Annual Research Report, 2015

Permit no: 2880/2015

Submitted to Ministry of Environment and Tourism (MET), 13th January 2016

University of Cape Town
Plant Conservation Unit
Department of Biological Sciences
Private Bag X3
Rondebosch
7701
South Africa

PhD candidate: Glynis J. Humphrey, humphrey.glynis@gmail.com
Supervisor: Assoc. Prof. Lindsey Gillson, lindsey.gillson@uct.ac.za
Social research advisor: Dr Gina Ziervogel, gina@csag.uct.ac.za

Title: The role of humans in the complex fire, climate and vegetation regimes of North-East Namibia.

Plant Conservation Unit | NRF National Research Foundation | access Applied Centre for Climate & Earth Systems Science | GreenMatter Fellow

Foreword

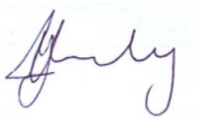
The overall aim of this research is to explain the present vegetation pattern of the Kavango East and Zambezi Region in relation to anthropogenic influence, fire occurrences, and climate and vegetation feedbacks within Bwabwata National Park (BNP) in north-east Namibia.

This study is designed to address factors influencing the present-day fire regime by developing an understanding of historical and present human land and fire use, vegetation and fire history, and climate variation over the last century. Preceding 1990, this area was subjected to three decades of war, inter - cultural conflict, deforestation, and resultant pressures over diminishing natural resources. In 1888, a policy of fire suppression was instated, and in 2006, early burning management strategies were implemented in the region. The success of these policies are largely undocumented.

This report provides preliminary findings of social data research that took place between 2014 and 2015. Interviews were carried out in eight villages with the Khwe-San and the Mbukushu communities' resident in BNP concerning traditional use of fire and current burning patterns. Twenty four Namibian stakeholders were interviewed about their perceptions the effects of a policy of fire suppression, and subsequent changing fire management strategies in the region. The final phase of data collection is scheduled to take place in February 2016 and will involve the collection of vegetation data in the park.

This research would not have been possible without the many people who were willing to engage on the subject of fire in Namibia, and to them I am indebted. This work has been financially supported by GreenMatter Fellowship, National Research Foundation (NRF), and the Applied Centre for Climate and Earth Systems Sciences (ACCESS). Great appreciation is extended to the Simmonds and Andy Moore for encouraging and providing me with the means to initiate this research.

This work is by no means complete, as the project is in the middle phase, and there are other aspects which are currently being researched. If there are any comments, or recommendations concerning this work in progress, please do not hesitate to share these with me.



Yours sincerely,
Glynis Humphrey
Plant Conservation Unit (PCU), University of Cape Town (UCT)

Table of Contents

Introduction 7
1.1 Study area 7
2.1 Political boundaries: 'Caprivi no more' 9
3.1 People and land use 9
4.1 Landscape and Vegetation 10
5.1 Namibia's fire history 12
6.1 Fire policies: past and present 14
Social component 16
7.1 Overview 16
8.1 Aims and objectives 17
Community perspectives 17
9.1 Research Questions 17
Stakeholder perspectives 17
10.1 Methods (2014 – 2015) 17
11.1 Data collection (2015) 18
12.1 Community Data 18
13.1 Stakeholder Data 19
14.1 Focus group meetings 20
15.1 Additional method: use of visual aids 22
16.1 Data Analysis 22
17.1 Conceptual model 23
Preliminary Results 23
18.1 Community perspectives 23
19.1 Historical and current burning strategies 25
20.1 Community perspectives of fire 29
21.1 Cultivation, fire & livelihoods 31
Summary statements: Community perspectives 34
22.1 Stakeholder perspectives 35
23.1 Early burning strategies 36
A shift in perspective 36
24.1 Increase in late dry season fires: question of early burning? 36
25.1 Absence of fire knowledge and understanding 37
26.1 Policy – fire management implementation conundrum 37
27.1 Traditional fire knowledge and government collaboration 38

28.1 Perceived changes in the fire regime 39
Summary statements: Stakeholder perspectives 40
29.1 Provisional synthesis 42
30.1 Description of research activities proposed for 2016 43
References 44
Acknowledgements 48
Appendix 49

