

From Burning to Learning: Adaptive Governance to Wildfires in the North-West Province of South Africa

Dewald van Niekerk

*African Centre for Disaster Studies, North-West University, Potchefstroom Campus, Private
Bag X6001, Potchefstroom, North-West Province, 2520 South Africa
Telephone: +27 (0)18 299 1634, Fax: +27 (0)87 231 5590
E-mail: Dewald.VanNiekerk@nwu.ac.za*

KEYWORDS Veld Fires. Ecological Management. Disaster Risk Reduction. Risk Governance

ABSTRACTS Wild fires are a recurring natural hazard on the African continent. Although wildfires are necessary for ecological management and regeneration of certain species, the risk posed transcends into impacts on sustainable development and the protection of livelihoods. Better management of wildfires becomes necessary because changes within the environment are becoming more complex. Social and ecological systems are intertwined and the resulting “complex or mega-system” needs to be able to learn and adapt to change. Research over a two-year period in the North-West Province of South Africa considered the adaptation in management (systems), which took place between various role-players in multi-layered and polycentric institutions. Through a qualitative research design, the 2011 and 2012 wild fire seasons were investigated. The notion of adaptive governance was used as benchmark to determine which transformative actions took place. The prime objective of the research is to what extent has adaptive governance taken place during the 2011 and 2012 wild fire seasons in North-West Province, South Africa? The research found that role-players were able to adapt their management systems to include aspects such as information provision, dealing with conflict, induced legal compliance, provision of infrastructure and resources, and encouraged participation and adaptation. The paper recommends that emphasis on conflict management and resolution, applying nesting through various management levels, devised rules for wild fire management relevant with the ecological conditions, and the implementation of accountability mechanisms to be put in place.

INTRODUCTION

Globally, wildfires are increasingly affecting rural, peri-urban and more and more, urban areas (Kassomenos 2010; Miller et al. 2012; Chang-Richards et al. 2013). Many reasons could be ascribed to this situation, such as urban development encroachment on traditional “green” areas, poor urban and land use planning, poor ecological management and lack of risk reduction strategies. It is, however, widely accepted that current climatic conditions, linked to anthropogenic climate change, are one of the main drivers (Hessl 2011). Wildfires mostly remain natural phenomena, necessary for rangeland management (Snyman 2004), regeneration of flora (Henderson et al. 2005), and for the promotion of biodiversity (Parr et al. 2009).

With increases in unregulated urbanisation and the subsequent expansion of urban areas, wildfire management has become a serious concern in many regions (Bowman et al. 2013; Miller et al. 2012; Bornman et al. 2009). Better, effective and integrated management of this natural hazard is a priority (Bornman et al. 2009; Müller 2007; Aguilar and Montiel 2011). Research undertak-

en in the USA (Aguilar and Montiel 2011), Australia (Taylor et al. 2013) and South Africa (Bornman et al. 2009) indicates an alarming lack of stakeholder participation in wildfire management, while Van Wilgen et al. (2012) indicate that, in general, wildfire management in most areas is characterised by uncertainty and conflict.

During August 2011, run-away wildfires (referred to as “veld fires” in South Africa) in the Dr. Kenneth Kaunda District Municipality (KKDM) in the North-West Province (see Fig. 1) of South Africa destroyed thousands of hectares of grazing land, and killed hundreds of livestock (Wiggill 2013; Van Vuuren 2013; Van Vuuren and Van Niekerk 2011; Van Niekerk and Coetzee 2011). The local municipality of Tlokwe (situated within the KKDM) soon realised that the continued veld fires and unfavourable climatic conditions had eroded their coping capacity and declared a local state of disaster in terms of Section 55 of the Disaster Management Act 57 of 2002. The assistance of a research team from the North-West University (Potchefstroom Campus) was solicited by the Tlokwe Local Municipality and the KKDM to investigate the veld fires from a transdisciplinary perspective. The investigation

aimed at providing a rapid impact assessment for disaster declaration and disaster relief purposes. One of the components of the research project was the investigation into the management of veld fires within the KKDM, with reference to the Tlokwe Local Municipality.

In this paper the researcher aims at explaining the research undertaken over a two-year period following the August 2011 veld fires, focussing specifically on the management and adaptive governance of veld fires within the North-West Province of South Africa. The main question which the research aimed to answer was: To what extent has adaptive governance taken place between the 2011 and 2012 wild fire seasons in North-West Province, South Africa? What followed in the months after the 2011 fires was a range of different interventions and adaptive governance strategies such as training, simulations, co-management, and stakeholder engagement, which significantly increased the capacities and abilities of the veld fire management teams, as well as related organisations and role-players. The effect of these interventions is measured through a comparative analysis between the 2011 and 2012 veld fire season. By making use of focus groups, key informant in-

terviews and direct observation over this period, as well as active involvement in the veld fire management fora, an account of adaptive governance strategies and actions undertaken by the various stakeholders in dealing with veld fires is provided. Comparisons will be drawn between the ideal legislative state, and the situations following the 2011 and also 2012 veld fire season. Reasons for the adaptive governance to veld fires will be provided and the value of participation and communication in creating effective and adaptive governance of veld fires will be alluded to. In the present paper, it is argued that how a cultivated disaster risk reduction mentality by stakeholders over this period has greatly contributed to improve overall coordination and management of veld fires, which utilises risk reduction strategies and adaptive management as its points of departure. Although the research is region specific (for example, KKDM in the North-West Province), the researcher suggests that the findings are valuable for veld fire management practices in the rest of South Africa and the larger southern Africa continent, and even beyond. However, before the research findings can be discussed, the sections to follow will highlight statutory and regulatory



