critical lesson is that the worst can happen. It is essential to plan and prepare for complex, large-scale events, simultaneous infrastructure failures and road closures, as well as high-visibility events generating intense public interest and extensive relief operations. As discussed later, social media is also becoming an increasingly powerful dynamic in disasters, and it is essential that authorities engage the medium.

In addition to building the capacity of firefighting resources, the insurance industry could consider practical measures to build the resilience of municipalities to infrastructural failures, such as sponsoring generators for fire stations and life-line services such as pump stations.

Ensuring that members of the public have escape routes and the emergency services access is critical to prevent deaths and injuries and property losses. In Knysna specifically, the lack of alternative roads to the N2 and single entry and exit roads to some suburbs, poses a danger to residents. The Municipality should seriously consider building additional roads to improve available escape and response options.

8. PERFORMANCE OF THE NATIONAL FIRE DANGER RATING SYSTEM

South Africa's National Fire Danger Rating System (NFDRS) is the system that is used to measure and report on the daily fire danger across South Africa. This system allows fire management agencies to determine their levels of readiness and inform the public of the potential for veldfires so that they can avoid activities that could result in veldfires.

The CSIR Meraka Institute recommended in 2013 that the Lowveld Fire Danger Index (LFDI), a system that was already being used in the Lowveld region of South Africa, be officially adopted as part of the

NFDRS because it was already being used by most fire managers across the country. In addition, the CSIR also recommended that the Fire Weather Index (FWI), as a sub-system of the Canadian Forest Fire Danger Rating System (CFFDRS) be included in the national fire danger rating system at a later stage.

In 2013, the LFDI was officially adopted as part of the NFDRS. The LFDI is now used in operational activities of local fire management and fire suppression agencies across South Africa, including areas such as the fynbos biome where the performance of LFDI as a fire danger index has not been properly evaluated.

This research project reviewed the performance of the LFDI and showed that it did not provide an adequate indication of the extreme conditions preceding and during the fires. It indicates that the fire danger level observed on the 7th of June was reached and even exceeded on many other days in the year up to the day the fires started (Figure 15). Also of concern is that the LFDI did not even reach the threshold for extreme fire danger as defined by the NFDRS.

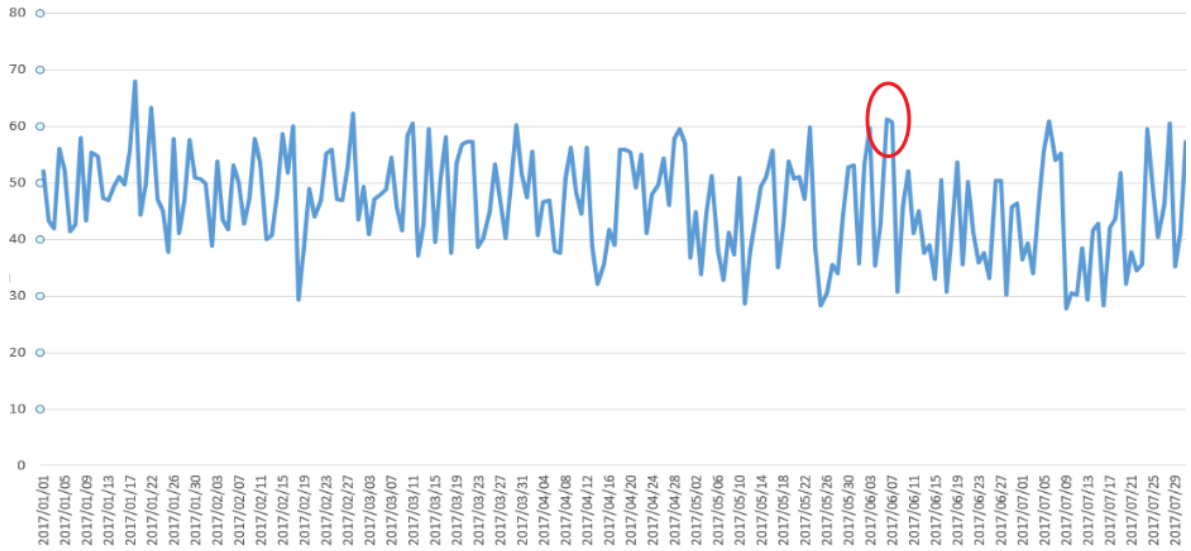

Figure 15: The Lowveld Fire Danger Index from January to August 2017; the red ellipse marks the time of the fires in June 2017.

FDIs are generally used in the geographic areas, for which they were designed, but the FWI is increasingly being used in many different countries throughout the world, including Africa, and it has been deployed operationally in the Global Wildfire Early Warning System. The CFFDRS includes a Daily Severity Rating (DSR), which gives an indication of how difficult a fire would be to control or suppress given the predicted or known weather conditions. Figure 16 shows the DSR values in Knysna since the beginning of 2017 and clearly shows a significant spike on the 7th June when the Knysna fires started.

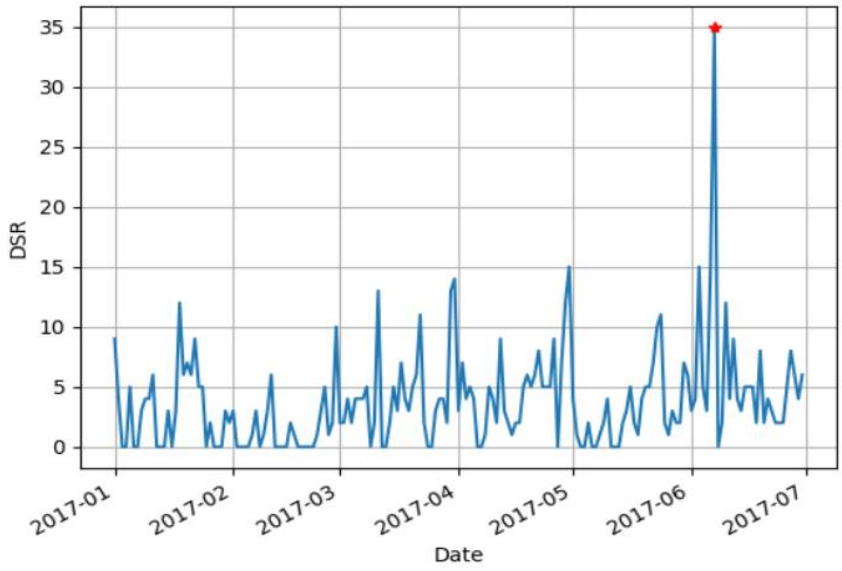

Figure 16: The Daily Severity Rating (DSR) from January to July 2019 indicates how difficult a fire would be to control or suppress; the red asterisk indicates the date the fires started.

An early warning signal based on the DSR calculated from the forecast weather would have helped the authorities to be better prepared to respond to the incident that unfolded.[5]

Lessons: Strengthening early warning

The current National Fire Danger Rating System is not appropriate for the Garden Route District and the fynbos biome in general.

An accurate early warning indicator could help authorities to be better prepared for incidents such as the Knysna fires. The Canadian Forest Fire Danger Rating System (CFFDRS), and specifically its Fire Weather Index (FWI) and Daily Severity Rating (DSR), would provide a useful complement to the current Fire Danger Rating System.

[5] For a detailed discussion of the reasons for the differences between the LFDI and the FWI/DSR please consult the CSIR's technical report titled: *CSIR Knysna Fires Report: Placing the Knysna fires in context, fire risk in the wildland urban intermix, the progression of the Knysna fires and post-fire environmental measures.*

9. THE RESPONSE - WHAT WORKED AND WHAT DID NOT?

The response included several highly commendable achievements. Thousands of people evacuated their homes and businesses safely, and multiple health facilities were evacuated. Given the ferocity of the fires, the population density in the areas affected and the very challenging environment, responders were remarkably successful in saving lives. Staff from a range of municipal and technical functions did an equally extraordinary job of supporting the front-line response, and addressing the impact on critical services, even while they themselves were affected by the fires. One of the central successes was the rapid mobilisation of resources. The number of personnel surged from an initial complement of approximately 30 firefighters from Knysna and surrounds on the morning of the 7th June (VWM, 2017), to over 600 personnel by the end of the day. This was made easier by the WCDMC's mutual aid agreements with District Municipalities.