List of Figures

Figure 1: Map of the study area within a southern African context (*black arrow and red box indicates the locality of the Bwabwata National Park within Namibia). 8
Figure 2: Map of Bwabwata National Park (BNP) within the Kavango East and Zambezi Regions (Ministry of Environment and Tourism, 2011). 8
Figure 3: Map showing the delineation of the Kavango East and Zambezi Regions within the BNP (Le Roux, 2013). 9
Figure 4: Map of the vegetation types within the BNP (Mendelsohn & Roberts, 1997). 10
Figure 5: Map of the broad vegetation structure classification within BNP (Mendelsohn & Roberts, 1997). 11
Figure 6: Google image showing the major relic dunes stabilised by vegetation in the BNP (Google, 2014). 12
Figure 7: Map of Namibia showing the concentration of the fire regime in the north-east of the country, 2012 (Ministry of Water, Agriculture, Forestry, 2013). 13
Figure 8: Map showing burned area (MODIS MCD45A data), 2012 (University of Maryland), and the distinctive pattern of large fires in the west, and small patchy burns in the east of BNP. 14
Figure 9: Map showing the BNP cores areas and community settlements in the Multiple Use Area (MUA). 19
Figure 10: Number of interview participants within each stakeholder category [n=24]. * MET (Ministry of Environment and Tourism); DoF (Directorate of Forestry); NGO (Non-governmental organisation). 20
Figure 11: Map showing the main [n = 14] and sub nodes [n= 72] categories based on thematic content analysis of interview data (n = 36) for the BNP community. 24
Figure 12: Thematic prevalence of codes associated with the use of fire described by the BNP communities. *Note the numbers on the y axis refer to the number of respondents who provided each response. 25
Figure 13: Conceptual model showing the associations between historical and current traditional-cultural practises by the BNP communities. *The numbers in parentheses refer to the number of participants who provided a response for each theme. 28
Figure 14: Number of node co-occurrences associated with a positive and negative perception of fire within the BNP community. 29
Figure 15: Intensity of node co-occurrences in association with veld food resources in the BNP community [n=36]. 30
Figure 16: Mean rainfall and number of mean monthly fire locations in BNP (2000 – 2015) (Rainfall data from Namibia's Meteorological station [Windhoek]; and MODIS MCD14ML (30 – 80% confidence) [FIRMS [University of Maryland]. 31

Figure 17: Mean number of monthly fire locations per unit area (2000 – 2015) in the wildlife core areas (Buffalo; Kwando; and Mahango) and within the Multiple Use Area (MUA) [MODIS MCD14ML [FIRMS [University of Maryland]..... 32
Figure 18: Seasonal calendar showing activities in relation to fire on the BNP community..... 33
Figure 19: Map showing the main [n = 18] and sub nodes [n= 68] categories based on thematic content analysis of interview data (n = 36) for the Stakeholder data [n=24]..... 35
Figure 20: Conceptual map representing the stakeholder's positive and negative perceptions of fire and associate codes [n=24]. 41

List of Tables

Table 1: List of semi structured interviews and their locality in Namibia [2014, 2015]..... 20

List of Photographs

Photograph 1: Focus group meeting in Chetto village involving the discussion on the use of veld food resources in the BNP. 21
Photograph 2: Example of a seasonal calendar following an individual interview within the BNP..... 21
Photograph 3: Example of using topographical maps to question the locality of large and small fires in the BNP..... 22

Appendix

Table 2: Community resource questionnaire: Use of fire and livelihood resources in the BNP (2014)..... 49
Table 3: Ministry Staff Interview questions (Windhoek) /MET & MWAF (Rundu, Katima Mulilo), October 2014..... 50
Table 4: Socio-demographic characteristics of community member participants [n=36]..... 51
Table 5: Socio-demographic characteristics of stakeholder participants [n=24]..... 52

Captions for frontcover images:

Photo 1 (far left): Grass layer following an early season burn in BNP.
Photo 2 (top middle): Roasted kernels removed from Mangetti nuts (|*Qom*) (*Schinziophyton rautanenii*)
Photo 3 (far right): Early season fire burning in the evening in the BNP.
Photo 4 (far left): Khwe women removing *Tceu* (*Guibourtia colesperma*) from higher branches.
Photo 5 (bottom middle): Handful of *Tceu.*
Photo 6 (far right) *Tceu* in the pot in preperation for cooking.