Fig. 1. Geographical location of the Dr. Kenneth Kaunda District Municipality in South Africa

requirements for veld fire management. This is done to establish the legal and organisational requirements for veld fire management in South Africa.

Setting the Context: 2011-2012 Veld Fire Season

The North-West Province of South Africa enjoys summer rainfall (October-April) and is mostly characterised by savannah and grassland biomes (Russell et al. 1990; Van Oudshoorn 2012), with an overall “high” to “extreme” veld fire risk class for its fire regime (Forsyth et al. 2010). Most of the savannah vegetation types are used for grazing mainly cattle and wildlife. The grasslands have two distinct categories: sweet grasses which are palatable to stock (domestic and wildlife), and sour grasses which are less so or unpalatable (Van Oudshoorn 2012). The grass plants tolerate fires well and are ideally suited for needed grazing conditions in the province. Goldammer and De Ronde (2004) believe that the biota of sub-Saharan Africa has adapted to the burden of veld fires. In most ecosystems, fires are a growth and regeneration necessity, linked to the seasonality of vegetation. However, veld fires can also cause widespread devastation, contributing to deforestation (Van der Werf et al. 2010) and erosion (Benavides-Solorio and MacDonald 2005). Moreover, as Pretorius (2011) indicates, urbanisation is arguably one of the biggest threats to the grassland ecology in Southern Africa, which makes peri-urban, and now also settlements in urban areas, at-risk of the possible threat of veld fires (Van Wilgen et al. 2012).

During the months of July-September 2011, most areas of the South Africa interior experienced above average winds, linked to very dry winter atmospheric conditions and the presence of significant biomass burn loads due to the types of biomes (Wiggill 2013). Both the ¹Lowveld Fire Danger Index (LFDI) and the Canadian Fire Weather Index (FWI) indicated the fire danger rating for the KKDM as “dangerous” ²(1001-2000 kJ/s/m) to “extremely dangerous” (>3000 kJ/s/m) over this period (WAMIS 2013a).

A number of municipalities in the North-West, Free State and Gauteng Provinces sustained significant damage due to veld fires, which occurred on 23 August 2011. The MODIS (Moderate Resolution Imaging Spectroradiometer) fire

locations recorded 14 534 veld fires within the whole of the South Africa Development Community (SADC) on that day alone (WAMIS 2013b). Veld fires in the KKDM spread rapidly over a vast geographical area, mostly because of the presence of high winds and high biomass load (Wiggill 2013; Van Vuuren and Van Niekerk 2011). The wind intensified the speed of onset and rapidly culminated into a high impact event. Landowners, especially farmers, sustained the gravest losses. On the day in question, 13 veld fires raged simultaneously within the KKDM, resulting in a loss of 84 206 hectares grazing which included 1 808 hectares of cultivated pastures, at a combined estimated cost of ZAR68 938 844 (estimated US\$7,2mil). Livestock loss in units amounted to 779 (US\$736 000) and infrastructure loss (for example, irrigation pipes, fencing and buildings) came to US\$1.2mil (Van Niekerk and Coetzee 2011). The African Centre for Disaster Studies (ACDS) at the North-West University (as part of the Tlokwe Local Municipality Technical Task Team on Veld Fires) conducted a rapid impact assessment of the August 2011 fires (Van Niekerk and Coetzee 2011). The magnitude of the event, and its impact, led the Tlokwe Local Municipality to declare a local state of disaster.

The events of August 2011 provided an ideal opportunity to investigate the veld fire seasons through a transdisciplinary approach. Researchers from the disciplines of disaster studies, public management, botany, agricultural economics, geographical information systems and remote sensing, psychology, communication studies, and fire safety partook in the multiyear research. The veld fire research allowed for academic-practitioner engagement, and through an action research design, the research team was able to contribute to adjustments and the improvement of planning and implementation practices associated with veld fire management and disaster risk reduction measures.

To determine the extent of changes in the veld fire management regime and adaptive governance it is necessary to firstly discuss adaptive governance and provide a benchmark against which changes in adaptive governance can be measured.