Weaknesses in the response revolved primarily around planning, leadership, training and the unprecedented magnitude and complexity of the incident. The magnitude of the fires was such that even with well trained, prepared and resourced response personnel, they would have been impossible to supress. Nonetheless, this research suggests an overall lack of preparedness, and associated gaps in training, resourcing and data collection, prevented optimal responses and utilisation of resources.

Key issues emerging from the initial response include:

- Preparation, planning and procedures

The findings highlight an overall absence of plans, policies and procedures to guide, systematise and inform fire operations and the larger disaster response. Critical gaps included the lack of:

- Evacuation plans to guide evacuations, and pre-determined procedures for communicating evacuation orders to the public;
- Response protocols at fire stations (VWM, 2018);
- Data collection to support resource planning and deployment (VWM, 2018); and
- A procedural or operational framework to guide the intergovernmental and interagency engagement and mobilisation of resources.

- Limited strategic oversight and leadership

There was inadequate strategic leadership at the municipal level. This was a critical problem early on, but remained an area of weakness throughout. Leadership issues were evident in two areas: (a) command and control during the initial response and (b) in the management of the civilian response. Civilian responders were also unsure of their institutional roles and responsibilities.

- Gaps in training

Many municipal firefighters were not trained in the Incident Command System (ICS), although GRDM's firefighters have since received ICS training. Many responders, including municipal firefighters, also lacked training in wildfire suppression and were allocated assignments for which they were not adequately trained, skilled and equipped (VWM, 2018). This reflects a wider training gap in the Western Cape. As Table 7 shows, only three local municipalities in the Western Cape have staff with

formal training in dealing with wildfires, with the remainder either self-trained or informally trained, although GRDM firefighters based in George, Hessequa and Kannaland have received training[6].

Table 7: Number of fire and rescue personnel with training in wildfire suppression.

	Number of personnel trained in wildfire suppression	
	Municipal	**District**
Bitou	None. Self-trained	
George*		44
Hessequa*		4
Kannaland*		4
Knysna	3 formally trained 25 informally trained	
Mossel Bay	44	
Oudtshoorn	4	

* Data for George and Hessequa was not accessible

** The Garden Route District Municipality has the official mandate to perform all fire services duties in Kannaland

- Gaps in prevailing systems

Fire and rescue services and disaster management at the district and municipal level could and did draw on knowledge, relationships and experience gained responding during previous incidents, but there was a reliance on relationships between people rather than systems. This is a challenge throughout the Western Cape. Very little is formalised, and institutional memory is relatively limited. This is also a challenge in municipalities more broadly, particularly in the context of frequent political changes.

There was also poor integration of emergency and municipal compliance systems, making it difficult to reconcile spending after the fact. Supply chain and procurement processes were also inadequately agile to meet the immediacies created by this disaster, sometimes forcing officials to by-pass processes in order to get things done.

- Inadequate data collection and analysis

Finally, the research identifies a need for more data collection analysis. Accurate and timely information is critical to support optimal decision-making, but there was limited data collection or analysis early in the response. This prevented, for example, a clear assessment of the movement and size of the fire, which is critical for informed and strategic decision-making.

The research also identifies challenges with respect to the provision of humanitarian assistance. As with the initial response, there were no plans in place to record and distribute donations or to guide government's engagement with NGOs.

- Inadequate facilities and resources to manage large-scale humanitarian relief operations

The volume of donations rapidly overwhelmed local capacities and systems, and there was no donation management system to log the source and nature of the items nor data collection on needs or distribution of donations - although systems were established as the incident progressed.

[6] Kannaland Municipality has no municipal firefighters and relies on GRDM personnel based in Riversdale.

- Poor data collection and sharing

As with the fire operation, there was inadequate data collection and sharing. This prevented the creation of a master beneficiary list, and in turn, a master distribution list, hampering the rationalisation of resources and resulting in duplication and concerns regarding accountability and equity concerns.

- Challenges in accepting financial donations

Accepting the money created procedural headaches and proved administratively challenging, suggesting a need for alternative arrangements. One option could be to establish agreements with humanitarian NGOs such as the South African Red Cross Society (SARCS), that would allow them to accept, administer and disburse donations on the behalf of government.

Learning from the disaster: Strengthening humanitarian response in the Western Cape

Recognising the challenges experienced in June 2017, the Western Cape's Department of Social Development (WCDSD) is developing a social relief management protocol to guide the Department's involvement in humanitarian responses. This establishes the WCDSD's role and responsibilities, provides guidance on donation management and identifies critical stakeholders who can help to support people affected by disasters. The Garden Route District Municipality (GRDM) is developing its own protocol, in collaboration with the WCDSD and other stakeholders, which also establishes roles and responsibilities and guidelines for the strategic deployment of resources.

Establishing such guidelines should facilitate more responsive and efficient action during future disaster events, and could provide a useful model for developing similar frameworks elsewhere in the South Africa.

Lessons: Strengthening response capacity

The essential lesson is that neither government, other agencies nor the public were adequately prepared for an incident on the scale of the Knysna fires, particularly at the local level. Given anticipated increases in the frequency of large wildfires in the future, preparing for large-scale, complex and multi-stakeholder events is essential.

This research identifies a need for:

- training and equipping people to better deal with complex events, particularly at the district and local scale;
- evacuation planning and communication strategies;
- planning to facilitate inter-governmental and inter-agency cooperation and resource mobilisation and make institutions more resilient;
- greater strategic leadership in both fire operations and civilian responses; and
- strengthened data collection and analysis to inform decision-making.

A good starting point would be to strengthen response planning. It is critical to develop evacuation plans, and to engage members of the public to create community-specific strategies, along with event thresholds that should trigger evacuations. Developing these plans could be included in efforts to promote more fire-ready communities. Mutual Aid Agreements between municipalities and plans and instruments to guide inter-agency and inter-departmental resource-sharing would facilitate more rapid and efficient action. Another is to ensure that all firefighting resources are properly equipped and trained to fight wildfires. As noted earlier, the insurance industry can assist in building local firefighting capacities through platforms such as Santam's Partnership for Risk and Resilience (P4RR) initiative.

Turning to the humanitarian response, this research highlights:

- the municipality's limited resources, facilities and expertise to manage large-scale relief operations;
- the need for standardisation with respect to beneficiary criteria and standards of relief and donation management systems;
- the importance of data collection and standardisation; and
- mechanisms to ensure information-sharing and alignment of relief activities across organisations.

The multiplicity of role-players involved in the humanitarian response, the flood of donations, and inadequate systems for managing these were key challenges, suggesting that the WCDSD and disaster management agencies need to identify and engage with NGOs involved in providing humanitarian assistance in the GRDM to define roles and responsibilities and minimum standards of relief during disasters. The guidelines being developed by both the WCDSD and the GRDM provide an opportunity and framework for engaging with a broader suite of NGOs. Given the lack of capacity in local government to cope with large-scale relief operations in many parts of South Africa, the findings suggest that local governments should consider alternative relief models that tap the expertise and capacity of NGOs. It is important that all NGOs are thoroughly vetted and that municipalities engage with and monitor NGOs on an ongoing basis to ensure fairness and the integrity of relief provision.

10. CRISIS COMMUNICATION DURING THE KNYSNA FIRES

Communication represented a critical challenge in all aspects of the response. Communication between the authorities and members of the public was sometimes poor, and as noted already, social media introduced an additional layer of complexity. Infrastructural failures, and the sheer volume of information and the speed with which the information changed, made communication more difficult. Unfortunately, a coherent media and communications strategy only emerged as the incident developed. Communication gaps were most evident in three areas:

- Evacuations

Members of the public frequently did not receive evacuation orders or instructions, or received information via friends and family members rather than official channels. Where people did receive orders, these did not always include essential information about what was happening or where to go. This created confusion; there were reports of people evacuating into the path of the fire, and then needing to re-evacuate (Edwards *et al.*, 2017, VWM, 2018).

- Requests for volunteers

There was no clear communication with members of the public regarding the need for volunteers, in the absence of which people self-dispatched. Although volunteers played an important role in the response, many of the volunteers lacked the appropriate training and were often not needed. Clear communication of needs early on during the incident would have made things easier.