Acronyms

Advanced Very High Resolution Radiometer	AVHRR
Applied Centre for Climate and Earth Systems Sciences	ACCESS
Bwabwata National Park	BNP
Community based Integrate fire management	CBiFM
Community Forest in North Eastern Namibia	CFNEN
Community Resource Monitors	CRM
Computer assisted qualitative data analysis	CAQDA
Directorate of Forestry	DoF
Fire Information for Resource Management System	FIRMS
Fire Management Plan	FMP
Geographical Information Systems	GIS
Global Fire Monitoring Centre	GFMC
Government of Namibia	GoN
Integrated Forest Fire Management	IFFM
Integrated Rural Development and Nature Conservation	IRDNC
Kavango/Upper Zambezi Transboundary Conservation Area	KAZATFCA
Kruger National Park	KNP
Ministry of Environment and Tourism	MET
Ministry of Water, Agriculture and Forestry	MWAF
Moderate Spatial Resolution Spectroradiometer	MODIS
Multiple-Use-Area	MUA
Namibia-Finland Forestry Programme	NFFP
National Oceanic and Atmospheric Administration	NOAA
National Research Funding	NRF
Non-Governmental Organisation	NGO
Participatory Rural Appraisal	PRA
Plant Conservation Unit	PCU
Polytechnic of Namibia	PoN
Protected Area	PA
South African Defence Force	SADF
Southern African Development Community	SADC
Sustainable Forest Management	SFM
Traditional Authority	TA
Traditional Fire Knowledge	TFK
University of Cape Town	UCT
University of Namibia	UNAM

Introduction

Savannas are generally defined as vegetation comprising a continuous grass layer usually with trees/and or shrubs showing similar structural and functional characteristics (Cole, 1986). The prevalence of grass biomass between the trees driven by rainfall, provides the fuel for large fires on the African continent. Thus, alternating wet and dry episodes interspersed with lightning storms provides the savanna biome with an ideal fire climate. The combination of Africa's natural history and human dispersal patterns sets the stage for investigating the geography of African fire – i.e. people and fire distribution. Anthropogenic fire originated in Africa, and has persisted longer than anywhere else (Pyne *et al*. 1998). The significance of this unique fire antiquity and the link to the anthropogenic control or absence of thereof, is of topical concern in protected conservation areas in Africa and elsewhere. Fire is recognised as having an important ecological role in the development and maintenance of productive savanna ecosystems. Research has concluded that fire has extended the grasslands and savannas at the expense of evergreen forests (Bond *et al.* 2004). The extent of which the forest-savanna-grassland transition is related to anthropogenic fire is of current social-ecological interest among fire ecologists through to the policy makers (Bond & Archibald, 2003). Previous research has raised a striking question about the human role in fire: how do humans alter fire patterns and therefore vegetation dynamics with the use of fire in savanna-woodland landscapes? On the opposite side of the match, the question remains how vegetation and climate influence fires in savannas.

Remote rural populations and their use of fire to manage land are described as one of the major causes of fires on the African continent (Mbow *et al.* 2000, Moore *et al.* 2002, Sheugunge *et al.* 2005). Fire science typically involves studies of 'fire regimes' representing a particular combination of fire characteristics, such as frequency, size, intensity, season, type and extent (Gill, 1975, Bond & Keeley, 2005), and the beneficial and negative ecological effects of fires on ecosystems and species (Flasse *et al.* 1998, Bowman *et al.* 2011). For a long period of time the role of anthropogenic fire was under appreciated (Walters, 2007), and few studies have investigated where, why, when and how much and how often rural people burn biomass for land management practises in southern Africa. People residing in remote regions customarily use for fire for a number of beneficial reasons that increase the diversity of livelihood options with limited access to resources. This aspect is seldom appraised in fire science literature. The objective of the social component of this research is to attempt to understand why, when, where and how often fires are set by the people residing in the north-east of Namibia residing in the Bwabwata National Park (BNP).