Adaptive Governance

Djalante et al. (2012, 2013) provide an in-depth account of the evolution of adaptive

governance of natural resources taking an interdisciplinary perspective. Quoting Holling (1973), Walters (1986), Ostrom (1990), Gunderson (1999), Carlsson and Berkes (2005), and Dietz et al. (2003), Djalante et al. (2013) highlight the emergence of adaptive governance from earlier thinking and combining of concepts and theories from such areas as adaptive management, cooperative management, co-management, and adaptive co-management. Adaptive governance, according to the authors cited above, relate to a cooperative approach in the management of local resources within socio-ecological systems. Adaptive governance aims to convey the difficulty of control, decision-making in uncertainty, dealing with diversity and reconciling conflict in groups with differing views, perspectives, interests, power relations and access to information (Dietz et al. 2003).

Although, not a linear evolutionary process, adaptive governance draws from the various management perspectives applied to the commons (Gondo 2011). Dietz et al. (2003) propose five requirements of adaptive management:

- provide information;
- deal with conflict,
- induce rule compliance,
- provide infrastructure, and
- encourage adaptation.

They furthermore hold eight strategies for meeting these requirements:

- devise rules relevant with ecological conditions,
- define boundaries of resources and users,
- set accountability mechanisms,
- apply graduated sanctions (for example, limited rule enforcement for violations),
- establish low-cost mechanism for conflict resolution,
- encourage participation/analytic deliberation,
- apply nesting (for example, allow for governance at various levels such as national, provincial, local, sub-local), and
- employ institutional variety (for example, employ a mixture of institutional types).

Within the theoretical scope of the requirements and strategies of adaptive governance, I will argue the extent to which adaptive governance has been absorbed in the management of veld fires in the area under investigation over the period 2011-2012. However, adaptive governance does not function in isolation. There are a

number of self-governing institutions, established by law, involved in overall veld fire management. Therefore, the statutory framework in which adaptive governance of veld fires in South Africa must manifest itself will firstly be discussed.

Statutory Imperatives to Veld Fire Management in South Africa

The management of veld and forest fires in South Africa is first and foremost governed by the National Veld and Forest Fire Act No. 101 of 1998. The Act calls for integrated fire management with the main aim to prevent and combat veld, forest and mountain fires. Van Wilgen et al. (2012) believe that, although this Act recognised the ecological role of fires in maintaining ecosystem processes, it overemphasises fire risk reduction and safety at the expense of ecological considerations (also see the work of Forsyth et al. 2010).

Through this legislation, provision is made for the formation of Fire Protection Associations (FPAs) consisting of land owners, municipalities and government departments, communities, and other organised entities such as catchment management agencies (Wester et al. 2003; Schreiner and Van Koppen 2002), conservation committees, nature conservancies, disaster risk management agencies, or other voluntary organisations. The variety of stakeholders correlate with what Djalante et al. (2012) call “polycentric and multilayered institutions” necessary for adaptive governance. FPAs have the purpose of predicting, preventing, managing and extinguishing veld fires. In an area where an FPA has been established, the local municipality (or municipalities in the case of spanning administrative boundaries due to topographical, geographical and/or vegetative conditions) in question must become a member, if there is a designated fire service within the municipality. FPAs must develop and coordinate a veld fire management strategy and co-ordinate with adjoining FPAs if the possibility exists that a fire could cross municipal boundaries. FPAs must identify the ecological conditions that affect fire danger, train its members in fire fighting and communicate information regarding veld fires in the area to relevant stakeholders. If a municipality is not a member of the FPA, a fire protection officer (FPO) must be appointed. An FPO must act as chief

executive officer (CEO) of the FPA, take control of any fire fighting in the area for which the FPA has been formed and train members in the applicable laws and roles of the FPA, as well as how to prevent and fight veld fires. In the case where a municipality is a member, the chief fire officer will be the FPO. If an FPO is also a forest officer, police officer or an officer in the fire brigade services, that FPO has the power to enforce the National Veld and Forest Fire Act.

Furthermore, FPAs must develop a business plan and a veld fire management strategy, undertake veld fire risk assessments, define rules for members, communicate fire risk related information to members (such as FDIs), and train and support all members to prevent and contain veld and forest fires (South Africa 1998b). However, the Act does not clearly state the desired interaction between the FPAs and other fire fighting agencies,, except by indicating that where a fire brigade service exists within a municipality, or where there is a designated fire fighting service, the municipality in question has to become a member of the FPA. The act also states that there is nothing preventing the formation of an umbrella association for a number of FPAs (that is, on a provincial level). The FPA is thus a poly-centric self-governing institution, which must balance ecological, economical and management issues within a specific veld fire regime.