- Requests for donations

Initially, there was also insufficient guidance provided to members of the public with respect to what donations were needed. In the absence of a communication strategy, many people donated inappropriate or unnecessary items. This was compounded by the absence of a donation inventory system, which prevented real-time analysis of gaps and a clear idea of the items needed and where. Ultimately, far more was donated than was needed, creating storage challenges and the problem of what to do with surplus items.

This underscores the importance of timely, proactive and clear communication to optimise and harness the goodwill generated during these kinds of incidents. Knysna Municipality's communication team made significant progress over the course of the incident, using a range of different media, and improving the targeting and quality of information over time. This included using contact details from the Municipality's data on rate-payers to SMS evacuation orders to specific areas.

Key point:

Communication between the authorities and the public was sometimes challenging. Difficulties associated with the event, particularly self-dispatching and donations, were in large part due to this communication gap and might have been avoided. Early, clear and ongoing communication is essential not only to provide information, but also to more effectively direct and harness the public's desire to help. Training municipal communications teams in crisis communication for comparable events would help strengthen their capacity to engage effectively with the public. Strengthening the ICS communication function would also facilitate more effective communication.

10.1 Social media – A double edged sword

Although social media helped to keep people informed and connected, there were challenges. Many of those on the frontline, particularly volunteers, used WhatsApp Messenger to communicate with one another, as did members of the public. Both Knysna's and the GRDM's communication teams used social media as an information source and to disseminate information. Facebook was another important source of information. However, social media also added a further layer of complexity. In addition to misinformation, official communication was confusing initially, as the status quo was changing constantly, and posts did not include times; this made it difficult to determine which information was most up to date.

This research suggests that the authorities have yet to really harness the power of social media and are behind the curve compared to prominent influencers. However, social media is an increasingly central dynamic in emergencies, in South Africa and internationally. It is therefore important that authorities proactively engage social media platforms, both because they represent a powerful tool and because

they need to influence the narrative to counter its more negative aspects, such as misinformation. Analysis of social media use during the Knysna Fires provides insight into how authorities can engage more prominently.

Key point:

Social media is becoming an increasingly important dynamic in disaster response; one that the authorities must engage with in order to remain current. This is particularly important given the potential for both intentional and unintentional misinformation.

10.2 Understanding how people use social media – A Facebook example

Recent research (Lendrum, 2019) provides insight into ways of better harnessing the potential of social media during disaster incidents. The research examined how people engaged on one influential Facebook page – the *Knysna Fires 7th of June* – during the incident. By late 2018, the group had received 49 080 likes and 52 105 followers and it was an important source of information both during and after the incident, providing a platform to mobilise resources to assist families affected by the fires.

The study extracted 8 770 posts for the period between the 7th and 11th June, from which 682 (one in every ten) were examined in-depth. The study broke the posts into two phases: the first for the period between the 7th-11th of June (348 posts) and the second for that between the 12th June-12th July 2017 (334 posts). The messages posted on the group were sorted into four main categories:

- information-related;
- action-related;
- emotion-related; and
- opinion-related posts.

The messages under each category were also sorted into five format types: content consisting only of text; only a photo; or only a video; text with a photo; and text with a video.

The findings show that people responded more to information-related posts, as reflected in the number of Comments, Likes and Shares (Table 8). The patterns are similar for both Phase 1 and 2, but in the recovery phase there was a slight shift towards posts coordinating action.

Table 8: The popularity of different types of messages.

Description	Phase 1	Phase 2
Most commented message: Sharing information	169 Comments	182 Comments
Most reacted to message: Sharing information	1 600 Likes	3 600 Likes
Most shared message: Sharing information	1 400 Shares	
Most shared message: Coordinating action		670 Shares
Average times a message was shared	13	13
Average comments in response to a message	4	3

Average reactions per message	20	43

Source: Lendrum, 2019

The findings also show that although most posts were text only, people responded more to content, including a visual component, with popularity determined by the number of comments and shares per message (Figure 17). In Phase 1, most messages (84%) were text, but those receiving the most comments and shares were either videos (42%) or photographs (38%). In Phase 2 posts with a visual component remained most popular, but particularly photographs accompanied by text (43%), or photos alone (38%). The content, however, suggests that this was because people had questions about the photos and videos without a text explanation.

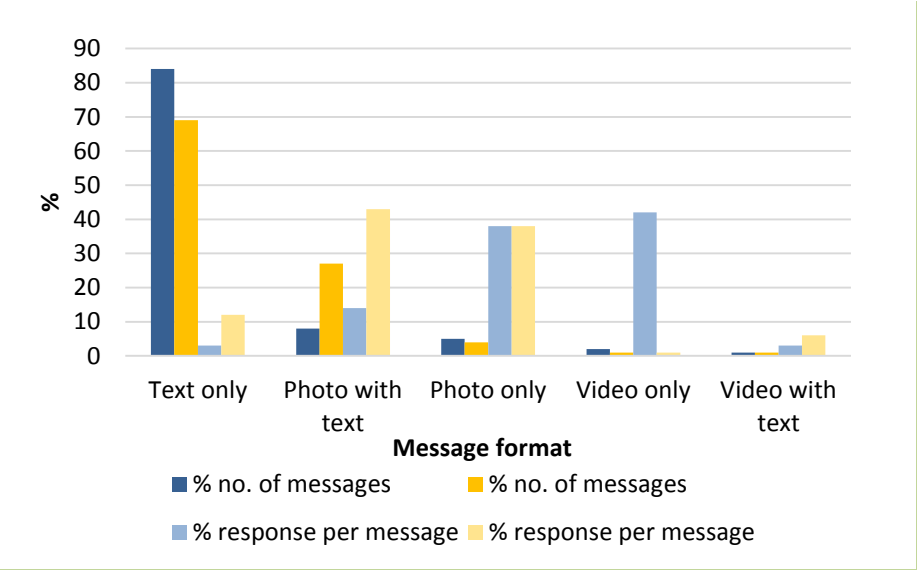

Figure 17: The popularity of different message formats. Phase 1 is shown by the blue bars, and Phase 2 by the yellow bars. Although text messages were the most common, people responded most to messages comprising a visual component. Source: Lendrum, 2019

This research suggests that the content and format of social media posts, on Facebook at least, can be targeted and made more useful and appealing for users. This is important where social media is used as a tool to receive and disseminate information and suggests ways of improving the reach and effectiveness of social media posts.

Key point:

Social media provides a useful tool for sharing information during disasters. In Knysna, Facebook users predominantly sought information and responded primarily to posts with a visual element. This suggests opportunities to target package information to reach a wider audience.

10.3 Twitter as a tool during and following the fires

Other research examined how Twitter was used during the event, again with a view to identifying lessons for improving crisis communication (Schoonwinkel and Cornelissen, 2019). That research examined 713 000 Tweets sent during and following the event, extracted using key words, from Twitter's global record for the period between the 6th and 14th of June 2017. The analysis looked at the

key role-players and influencers and the types of communities or conversations around topics. It shows that non-governmental role-players were most prominent in the Twittersphere.

Figure 18 shows the primary Twitter accounts discussing the Knysna Fires. The top right shows that users who often tweeted and were retweeted, indicating accounts that were critical sources of information. The top left quadrant contains users that tended to retweet other users' tweets without gaining much traction, while the bottom right quadrant contains users who did not tweet frequently but retweeted a great deal.