1.1 Study area

Bwabwata National Park (BNP), the former western Caprivi Game Park is situated within a fire nexus in southern Africa (Figure 1). The BNP is 6334 km² in extent (Pricope & Binford, 2012), and straddles the Kavango East and Zambezi Regions (Figure 2 & Figure 3). It's approximately 180 km wide from east to west and 32 km in width (Brown & Barnes, 1994) mm, and characterised as a flat landscape approximately 1000 meters above sea level (Trollope & Trollope, 1998). BNP is surrounded by four savanna fire prone countries namely Angola to the north, Botswana to the south, and Zambia and Zimbabwe to the north and east respectively within the Kavango/Upper Zambezi Transboundary Conservation Area (KAZATFCA). The BNP is bordered by the substantial floodplains of the Zambezi, Kwando-Linyanti and Kavango Rivers and holds the territory of the largest global transboundary elephant concentration within the KAZATFCA, and contains a number of 'biodiversity hotspots', because of high bird diversity and largest wetland ecosystem in Namibia (Taylor, 2007). BNP management is viewed as a cornerstone accomplishment in

Namibia, as both humans and wildlife are now living in a status quo that offers benefits to both conservation and rural communities (MET, 2010).

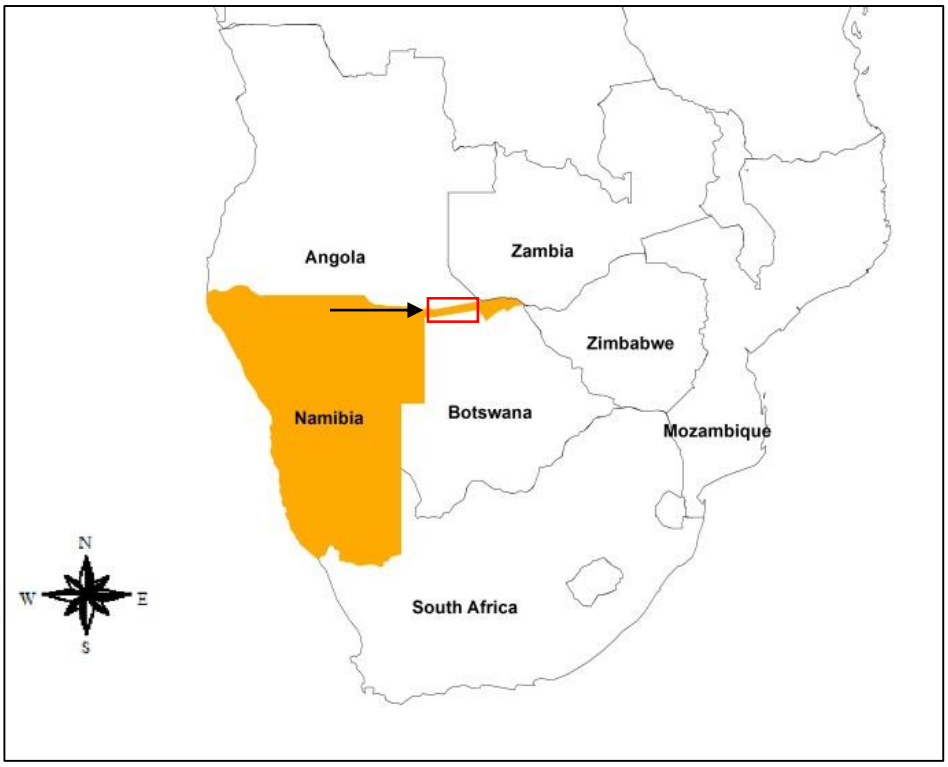


Figure 1: Map of the study area within a southern African context (*black arrow and red box indicates the locality of the Bwabwata National Park within Namibia).