In the management of veld fires, FPAs should also take note of related legislation such as the National Environment Management Act No. 107 of 1998 (South Africa 1999), the Disaster Management Act No. 57 of 2002 (South Africa 2003), Fire Brigade Services Act No. 99 of 1987 (South Africa 1987), Conservation of Agricultural Resources Act No. 43 of 1983 (South Africa 1983), National Environmental Management: Biodiversity Act No. 10 of 2004 (South Africa 2004), and the Environment Conservation Act No. 73 of 1989 (South Africa 1989), as well as local plans and policies such as municipal Integrated Development Plans (South Africa 1998a) and disaster risk management plans of municipalities. Each of these Acts addresses certain issues relating to the management of the environment, disasters and risk, and veld fires. Most significant to the management of veld fires and adaptive governance are the structures, networks, collaboration and institutions for disaster risk management according to the Disaster Management Act No. 57 of 2002 (Van Niekerk 2006).

However, the presence of veld fires does not constitute a disaster in itself. Therefore, the disaster risk management structures and processes of government have a specific role and function, which include both risk reduction (preventative) and response-oriented functions. Most Disaster Risk Management Centres at local government level (which should be part of a FPA) have disaster risk reduction advisory fora and technical task teams or committees responsible for the strategic management of the most prevalent hazards in their geographical area (Botha et al. 2011; Botha and Van Niekerk 2013). This is also the case of the Tlokwe Local Municipality and the KKDM, both having operational technical task teams (TTT) for veld fires. Membership of the TTT is multi-layered and diverse, and it facilitates interaction and coordination among public servants and public institutions, private sector, parastatal organisations (such as utilities companies), academia and research, as well as community representatives (such as FPAs and farmers' organisations). This research is mostly concerned with the role-players forming part of the TTT which is more diverse than the FPA, because of its linkages to the overall disaster risk profile of a municipality. The TTT (in) formed the research respondents, which provided in-depth and rich data regarding the progression of adaptive governance over the fire seasons.

METHODOLOGY

The research is based on consultation with a range of stakeholders intimately involved with veld fire management within the KKDM. Included in the research were members of the FPA, fire brigade services, disaster management officials, agricultural extension workers, the South African Police Service (SAPS), as well as farmers and land owners affected by the 2011-2012 veld fire season. The research used a qualitative research design. The qualitative research design aims at gaining an in-depth understanding of human behaviour and social phenomena. This research approach mainly depends on data that were retrieved from observations and recordings, and reports into the written word. The qualitative data was collected through face-to-face-, focus group-, key informant-, e-mail-, and telephonic interviews, as well as participant observation.

The research consisted of two phases. The first phase considered the period immediately following the 2011 veld fire season whereas the second involved the period leading up to, and following, the 2012 veld fire season. In all cases, the same respondents were targeted which allowed for comparison of the qualitative data. The members of the TTT formed the total population of the research and could thus be sampled purposefully (opportunistic and convenient). The qualitative data was analysed using the eight steps as proposed to by Tesch (1990), which are:

- (i) Thorough reading through and making notes of all transcribed material.
- (ii) Consider the substance of interviews conducted looking for the underlying meaning.
- (iii) Compile a list of all topics that came to the fore in the research.
- (iv) Cluster these topics.

- (v) By using clustered list, once again consider the data. Code the topics and correlate coding with data.
- (vi) Elaborate on the topics with the aim to turn them into certain categories and determine interrelationship.
- (vii) Make a final decision on the coding of the categories and alphabetise the list.
- (viii) If necessary, recode existing data.

The data from the first and second phase of the research were analysed independently, compared and clustered as a whole. The difference in respondents' perception (and in some cases supported by evidence) from 2011 to 2012 provides the basis for comparison and answers the main question of how adaptive governance to veld fires has taken place. The five requirements and eight strategies for adaptive governance, as referred to previously, were used as the foundation for comparative data analysis in the discussion.

Table 1: Categories and topics from the data analysis

<i>Categories</i>	<i>Topics</i>
Communication and Relationships	Communication infrastructure Communication management Conflict management Methods and forms of communication Stakeholder relationships (communal and exchange)
Governance	Decision-making Policies, strategies and plans Power relationships Representation Roles and responsibilities
Knowledge, Information, and Education	Existing knowledge sets Information management and sharing Management of biome Sharing of expertise Skills and personnel Uncertainties
Leadership	Commitment Common goals Openness Responsibilities Support
Legal Compliance	♦ Accountability ♦ Enforcement ♦ Ethical code ♦ Self regulation ♦ Legislation and by-laws monitoring
Resources and Support	Funding Lack of local government support Outside support Resource constraints
Structures and Stakeholders	Buy in Coordination Participation Understanding

RESULTS

The analysis of the results identified a number of categories and their linked topics from the research. Once all the data of both phases of the research was considered, coded and clustered, the categories and topics as listed in Table 1 emerged.

The comparison in datasets brought one key finding to the fore. Although the same categories emerged, the perceptions relating to the topics differed from 2011 to 2012. Given the disastrous circumstances following the 2011 veld fire season, it is logical that one of the major findings of the research is an overall negative perspective on veld fire management within the area under investigation (Becker 2013). Following the 2012 veld fire season, instead, a more positive outlook on veld fire management by all respondents emerges. One of the reasons is that, in the months of May–November 2011, a total of 8 983 km² of the total area (104 882 km²) of the North-West Province experienced veld fires, as opposed to the 3 007 km² over the same period in 2012 (WAMIS 2013b). However, some underlying evidence suggests that it is adaptive governance which mainly drives these perceptions, and not necessarily a less severe 2012 veld fire season (compared to 2011).