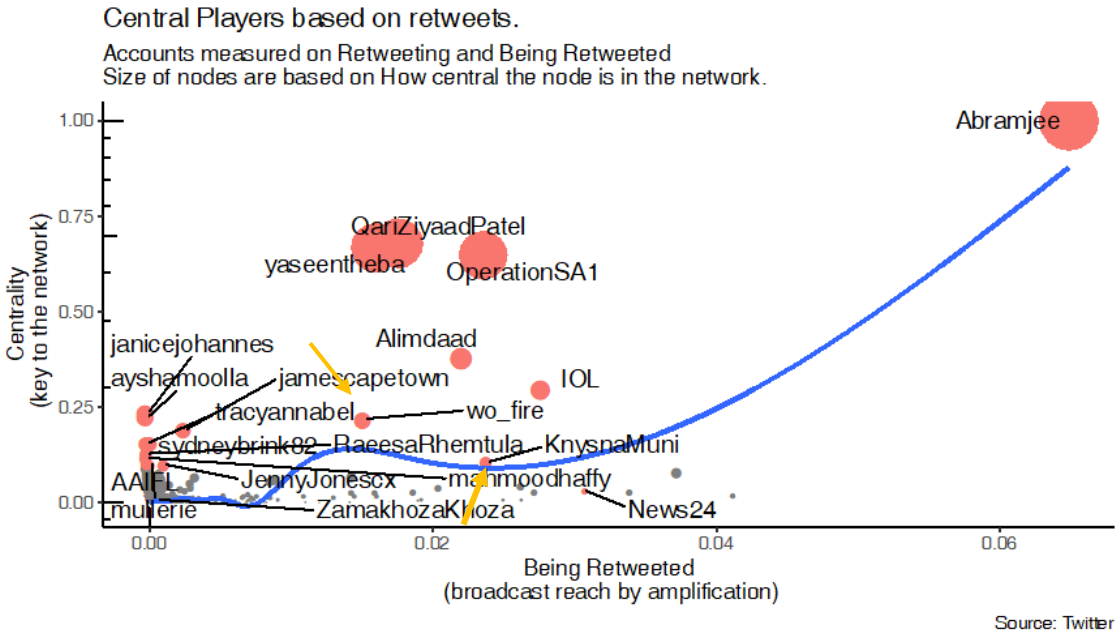

Figure 18: The prominent Twitter accounts discussing the Knysna Fires. An account's 'centrality' is determined by the number of tweets that a user posts relative to the number of tweets mentioning their account. Source: Schoonwinkel and Cornelisson, 2019.

There were several active accounts, including individuals and organisations involved in relief efforts, such as Al Imdaad Foundation, news media such as News24 and IOL, role-players such as WoF and members of the public, as well as Knysna Municipality's Twitter account. However, by far the most prominent was journalist Yusuf Abramjee's account, which also represented the humanitarian assistance organisation Al Imdaad Foundation. Al Imdaad Foundation was additionally represented by Qari Ziyaad Patel and had its own account (Figure 18). WoF and Knysna Municipality appear (the yellow arrows) but are much less visible, probably because they have a smaller audience and were not promoted by larger accounts.

Figure 19 identifies 'communities' discussing the incident, and shows once more that the independent key players, such as Abramjee, QariZiyaadPatel and OperationSA, were much more central than the official channels. The key players amplified the call for donations and relief efforts regarding the disaster by personally contributing to the discussion. Unsurprisingly, discussions revolved primarily around relief efforts, although the fires and evacuations were also discussed. The discussion around the

evacuations revolved mostly around asking people to help with evacuations, or news regarding the evacuations.

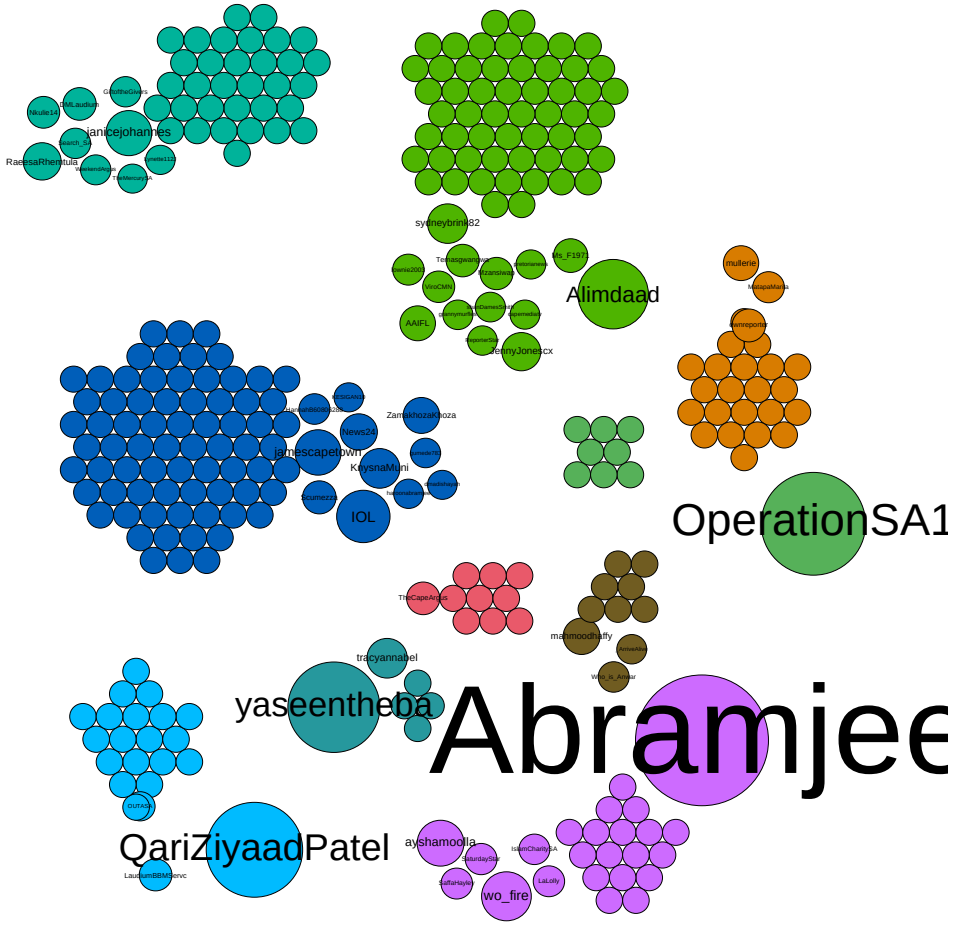

Figure 19: The plot identifies 'communities' or parties that predominantly interact with each other and shows the largest and most relevant communities discussing the event. The colours show the different communities, while the size of the circles shows an account's centrality or influence over communities.

Overall, the analysis shows that NGOs, and specifically those concerned with relief, had a far higher profile on Twitter than official sources. Knysna Municipality was represented, as was WoF, but their tweets did not have the same visibility or traction.

The emphasis on relief was largely due to the activity of a handful of very active, influential accounts that dominated the conversations. These amplifiers have many followers, and by retweeting tweets were able to enlarge the discussion around this issue. By doing so, they undoubtedly played an important role in mobilising the public to donate, but as discussed earlier, this was not entirely beneficial to the response. This suggests that authorities need to communicate clearly and as early as possible regarding the need for assistance. These influential users could help to get the message out and to moderate public action.

Key points:

The analysis suggests that the authorities have yet to harness the power of social media and are behind the curve compared to prominent influencers. Tweets on the Knysna fires focused predominantly on humanitarian efforts because a small number of influential relief-oriented accounts shaped the conversation. Although the Knysna Municipality and WoF were both active, they did not have the same visibility and traction, primarily owing to their smaller number of followers.

The findings suggest that official sources can increase their visibility by proactively identifying and engaging these 'influencers' in their preparation and planning, and obtaining their assistance in amplifying warnings and information during and following disasters.

Lessons: Improving communication

The research highlights the importance of effective communication during disasters. It is critical that the authorities communicate with members of the public effectively, as consistently and as early as possible. This is not only essential to keep them informed and safer, but also to ensure that the public is aware of their needs and requirements, and how they can best help.

Social media platforms represent a powerful communication tool, but the authorities have yet to harness them optimally. This is necessary not only because these platforms represent a powerful tool to engage the public but also because the authorities need to counter negative aspects, such as misinformation. Such engagement need not be confined to crisis communication during incidents; social media also provides a medium to interface with the public during and after events, when it provides opportunities to educate, organise and keep people informed.

It is interesting that Facebook and Twitter appear to have played quite different roles during the incident. Both were used to mobilise resources, but the 7th June Facebook page also shared information, while Twitter influencers focused on donations and relief. This may because the Facebook Page was established and curated by locals, while Twitter users were mostly spectators and remote from the incident. This suggests that depending on the prominent users, social media platforms could be used to target different audiences and for different ends.