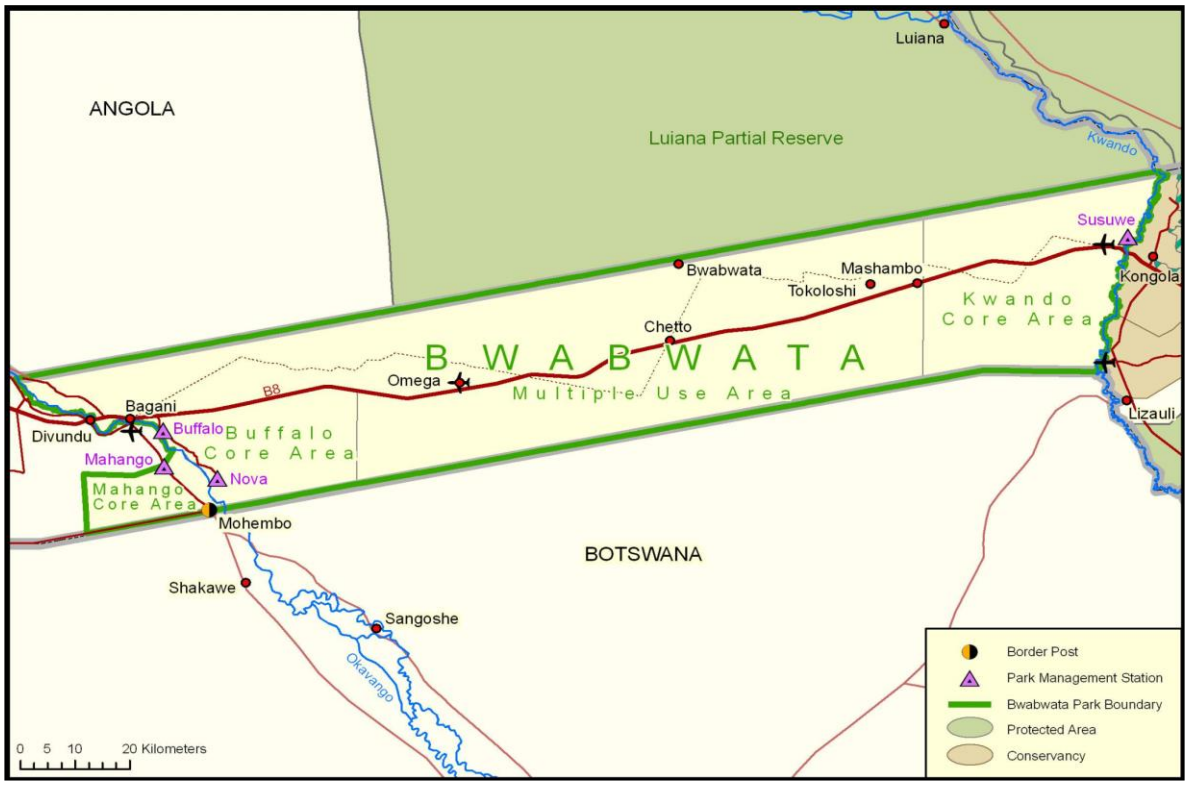


Figure 2: Map of Bwabwata National Park (BNP) within the Kavango East and Zambezi Regions (Ministry of Environment and Tourism, 2011).

2.1 Political boundaries: 'Caprivi no more'

In 2013, prior to the Namibian elections, the colonial name of the Caprivi was renamed and split into the Zambezi region, and the Kavango regions , namely the Kavango East and West (Immanuel, 2013). The BNP, thus straddles the Zambezi and the Kavango East regions (Figure 3).