Two key aspects from the 2011 veld fire season, which came to the fore, were the lack of proper communication management and poor stakeholder relationships. The respondents felt that the various role-players were unable to communicate due to ineffective communication management and lack of communication infrastructure (Wiggill 2013). To address the deficiencies identified by the respondents, a number of communication capacity building initiatives were implemented with the assistance of the North-West University (Potchefstroom Campus) (Wiggill 2013). The contrast in the responses from role-players after the 2012 veld fire season indicates a significant improvement in communication. In general the perception of respondents post-2012 was that stakeholder relationships had improved and as one respondent noted: “Everyone is not pulling in their own direction anymore.” Better communication may also lead to more effective conflict resolution. However, a number of role-players still believe the relations between the FPA and the local municipality can be improved.

After the 2011 veld fire season, respondents agreed that there was an overall absence in governance of veld fires. This relates to issues such as decision-making, policies, strategies and plans, power relationships, representation, and roles and responsibilities. After the 2012 veld fire season, respondents felt more positive regarding the overall governance, but a number of concerns were raised, such as local political infighting, limited government department involvement, absence of functioning response structures and lack of Memoranda of Understanding between different role-players which might facilitate better cooperation. These findings correlate with the literature as mentioned earlier.

‘Knowledge, information and education’ emerged as key categories in the research. Most of the blame for the disastrous outcomes of the 2011 veld fire season was attributed to the lack of knowledge, skills, equipment, and abilities. The overall awareness of the need for knowledge leads to a number of training interventions. Notably, as mentioned before, training was carried out in communication and stakeholder management, Incident Command System (ICS) and introductory courses on disaster risk reduction were delivered. Linked to the formal training interventions were skills and knowledge transfer via the various veld fire management structures (such as the Technical Task Team on Veld Fires and the FPA). Supplementing theoretical and practical knowledge, the majority of the stakeholders also participated in a disaster simulation exercise, which took place following the 2011 veld fire season. All the interventions contributed significantly to adaptive governance as evidenced in the successes of the 2012 veld fire season.

The analysis of the 2011 data indicated a significant lack of leadership. Unfortunately, it seems that the overall perception of respondents in 2012 on this issue did not change considerably. The prime reasons may include the constraints in coordination and involvement of the local municipality disaster risk management structures. This can, to an extent, be attributed to political infighting in the municipality and general lack of political and administrative leadership (Marrian 2013; Sapa 2013; Sparks 2013), which manifests itself through poor service delivery.

Furthermore, limited legal compliance was cited as a hindrance to good veld fire gover-

nance in 2011. Respondents felt that although the legal instruments (for example, National Veld and Forest Fire Act, Disaster Management Act, Fire Brigade Services Act and Disaster Risk Management Plans) for mitigating veld fire risks exist, the successful application thereof was lacking. In contrast, the FPA engaged in a significant public awareness campaign in which land owners, public and parastatal institutions, and the public in general, were made aware of their role in veld fire prevention and punitive measures according to the legislation. As a result, the legal compliance by landowners (for example, making of fire breaks and adhering to warnings and the FDIs) was improved in the 2012 veld fire season.

Resources and support was identified as another category emerging from the research. Linked to the absence of communication in 2011 was the lack of the physical communication infrastructure. Although not fully addressed in the 2012 season, it is noticeable that the communication infrastructure was somewhat improved, and alternative methods of communication were agreed upon by the various role-players. Respondents believe that the most encouraging aspect under this category was the equipment support, which the FPA and landowners received from the KKDM Disaster Risk Management Centre. Following the 2011 fires, the district provided significant monetary support to buy robust veld fire fighting equipment. However, in 2012, respondents indicated that most government departments remained under-funded for their tasks in veld fire management in the KKDM. Furthermore, the FPA was able to obtain the services of the Working on Fire Programme (WoF), a government-funded, job-creation programme focusing on integrated fire management in South Africa.

The last category identified was 'structures and stakeholders'. In 2011, the respondents were unanimous in their belief that the lack of a functioning structure hinders veld fire governance. Most respondents agreed that structure followed strategy. On the contrary, the period subsequent to the 2012 veld fire season is characterised by a more strategic approach by stakeholders. This is seen in the joint planning, training and simulations that took place. Additionally, the Working in Fire (WoF) Programme supports training and capacity development in veld fire suppression, as well as aerial veld fire fight-

ing capabilities in the form of spotter aeroplanes and fire suppression enabled helicopters. Following the 2011 veld fire season, aerial and ground support were provided by WoF to the FPA.