The analysis also provides some insight into how the authorities can boost their social media presence and disseminate information more effectively – although these need to be explored further. One way is to making posts more visual. The other is to pre-emptively identify and elicit the assistance of prominent influencers to improve the visibility of messages and official accounts. As with other aspects of crisis communication, it is critical that official communications teams engage as early as possible to proactively shape the conversation before it gets away from them.

11. POST-FIRE RECOVERY EFFORTS

Recovery efforts were centred on the Garden Route Rebuild Initiative (GRRI). The GRRI sought to optimise efforts to "Build Back Better". Given the scale of the damage to housing, infrastructure and the environment, the extensive humanitarian support needs, and the large number of role-players gearing up to respond, the GRRI was envisaged as the anchor for a comprehensive, integrated reconstruction and recovery effort for the Garden Route.

The initiative aimed to create a multi-disciplinary, inter-governmental and multi-sectoral platform to align and maximise recovery and rehabilitation efforts. It brought together national, provincial and local government, state-owned enterprises, community members, civil society organisations and the private sector in seven sector-based working groups to design and implement recovery projects. The GRRI had six workstreams:

- Humanitarian assistance;
- Reconstruction;
- Infrastructure rehabilitation;
- Environmental management;
- Business support; and
- Skills development.

The initiative represented a good example of inter-governmental cooperation. It also brought together role-players that would not have usually engaged with one another, which built relationships between stakeholders. However, as discussed in greater detail in RADAR's technical report, weaknesses included additional demands placed on governmental stakeholders and inadequate engagement with municipal partners.[7] However, arguably, the greatest obstacle to 'Building Back Better' was obtaining funding for recovery efforts, along with slow disbursement of allocated funds.

This obstacle was most prominently illustrated in the Environmental Management Workstream. Environmentalists realised early on that there was a pressing need to stabilise slopes denuded by the fires to prevent landslides and erosion and to remove alien vegetation, which if not effectively controlled would increase fuel loads and suppress the recovery of the biodiversity and natural ecosystems in the invaded areas. Building on donations from the public, the GRDM provided R700 000 for slope stabilisation efforts, but the National Disaster Management Centre was approached to provide an additional R37 million to finance ambitious programmes to prevent the regeneration of alien plant species. The National Treasury ultimately committed R54 million for environmental work through its drought relief fund, but only in November 2018 – 16 months after incident.

The absence of funding prevented implementation of the envisaged projects. Knysna Municipality independently obtained funding from the Department of Environmental Affairs and Development Planning (DEADP), and by late 2018 had cleared approximately 600 hectares of municipal land, although most burned land was not cleared. Most stakeholders feel that the absence of funding will exponentially increase fuel loads in areas affected, with many commenting that fire risk is higher now

[7] Pharoah, R., Fortune, G., Lendrum, D., Schoonwinkel, P. and Cornellisen, L. (2019) *Feeling the Heat: Post event review of the June 2017 Knysna Fires*. Research Alliance for Disaster and Risk Reduction, Stellenbosch University.

than before the fires. In addition, clearing now will be considerably more expensive, as vegetation is older and better established. Funds also needed to be spent by the end of the 2018/19 financial year, leaving very little time for planning and resourcing the rehabilitation efforts.

Rapid deployment of post-fire, anti-erosion measures

Various actions were taken to limit erosion and sediment loss on steep areas, upslope of infrastructure such as roads, houses and pump stations, particularly where there have been severe fires. In total, 358 fibre mats and 5 826 fibre rolls were installed on these high-risk slopes. These are the kinds of responses that should become the norm.

Two positive outcomes of stabilising the steep slopes, and allowing the vegetation to re-establish itself rapidly, were: (a) that it minimised localised mudslides, thereby preventing homes and infrastructure being flooded in the weeks and months after the fire; and (b) it also limited the amount of silt from the burnt area that would be deposited in the environmentally sensitive Knysna Lagoon.

Unfortunately, no formal and comprehensive record of the re-vegetation process is being kept, missing an excellent opportunity to learn from what worked, what did not, and what to improve in the future. The funding of such monitoring should become part of the rehabilitation measures, including clarifying who should be doing such monitoring.

The use of donations to fund erosion control measures created unanticipated tensions. This may have been due to inadequate communication with donors and members of the public regarding what was needed to facilitate recovery efforts, and how money was to be used. Some members of the public and NGOs involved in recovery efforts were unhappy as they anticipated that money would be earmarked for humanitarian efforts.

Current mechanisms for releasing emergency funding also hampered other aspects of recovery in the Garden Route. Despite the declaration of disasters in Knysna and Bitou Municipality, governmental role-players struggled to secure emergency funding. The GRDM's Environmental Health Department did receive R2 million from the Western Cape's Department of Local Government to safely remove and dispose of remove rubble containing asbestos, but this was funded through normal procurement processes, and funding was only released in April 2018 – almost one year after the incident.

Lessons: Resourcing recovery

Despite successes, the GRRI surfaced several challenges undermining recovery. Unresponsive funding mechanisms represent a core blockage in the recovery process, preventing time-critical activities that will speed recovery and reduce risk. Lengthy procurement procedures also frustrate efforts to rehabilitate infrastructure, for instance. The experience of the environmental workstream and the asbestos removal project suggest an urgent need for more responsive, quick-release funding mechanisms (i.e. within days or weeks) that do not require the funds to be spent within a given financial year. This research also highlights the importance of transparency and buy-in.

12. COUNTING THE COST

The fires cost government and the insurance and forestry industries a little over R3 billion in direct costs (Table 9), but these figures under-estimate the true cost of the incident. The impact on those who lost homes, businesses and jobs was immense, but this is impossible to quantify as the information is not publicly available. Data on the losses sustained by parastatals was also unavailable. In addition, there are indirect costs that are difficult to measure. The private sector sustained the heaviest losses.

Table 9: Summary table of the direct losses for the fire disaster in June 2017.

Sector	Description	Area affected	Damage cost (ZAR)
Agriculture	Damage to farms	Bitou	9 268 994
		Knysna	16 504 247
	WCDoA expenses	Cost for emergency relief (fodder)	935 783
	Agriculture subtotal		**26 709 023**
Education	Infrastructure damage	Knysna - Knysna High Hostel and Elandskraal Creche	21 000 000
	Education subtotal		**21 000 000**
Environmental	Environmental damage and mitigation projects	Knysna	54 536 705
	Environmental subtotal		**54 536 705**
Public Works	Asbestos removal	Knysna	64 362 400
	Public Works subtotal		**64 362 400**
Human Settlements	Housing	Bitou - Kranshoek (3 units)	127 295
		Knysna - White Location (45 units)	5 399 100
	Housing subtotal		**5 526 395**
Municipal Infrastructure	Water & Sewer	Bitou	15 156 450
		Knysna - damages	5 646 331
		Knysna - cost of emergency repairs	4 060 000
		Water & Sewer subtotal	24 862 781
	Electricity	Bitou	1 700 000
		Knysna - damages	5 769 527
		Knysna - cost of emergency repairs	6 339 073
		Electricity subtotal	13 808 600
	Municipal Infrastructure subtotal		**38 671 381**
Forestry Industry	Timber loss		625 960 000
	Forestry Industry subtotal		**625 960 000**
Insurance Industry	Claims		2 200 000 000
	Insurance Industry subtotal		**2 200 000 000**
Total damage			**3 036 765 904**

As shown in Figure 20, the bulk of the costs (72%) were sustained by the insurance industry, with the event costing insurers approximately R2.2 billion in claims. The forestry industry was next, sustaining a little under R636 million in timber losses (21%). The remaining losses were incurred by government departments, with the Western Cape's Department of Transport and Public Works, DEADP and Municipalities bearing the heaviest losses. The costs incurred by Provincial and Municipal government amounted to just under R211 million.