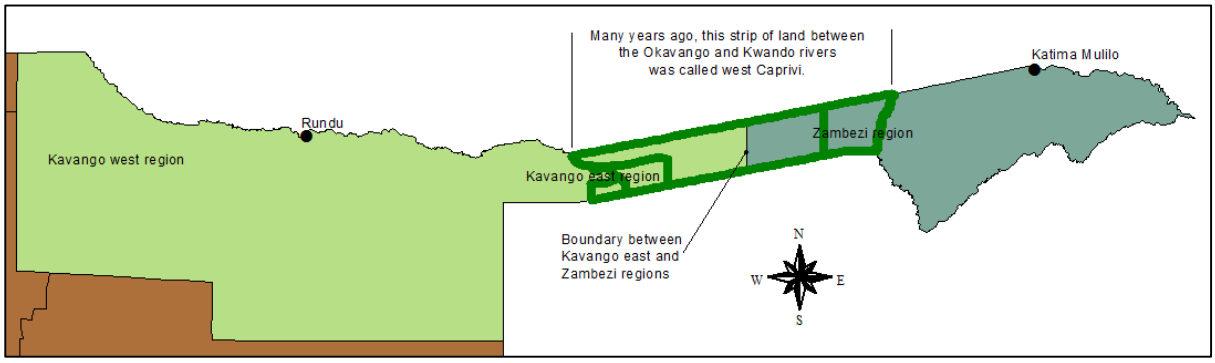


Figure 3: Map showing the delineation of the Kavango East and Zambezi Regions within the BNP (Le Roux, 2013).

3.1 People and land use

The majority of people in the Kavango East live in rural areas where the livelihood of the community is based upon subsistence farming and direct dependence on the natural resources (Beatty, 2011). Specifically, livestock grazing and crop farming together with natural product harvesting provide the basis of livelihood options for the inhabiting community (Beatty, 2011). The area has a population of 107 905 (Immanuel, 2013) and is home to two major and distinct indigenous people; mainly the Khwe San (population of 5 000 – 7000), and to a lesser extent Xk!k and Vasekela people, (LEAD, 2006). The Bantu-speaking Mbukushu people make up 16 % of the BNP's population and are politically dominant in the area since they are the only indigenous group with a Traditional Authority (TA) recognised by government (Dain-Owens *et al.* 2010). The Khwe San and Mbukushu are resident within the boundaries of the MUA within the BNP, and as such, the BNP is unique as it supports both people and wildlife. The western Kavango is the Khwe San's ancestral land (LEAD, 2006), and they have been burning the vegetation for hundreds of years and have a deep ecological knowledge of the area of plants and animals (Frederick Alpers. pers comm, Suzman, 2001, 2006). Yet, little is known about the Khwe-San and the Mbukushu's people's reasons for using fire.

The BNP has been divided into three wildlife core areas (Buffalo, Mahango and Kwando) and a large Multiple-Use-Area (MUA) to support key government constitutional biodiversity objectives. The MUA is zoned for community based tourism, trophy hunting, human settlement and development and the harvesting of natural resources is vital to the livelihoods of the BNP's surrounding and resident communities (MET, 2009). The Kwando and Buffalo core areas are prime riparian wild food collection areas for the Khwe community residing in the area (Mulonga, 2006). Before the arrival of the SADF, Khwe engaged in variety of livelihood strategies: hunting/trapping, veld food gathering, cultivation (millet, maize and vegetables) and fishing along both rivers (Jones & Dieckmann, 2014). Like most of the San in Namibia, years of dislocation, military service and resettlement have altered their relationship with the land (Suzman, 2006).

4.1 Landscape and Vegetation

The study area has the highest rainfall in the country (600 – 700 mm), and falls within the sub-tropical savanna region, (Cole, 1986, Moore *et al.* 2002, Beatty, 2011) on the Kalahari Basin, in the broad leave tree-shrub savanna biome of the miombo eco-region of southern Africa (Jones & Barnes, 2009), covering 20% of Namibia's land area. Most of the region is communal land, but a significant part is state forest, national park and a wildlife conservation area (Moore *et al.* 2002). The vegetation is influenced by three factors, namely soils, floods and fire (Trollope & Trollope, 1998). The dry, semi-arid to open woodlands characteristic of the region are nationally and officially classified as dry forests (MWAF, 2011).