DISCUSSION

To determine how adaptive governance took place during the 2011 and 2012 veld fire seasons the requirements and strategies of Dietz et al. (2003), presented above, are used as a benchmark. Most of the actions and activities by the various veld fire management role-players following the 2011 veld fire season were geared towards the elimination and reduction of veld fires, and their consequential environmental impact. An emergence of a disaster risk reduction perspective by all institutions and stakeholders involved was noticeable. This can be seen through better joint planning and decision-making.

Providing information to stakeholders and other role-players became critical to communicating veld fire risk reduction behaviour following the 2011 veld fire season. The FPA as well as the KKDM Disaster Risk Management Centre made significant progress in their various veld fire awareness campaigns. This is shown in the almost lack of awareness campaigns in 2011 followed by significant efforts in 2012-2013. Part of the information delivery process was the communication of the FPA strategy as per the National Veld and Forest Fire Act. To this purpose, the FPA developed a synopsis booklet of the legislation incorporating their own strategy in the local languages. This enabled a concise and precise understanding of the legal obligations of the various parties in veld fire governance. The KKDM Disaster Risk Management Centre, through its Public Information and Education and Research (PIER) section, also implemented a number of awareness raising initiatives in the most at-risk communities. Stringent rules in terms of open fires, linked to ecological and meteorological conditions were devised and are still being enforced. It is, however, worrisome to note that animosity and conflict still remains between the role-players and, in particular, within the FPA and the Tlokwe Local Municipality Disaster Risk Management structures. The research showed that although some successes in conflict management have been made, a lot still needs to be achieved. This can mostly be ascribed to a lack

of trust, poor stakeholder management and the lack of an accountability mechanism among all parties, as highlighted by the research of Wiggill (2013). If a proper conflict resolution mechanism or process cannot be found, it may jeopardise relationships between all parties.

Furthermore, the FPA with the assistance of the SAPS induced rule compliance by advocating for the enforcement of the National Veld and Forest Fire Act and its resultant fine-based system though applying graduated sanctions. Linked to the awareness campaign, all stakeholders were made aware of the punitive measures that will be used for non-compliance. It is noticeable that since 2011 the amount of new FPA members has increased significantly (521 in 2011 to 698 in 2012 - 34% increase). This shows improved willingness by land owners and other role-players to engage in veld fire management activities, and a commitment on the side of the veld fire management structures to encourage participation. However, the 2012 research indicates limited involvement from private sector and government departments alike.

Investment in infrastructure in the form of skid units, personal protective equipment and fire beaters, as well as the added capacity for veld fire suppression by the WoF teams (through financial support by the KKDM) assisted in the adaptive governance. The supply of the much-needed equipment by the KKDM to the FPA, furthermore, strengthened their relationships and trust. The last requirement of adaptive governance - encourage adaptation - is a constant between all role-players. Open dialogue between most stakeholders allows for better understanding, joint decision-making, thus better and quicker adaptation with the added value of institutional variety.

CONCLUSION

The research suggests that adaptive governance has taken place and eased in the overall management of veld fires in the KKDM. The adaptive governance was driven by a common threat to ecological well-being and to the protection of livelihoods and infrastructure. Effective adaptive governance to veld fire management not only requires factual information about the state of the environment, human actions and institutional buy-in, but also information about uncertainty and values. Without effective adap-

tive governance and institutions at the appropriate scale, natural resources, the environment, and livelihoods are in peril.

In the present paper, it is aimed to display how adaptive governance takes place in between diverse role-players with the common objective of preventing and reducing the risks of veld fires in the North-West Province of South Africa. Through an adaptive governance approach the stakeholders devised rules for veld fire management relevant to the ecological conditions in the KKDM. Boundaries of resources and users were defined, and an accountability mechanism, which ensures graduated sanctions, was devised. Participation in the adaptive governance process was enhanced, although it is still not ideal, and nesting was applied through the allocation of authority at multiple levels in the polycentric and multi-layered institutions responsible for veld fire management. It is recommended that much more attention must be given to better stakeholder participation, as well as conflict management and resolution. Applying nesting through allocation of authority at various management levels (within and outside government) will enable stakeholder ownership. Furthermore, it was accepted that rules for veld fire management, relevant to the ecological conditions, must constantly be devised, adapted and implemented. This can be achieved through the implementation of accountability mechanisms, as was the case in the KKDM study.

ACKNOWLEDGEMENTS

I would like to acknowledge the financial contribution of the Disaster Risk Management Centre of the Dr. Kenneth Kaunda District Municipality to this research. I owe gratitude to Gerrit van der Waldt and Clara Bocchino for their comments on earlier drafts of this article. My thanks to the very valuable comments provided by the two reviewers.

NOTES

- ¹ "Fire danger indices (FDIs) describe the conditions that influence the ease of ignition, rate of spread, difficulty of control and potential impact of fire. It is used to assess the safety of prescribed burning activities, to improve real-time fire fighting preparedness and as an assessment tool in logistic planning of fire fighting resources" (WAMIS 2013a).
- ² kJ/s/m refers to the release of heat energy per unit time per unit length of fire front (Byram 1959).