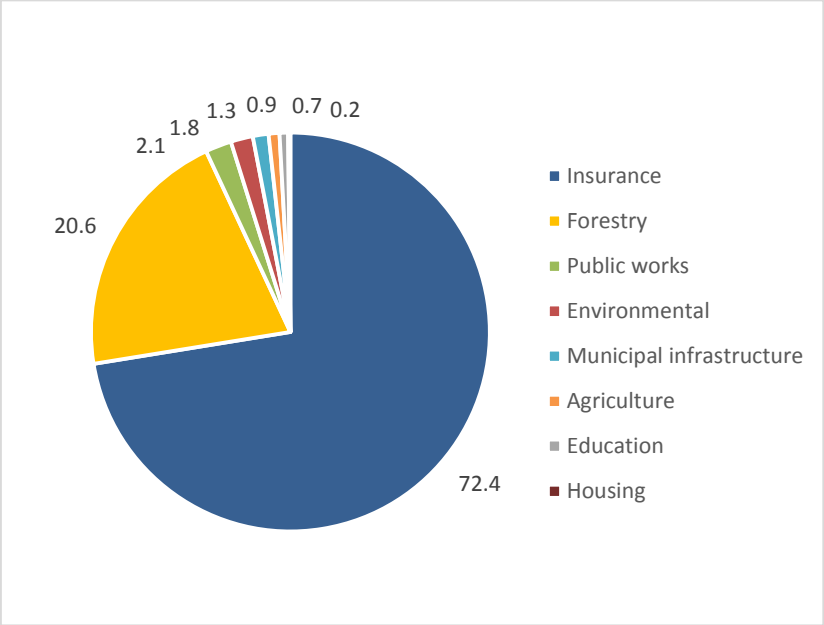

Figure 20: The proportion of damage costs incurred by government and the forestry and insurance industries. The bulk of these costs were sustained by Forestry. The remainder were incurred by government departments, particularly the Western Cape's Department of Transport and Public Works, DEADP and Municipalities.

Timber losses (Figure 21) and firefighting cost the forestry sector R626 million. A further R21.6 million was spent on recovery, including measures to preserve the 728 000 m^3 of felled timber and minimise the impact on the market of a short-term over-supply following the fires. The costs constitute a serious blow to the forestry industry in the Southern Cape. Some believe that regular fires are threatening the sustainability of the sector, particularly where incidents occur close to one another, such as with the 2018 fires in the Garden Route (Stehle, 2018). The impacts will be felt throughout the region, as companies are forced to downscale, with knock-on effects for saw mills and the furniture industry.

Figure 21: A pine plantation near the junction of the Rheenendal Road and N2 Highway showing damage varying from almost complete combustion (left) to limited damage (right) (Image taken by G. Forsyth, CSIR).

This research also suggests that the fires had a profound impact on Knysna's residents and economy. It is estimated that approximately 2 000 formal sector jobs were lost, with an unknown number in the informal sector. Over 900 houses were destroyed or rendered uninhabitable. Many believe that Knysna is still feeling the effects of the combined personal and business impacts. People have less disposable income to spend on goods and services, and some restaurants and small businesses report a noticeable reduction in customers.

Challenges to restoring infrastructure following disasters

The research suggests that prevailing emergency and recovery funding processes may inadvertently undermine the principle of 'building back better'. Provincial and municipal departments submitting claims for emergency and recovery funding following a disaster must specify whether the damaged infrastructure has already been repaired, in which case it is usually excluded from allocations. The problem is that this penalises departments who undertake temporary repairs. For example, Knysna Municipality's Electrical and Energy Services Department spent R6.4 million on emergency repairs to restore essential electrical reticulation and infrastructure immediately following the fires. Some of these repairs were known to be temporary because they used second-hand parts nearing the end of their lifespan. However, because the electrical systems were functioning when the damage was assessed, they were not awarded the funding needed to make permanent repairs, and engineers expect to see the aging parts failing in the near future.

Lessons: The cost of fires

The economic cost of the Knysna fires was enormous. Even though official figures probably under-represent the cost of the fires, the losses sustained by government and the insurance and forestry industries highlight the destructiveness of large fires - and the value of investing in risk reduction. The return on money spent on efforts to prevent destructive wildfires and mitigate their impact is exponential compared to the costs of not acting. The losses sustained by insurance companies, in particular, underscore the benefits that the insurance industry could gain by being more pro-active, particularly given anticipated increases in the frequency and severity of fires due to global warming.

13. THE LONG ROAD TO RECOVERY

Knysna has yet to 'bounce back'. A large proportion of dwellings in Knysna had not been rebuilt or were not being rebuilt by 1st January 2019, almost two years after the fire (Figure 22). Figure 23 is a zoomed-in image of an area affected by the fires and provides an illustrative snapshot of the situation in some suburbs. Some of these houses may still be rebuilt in the future, but 16 months after the fire many stands appear to be vacant or the houses remained in ruins. The research suggests that in some cases, homeowners have been unable to rebuild, or did not want to, preferring to move somewhere else.

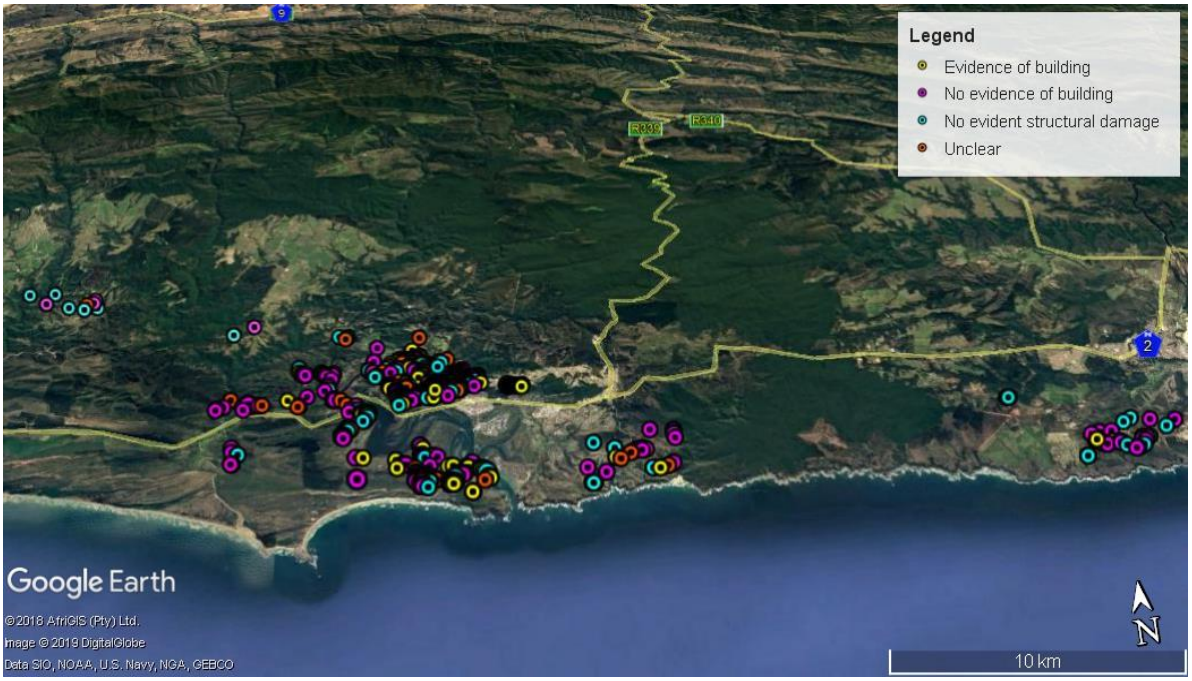

Figure 22: Rebuilding status of houses damaged or destroyed by the 2017 fires (1 January 2019). The pink markers show dwellings that (in aerial imagery) did not show evidence of being rebuilt.