The soils vary from Kalahari sand to hydromorphic and organic clay soils in areas that are regularly flooded by the Okavango, Zambezi, Chobe, Linyanti and Kwando River systems (Mendelsohn & Roberts, 1997). The region has the highest density and variety of trees and plants in Namibia (Ashley & LaFranchi, 1997). The dominant tree species occurring in the deep aeolian Kalahari sands belong to the subfamily Caesalpinioideae and comprise species typical of these ecosystems, of which are *Baikiaea plurijuga* (Zambezi Teak), *Burkea africana* (Wild syringa), *Guibourtia colesoperma* (False mopane) and *Colosphospermum mopane* (Mopane) (MWAF, 2011). Other species of relevance to the region are *Pterocarpus angolensis* (Kiaat), *Sclerocarya birrea, Terminalia serciea and Schiniziophyton rautanenii* (Mangetti) (MWAF, 2011). Historically, *P. angolensis* and *B.plurijuga* were commercially harvested from the dry woodlands (Erkkilá & Sisskonen, 1992, MWAF, 2011), but currently no formal or commercial logging is allowed (Mendelsohn & Roberts, 1997). Mendelsohn & Roberts (1997) with the use of satellite imagery and aerial and ground surveys mapped 36 vegetation units in the Caprivi. The vegetation units consisting of type and structure relevant to the BNP are depicted in Figure's 4 and 5 below.

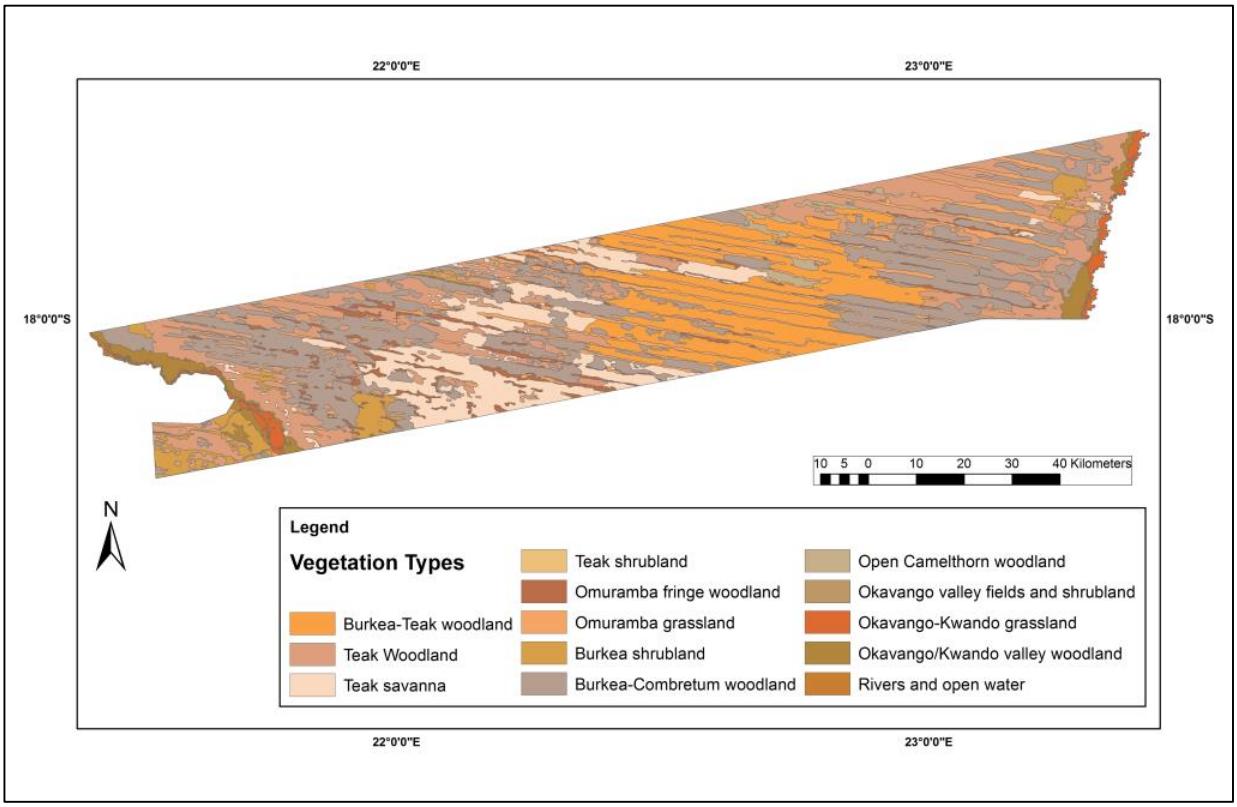


Figure 4: Map of the vegetation types within the BNP (Mendelsohn & Roberts, 1997).