REFERENCES

- Aguilar S, Montiel C 2011. The challenge of applying governance and sustainable development to wildland fire management in Southern Europe. *Journal of Forestry Research*, 22(4): 627–639.
- Becker C 2013. Farmers' Experiences and Coping After Disastrous Veld Fires in the North-West Province. *Paper presented at First Biennial Conference of the Southern Africa Society for Disaster Reduction*, Potchefstroom, South Africa, 10 to 12 October 2012.
- Benavides-Solorio JD, MacDonald LH 2005. Measurement and prediction of post-fire erosion at the hill-slope scale, Colorado Front Range. *Int J Wildland Fire*, 14(4): 457–474.
- Bornman ME, Nealer EJ, Stevens JB 2009. Effective linkages and participatory governance in the management of veld fires. *South African Journal of Agricultural Extension*, 38: 51–64.
- Botha D, Van Niekerk D 2013. Views from the front-line: A critical assessment of local risk governance in South Africa. *Jambá: Journal of Disaster Risk Studies*, 5: 1–10.
- Botha D, van Niekerk D, Wentink G, Coetzee C, Forbes-Biggs K, Maartens Y, Annandale E, Tshona T, Raju E 2011. *Disaster Risk Management Status Assessment at Municipalities in South Africa*. Pretoria: South African Local Government Association (SALGA).
- Bowman DM, Murphy BP, Boer MM, Bradstock RA, Cary GJ, Cochrane MA, Fensham RJ, Krawchuk MA, Price OF, Williams RJ 2013. Forest fire management, climate change, and the risk of catastrophic carbon losses. *Frontiers in Ecology and the Environment*, 11(2): 66–67.
- Byram GM 1959. *Forest Fire: Control and Use*. New York: McGraw-Hill.
- Carlsson L, Berkes F 2005. Co-management: Concepts and methodological implications. *Journal of Environmental Management*, 75(1): 65–76.
- Chang-Richards Y, Wilkinson S, Potangaroa R, Seville E 2013. Resource challenges for housing reconstruction: A longitudinal study of the Australian bushfires. *Disaster Prevention and Management*, 22(2): 172–181.
- Dietz T, Ostrom E, Stern P 2003. The struggle to govern the Commons. *Science*, 302(5652): 1907–1912.
- Djalante R, Holley C, Thomalla F 2012. Adaptive governance and managing resilience to natural hazards. *International Journal of Disaster Risk Science*, 2(4): 1–14.
- Djalante R, Holley C, Thomalla F, Carnegie M 2013. Pathways for adaptive and integrated disaster resilience. *Natural Hazards*. 69: 2105–2135.
- Forsyth GG, Kruger FJ, Le Maitre DC 2010. *National Veldfire Risk assessment: Analysis of Exposure of Social, Economic and Environmental Assets to Veld-fire Hazards in South Africa*. Stellenbosch: CSIR.
- Goldammer JG, De Ronde C 2004. *Wildland Fire Management Handbook for Sub-Sahara Africa*. Freiburg: Global Fire Monitoring Centre.
- Gondo T 2011. Adaptive co-management of natural resources: A solution or problem? *Journal of Human Ecology*, 33(2): 119–131.
- Gunderson L 1999. Resilience, flexibility and adaptive management—antidotes for spurious certitude. *Conservation Ecology*, 3(1): 7.
- Henderson M, Kalabokidis K, Marmaras E, Konstantinidis P, Marangudakis M 2005. Fire and society: A comparative analysis of wildfire in Greece and the United States. *Human Ecology Review*, 12(2): 169.
- Hessl AE 2011. Pathways for climate change effects on fire: Models, data, and uncertainties. *Progress in Physical Geography*, 35(3): 393–407.
- Holling CS 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4: 1–23.
- Jansen Van Vuuren ID 2013. A framework for rapid impact assessment with special reference to wild-fires. *Jambá: Journal of Disaster Risk Studies*, 5(2): 1–8.
- Jansen Van Vuuren ID, Van Niekerk D 2011. Veld fire rapid impact assessment. *Position IT*, (October), 49–50.
- Kassomenos P 2010. Physics and chemistry of the earth. *Physics and Chemistry of the Earth*, 35(9–12): 544–552.
- Marrian N 2013. Tlokwe Councillor Choose to Stand Against ANC. Business Day. From <<http://www.bdlive.co.za/national/politics/2013/08/28/tlokwe-councillors-choose-to-stand-against-anc>> (Retrieved on 2 September 2013).
- Miller JD, Skinner CN, Safford HD, Knapp EE, Ramirez CM 2012. Trends and causes of severity, size, and number of fires in northwestern California, USA. *Ecological Applications*, 22(1): 184–203.
- Müller K 2007. Organisational innovation: Some emerging environmental models in South Africa. *Politeia*, 26(1): 45–59.
- Ostrom E 1990. *Governing the Commons*. Cambridge: Cambridge University Press.
- Parr CL, Woinarski JCZ, Pienaar DJ 2009. Cornerstones of biodiversity conservation? Comparing the management effectiveness of Kruger and Kakadu National Parks, two key savanna reserves. *Biodiversity and Conservation*, 18(13): 3643–3662.
- Pretorius E 2011. *Determining the Diversity of Nocturnal Flying Insects of the Grassland in the Krugersdorp Nature Reserve*. Johannesburg: University of Johannesburg.
- Russell GEG, Roux WL, Leistner OA 1990. *Grasses of Southern Africa: An Identification Manual with Keys, Descriptions, Distributions, Classification, and Automated Identification and Information Retrieval from Computerized Data*. Kirstenbosch: Botanical Research Institute.
- Sapa 2013. Reinstated Tlokwe Councillors Not Up For By-election. City Press. From <<http://www.citypress.co.za/politics/reinstated-tlokwe-councillors-not-up-for-by-election/>> (Retrieved on 2 September 2013).
- Schreiner B, Van Koppen B 2002. Catchment management agencies for poverty eradication in South Africa. *Physics and Chemistry of the Earth*, 27(11): 969–976.
- Snyman HA 2004. Short-term response in productivity following an unplanned fire in a semi-arid rangeland of South Africa. *Journal of Arid Environments*, 56(3): 465–485.