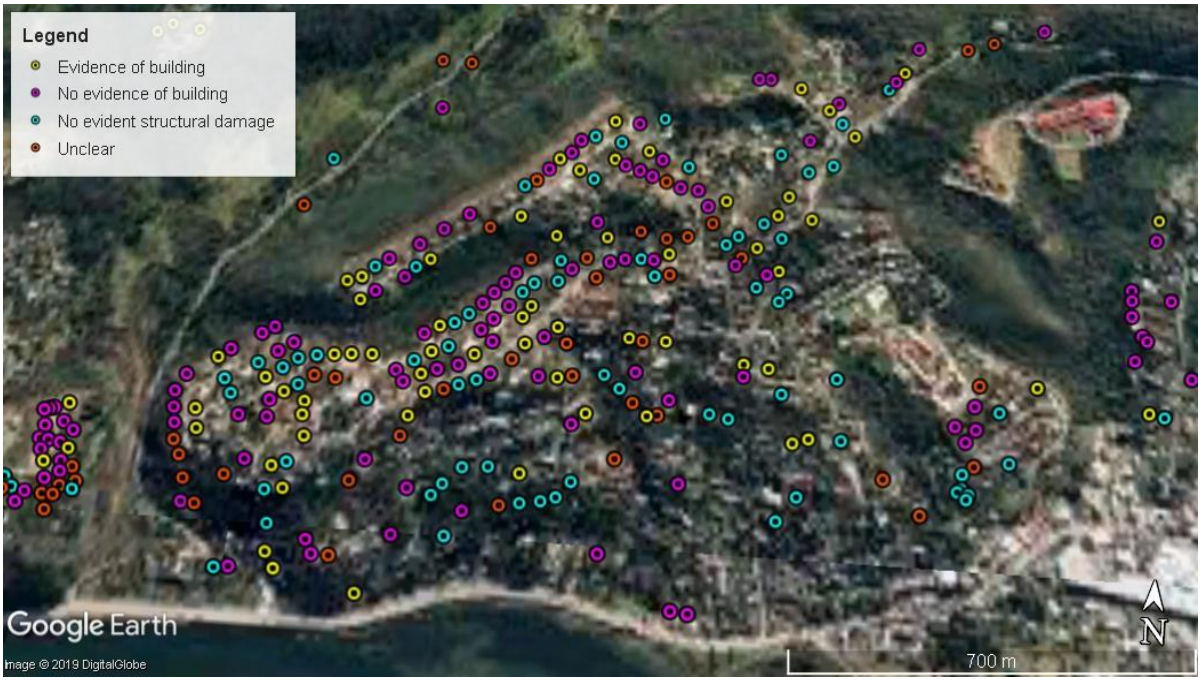

Figure 23: Zoom-in snapshot of an area affected by the fires (1 January 2019). Yellow markers show dwellings that have been rebuilt or show evidence of rebuilding.

13.1 Insurance and the 'missing middle'

Many of the homes and businesses damaged or destroyed by the Knysna fire were not insured or were under-insured, which means that people are struggling to rebuild. Data collected by Knysna Municipality following the fires suggests that most households (77%) who lost homes, or whose houses were uninhabitable, were insured (Figure 24) – although the statistics do not reflect how many were appropriately insured. Other estimates place the number of uninsured much higher, with some NGOs estimating that more than half of those affected did not have insurance. Knysna Municipality's data also indicates that of the 134 businesses affected, one third (33.3%) of properties and more than half (52.7%) of the contents were not insured.

The findings highlight a 'missing-middle' of people who have been left in a precarious position by the fires. Many of these households could not afford insurance and lost everything in the fires. A key challenge is understanding how to support these households who currently fall through gaps in existing social safety nets. The insurance industry could perhaps play a role by exploring insurance options that are more affordable and tailored to the needs of pensioners and others in this group.

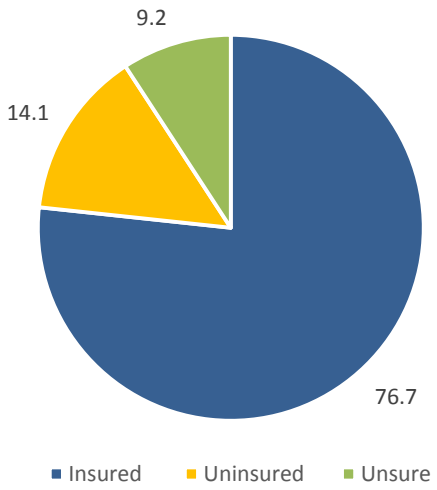

Figure 24: Insurance levels amongst households whose homes were damaged or destroyed. Source: Knysna Municipality: Fire Disaster Damage Assessment

Lessons: Supporting the 'Missing Middle'

The fires had a profound impact on Knysna's residents and economy, and recovery is happening slowly. Many of the homes and businesses damaged or destroyed were not insured or were under-insured, and people are struggling to rebuild. The findings highlight a 'missing-middle' of people who have been left in a precarious position by the fires. A key challenge lies in knowing how to support these households, who currently fall through gaps in existing social safety nets. The insurance industry could play a role by exploring insurance options that are more affordable and tailored to the needs of pensioners and others in this group.

14. RECOMMENDATIONS

Wildfires are both necessary and expected in South African ecosystems, and with global environmental change, are likely to become more frequent. The conditions conducive to uncontrollable 'mega-fires' also are likely to occur more frequently. Population growth and the expansion of the WUI are also increasing both the communities' exposure to wildfires and the likelihood of human activities starting fires. Despite this, it is possible to reduce both reduce the risk of destructive fires and their impact on the exposed communities. However, we first must recognise that our current fragmented approaches to fire management, which involve a range of organisations and actors, are not effective, especially in a changing fire environment. We also need to strengthen our ability to respond to fires through capacity-building, planning and preparation.

Integrated Fire Management (IFM) incorporated different fire management activities in a strategic framework to reduce the overall impact of unwanted fire damage and promote the beneficial use of

fire. A clear and shared understanding of IFM is essential to successfully engaging all stakeholders in fire risk management (FynbosFire 2016). IFM should inform all activities aimed at reducing the risk of damaging fires and improving readiness, response and recovery planning. The recommendations that follow need to be implemented within the context of IFM.

RECOMMENDATIONS FOR GOVERNMENT

REDUCING THE RISK AND IMPACT OF WILDFIRES:

- The authorities must commission research to assess the risk of damaging wildfires to vulnerable communities along the WUI in settlements across South Africa.
- Municipalities should ensure that they manage fuel loads on municipal land along the WUI. They should protect vulnerable infrastructure through zonation or restrictions and fire-proofing of structures.
- Municipalities should consider introducing by-lays to promote fire risk reduction, and explore measures to enforce existing legislation. They should also incorporate fire-risk reduction into the planning of new developments.
- Municipalities should work with FPAs to effectively educate the public so they have a far better understanding of fire risks and what they can do to reduce them. They should find ways of maintaining awareness during wildfire-free periods. Education activities should include people living in informal settlements along the WUI. FPAs must be remunerated for their efforts.
- Municipal fire and rescue services should take pre-emptive action to deal with naturally occurring fires if they are within inhabited landscapes, regardless of whether they present an imminent threat. Provincial government should assist with additional training and resources where needed.
- District Municipalities, in collaboration with FPAs, should develop and adhere to standard operating procedures for remote-area and lightning-strike ignition monitoring and suppression.

REDUCING FUEL LOADS:

- The National Disaster Management Centre (NDMC), DEADP and other relevant role-players should explore ways of addressing disincentives that favour risk aversion and hinder adaptive management both within and between organisations.
- Municipalities must support FPAs to develop collaborative local networks among organisations working on fire-related issues to build trust, an understanding of how to reduce fire risk and how to turn this understanding into action.

ENHANCE THE FIRE DANGER INDEX COMPONENT OF THE NATIONAL FIRE DANGER RATING SYSTEM:

- The NDMC together with South African Weather Service should consider including the Canadian FWI in the National Fire Danger Rating System in addition to the LFDI currently in use.
- The NDMC together with South African Weather Service should consider including the Canadian FWI in the National Fire Danger Rating System in addition to the LFDI currently in use.

STRENGTHEN PLANNING AT THE MUNICIPAL AND DISTRICT LEVEL:

- Provincial Disaster Management Centres should train and equip resources to better deal with complex, multi-stakeholder responses.

- Municipal disaster management and/or the fire and rescue services must give top priority to the development of evacuation plans. These should incorporate responses under different conditions and provide for the simultaneous loss of electricity and ICT infrastructure.
- Municipal disaster management centres should work with the fire and rescue services and municipal managers to identify and include critical role-players to be included in disaster planning. Scenario exercises and training will help identify critical role-players, establish roles and responsibilities and build relationships. Planning activities should include both civilian role-players and emergency responders.
- Municipal disaster management centres and/or the fire and rescue services should establish agreements to facilitate inter-governmental cooperation and resource mobilisation. The National Incident Management System (NIMS), which promotes the Multi-Stakeholder Coordination System, provides a framework for strengthening collective action at this level.
- Municipal disaster management centres and/or the fire and rescue services should also establish Memorandums of Understanding with agencies such as SANParks and CapeNature to define their roles and responsibilities.
- Disaster management and the fire services should engage with municipalities to explore how to better integrate municipal funding and oversight mechanisms. Municipalities should explore the potential for expediting extraordinary procurement and funding during emergencies.