- South Africa 1983. *Conservation of Agricultural Resources Act No. 43 of 1983*. Pretoria: Government Printers.
- South Africa 1987. *Fire Services Act No. 99 of 1987*. Pretoria: Government Printers.
- South Africa 1989. *Environment Conservation Act No. 73 of 1989*. Pretoria: Government Printers.
- South Africa 1998a. *Municipal Structures Act No. 117 of 1998*. Pretoria: Government Printers.
- South Africa 1998b. *National Veld and Forest Fire Act No. 101 of 1998*. Pretoria: Government Printers.
- South Africa 1999. *National Environmental Management Act No. 107 of 1998*. Pretoria: Government Printers.
- South Africa 2003. *Disaster Management Act No. 57 of 2002*. Pretoria: Government Printers.
- South Africa 2004. *National Environmental Management: Biodiversity Act No. 10 of 2004*. Pretoria: Government Printers.
- Sparks A 2013. Putsch of Potch Opens up Challenges to Ruling Party. Business Day. From: <<http://www.bdlive.co.za/opinion/columnists/2013/08/14/putsch-of-potch-opens-up-challenges-to-ruling-party>> (Retrieved on 2 September 2013).
- Taylor RS, Watson SJ, Bennett, AF, Clarke MF 2013. Which fire management strategies benefit biodiversity? A landscape-perspective case study using birds in Mallee ecosystems of south-eastern Australia. *Biological Conservation*, 159(C): 248–256.
- Tesch R 1990. *Qualitative Research: Analysis Types and Software Tools*. New York: Flamer.
- Van der Werf GR, Randerson JT, Giglio L, Collatz GJ, Mu M, Kasibhatla PS, Morton DC, DeFries RS, Jin Y, Van Leeuwen TT 2010. Global fire emissions and the contribution of deforestation, savanna, forest, agricultural, and peat fires (1997–2009). *Atmospheric Chemistry and Physics*, 10(23): 11707–11735.
- Van Niekerk D 2006. Disaster Risk Management in South Africa: The function and the activity—towards an integrated approach. *Politeia*, 25(2): 95–115.
- Van Niekerk D, Coetzee C 2011. *Rapid Impact Assessment Report: Veld Fires in the Tlokwe Local Municipality on 23 August 2011*. Potchefstroom: Tlokwe Local Municipality.
- Van Oudshoorn F 2012. *Guide to Grasses of Southern Africa*. Pretoria: Briza Publications.
- Van Wilgen BW, Forsyth GG, Prins P 2012. The management of fire-adapted ecosystems in an urban setting: The case of Table Mountain National Park, South Africa. *Ecology and Society*, 17(1): art8.
- Walters CJ 1986. *Adaptive Management of Renewable Resources*. New York: McGraw-Hill.
- Wester P, Merrey DJ De Lange M 2003. Boundaries of consent: Stakeholder representation in River Basin Management in Mexico and South Africa. *World Development*, 31(5): 797–812.
- Wide Area Monitoring Information System (WAMIS) 2013a. Fire Danger. From <<http://wamis.meraka.org.za/products/fire-danger>> (Retrieved on 29 July 2013).
- Wide Area Monitoring Information System (WAMIS) 2013b. Fire Products. From <<http://wamis.meraka.org.za/products/fire>> (Retrieved on 29 July 2013).
- Wiggill MN 2013. Communication management during the veld fires of 23 August 2011 in the Tlokwe Local Municipality: A cautionary tale. *Jàmbá: Journal of Disaster Risk Studies*, 5(2): 1–9.