STRENGTHEN CAPACITY TO RESPOND TO WILDFIRES:

- The national disaster management centre must prioritise capacity-building in the fire and rescue services, particularly with respect to training and equipping municipal firefighters to respond to wildfires, particularly on the WUI.
- The WCDMC, and other provincial disaster management centres, should develop the logistical and institutional capacity to support the implementation of the ICS, especially for extended incidents. ICS training should also be considered for municipalities' senior management and communications teams.
- Municipal fire and rescue services must work with FPAs to ensure that communities become more self-sufficient and self-organised to be better prepared for wildfires. This should include providing guidance on defending properties, developing evacuation plans and identifying safe refuges when there is no way out.
- Municipal disaster management centres must ensure that communities have access to early warnings and are able to act on warnings. This should be linked to evacuation planning.
- Municipal planning departments and the relevant municipalities must ensure that towns, suburbs and developments have enough access routes for efficient access and egress, especially for emergency services. This must include roads to access natural vegetation in areas behind secure estates because walls and fences will not prevent fire from spotting into the estate or finding continuous fuels. Knysna Municipality must consider building an additional road to provide alternative routes into and out of Knysna if the N2 is closed.
- Municipalities must fire-proof critical infrastructure and ensure that sufficient water is available for firefighting, even in the event of fire damage.
- Municipalities, in collaboration with FPAs, should review policies relating to the use of back-burning during an incident. Approval by the incident commander should be granted based on the current and foreseen fire behaviour.
- Municipal fire services must strengthen coordinated information gathering and fire behaviour analysis capacities to improve situational awareness and intelligence in the incident management team. A person dedicated to documenting, in detail, the progress, behaviour of the fire and the responses must be present in the Situation Unit at the Incident Command Post.

STRENGTHEN HUMANITARIAN RELIEF MANAGEMENT:

- Municipal disaster management centres at both the district and local level must work with the WCDSD to identify and engage with prominent NGOs to define roles and responsibilities and minimum standards of relief during disasters. The guidelines being developed by both the WCDSD and the GRDM provide an opportunity and framework for engaging with a broader suite of NGOs.
- Identified NGOs need to be included in coordination structures to ensure information-sharing and alignment of activities. They should also be included in response planning and exercises.
- Municipalities also need to explore arrangements for accepting financial donations. One option could be to establish agreements with humanitarian NGOs such as the SARCS that would allow them to accept, administer and disburse donations on the behalf of government.

IMPROVING COMMUNICATION WITH THE PUBLIC:

- Municipalities must ensure that communication personnel receive training on crisis communication, and that communication units are adequately staffed and resourced.
- Communications teams must identify high-profile social media influencers and enlist their support in spreading messages and directing users to information sources.
- Communications teams should engage as early as possible to proactively shape the conversation.

PLAN POST-FIRE ENVIRONMENTAL RECOVERY AND REHABILITATION PROPERLY:

- DEADP, in collaboration with FPAs, must get all relevant stakeholders (officials, business and knowledgeable private individuals) around the table as soon as possible after an event to plan and prioritise control efforts and thereby optimise the use of resources.

ENABLE RESPONSIVE ACTION TO ADDRESS TIME-SENSITIVE REHABILITATION CONCERNS:

- The WCDMC must engage with the NDMC and Treasury to explore quick-release funding mechanisms to enable time-sensitive recovery activities immediately after a disaster.

DATA COLLECTION FOR RISK ASSESSMENT AND MONITORING TO INFORM RISK REDUCTION:

- All municipal impacts should be recorded, independently of funding processes. There should be uniformity across all municipalities and sectors for calculating and presenting damage costs. These should be actual costs and not estimates.
- The WCDMC should establish a standard impact reporting procedure for municipalities and government departments. This includes the standardisation of electronic formats, and clear designation of a focal point to consolidate information, as onerous reporting demands on technical personnel keep them from their core responsibilities.
- Impact reporting templates should include a description of damage and a spatial reference (i.e. GPS co-ordinates).
- Post-disaster assessment findings should be integrated into risk assessments as a measure of actual as opposed to possible impacts.

RECOMMENDATIONS FOR INSURANCE INDUSTRY

REDUCING THE RISK AND IMPACT OF WILDFIRES:

- The insurance industry can also assist in reducing fire risk by building the capacity of municipal fire services and FPAs to prevent and respond to wildfires.
- The insurance industry could also sponsor an annual WUI seminar to encourage sharing of experiences and the latest approaches and advancements in risk reduction and suppression.

REDUCING FUEL LOADS:

- Insurers should support prescribed burning by extending insurance cover for the execution of prescribed burns. Companies should work with fire protection associations and fire and rescue services to determine the details of these policies.
- The insurance industry should also support risk reduction by requiring policy-holders to undertake measures to reduce risk, such as reducing flammable materials in the HIZ and creating defensible spaces around homes. Outside of the WUI, this could include requiring that policy-holders join their local FPA.

ENABLE RESPONSIVE ACTION TO ADDRESS TIME-SENSITIVE REHABILITATION CONCERNS:

- The insurance industry could assist in the rapid mobilisation of resources by creating a Disaster Fund to assist in funding immediately-needed interventions in the interim.

CREATE INSURANCE PRODUCTS TO SUPPORT HOUSEHOLDS IN THE 'MISSING MIDDLE':

- The insurance industry should explore developing more affordable insurance products to support households in the 'missing middle', who may otherwise be unable to afford insurance.

RECOMMENDATIONS FOR COMMUNITIES

REDUCING THE RISK AND IMPACT OF WILDFIRES:

- Residents can reduce the risk to homes by addressing risk in the HIZ, creating defensible space around structures and managing or modifying vegetation to reduce fire intensity and spotting.
- Residents should join their local Fire Protection Association.
- Residents should participate in setting up FireWise communities.

CONTROLLING INVASIVE ALIEN PLANTS AFTER FIRES

- Residents and landowners should work together with FPAs to map the extent and densities of invasive alien plant regrowth accurately; this is fundamental to determining the amount and duration of funding required to control the massive regeneration of invading plant species after fires. DEADP must provide the necessary support.

INSURANCE COVER:

- Residents should check regularly that they are adequately insured for fire.

RECOMMENDATIONS FOR ALL STAKEHOLDERS

ADOPT A LEARNING APPROACH:

- It is often very difficult to get detailed information after fires on facts like who did what and when, what then happened and why. The real problem is that the opportunity for sharing the learning and for adapting is lost or, at the very least, delayed. Resolving this challenge is critical to inform a learning and adaptive approach to support more effective veldfire risk management.

15. CONCLUSIONS

When extreme weather, drought and ignitions combine, as they did in the Knysna fires, all fire protection measures can fail, and will do so in many cases. Nonetheless, prevention is critical to reducing the risk of severe and damaging fires. We can and must strengthen capacity to respond when fires occur, but we must prioritise prevention and preparedness. Without effective fire protection measures, human lives, livelihoods and assets will be exposed to far greater and, often, eminently avoidable fire hazards – particularly given expected global environmental change. In addition, the risks faced by those attempting to fight the fire or protect their properties are significantly increased because they are exposed to far greater fire hazards. The impacts on the resilience and recovery of the natural environments affected by these fires will also be significantly greater. The one beneficiary, so to speak, is the invading alien plants, which will multiply and create an even greater fire hazard if they are not dealt with promptly and effectively.

The costs of the Knysna fires to the town and its inhabitants illustrate the importance of implementing effective measures to reduce risk in the Garden Route and South Africa. The benefits of fuel reduction, from measures such as prescribed burning in rural areas outside the WUI, to ensuring that firewood is not stacked against the walls of a house and gutters are clear of litter, far outweigh the costs.

Everyone has a role to play in this and citizens need to realise their responsibilities and not place all the responsibility on fire management agencies. The insurance industry can play a critical role in supporting risk reduction, and rehabilitation and recovery.

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