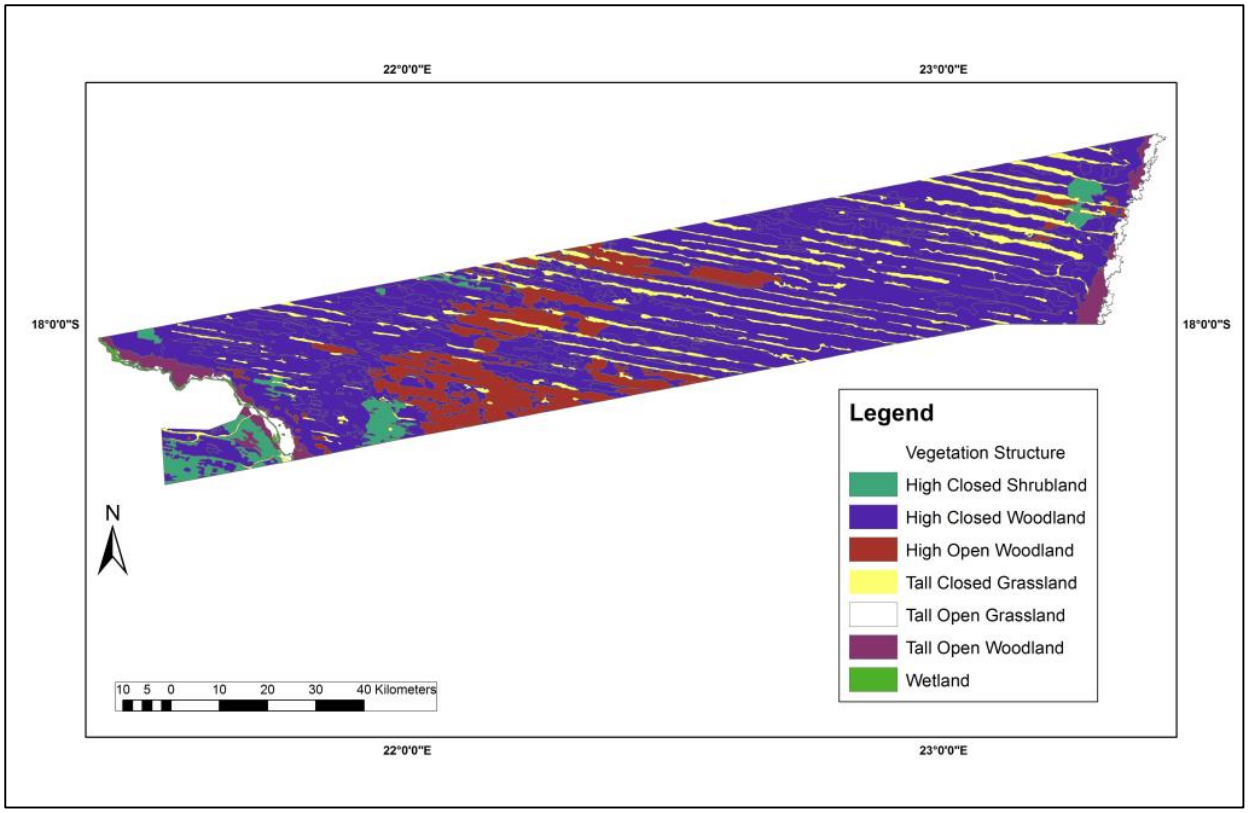


Figure 5: Map of the broad vegetation structure classification within BNP (Mendelsohn & Roberts, 1997).

1.1.1.1 Palaeo landscape: Linear dunes

The BNP falls within Mega-Kalahari sand sea classified as the Kalahari landform (FAO, 1984) that reflects major relic linear dunes with a roughly east-west orientation (Moore *et al.* 2012). Today these dunes are highly degraded, and in places only diagnosable by vegetation contrasts between the crests, which support tall trees separated by grass intervening ''straats'' (inter-dune swales) (MacFarlane & Eckardt, 2007). Former crest heights approximated ~ 90 m estimated from average straat width of 1.75 to /0.3 km separating adjacent dunes (Groves, 1969). Research by Moore *et al.* (2012) re-evaluated the antiquity and historical relationships among principal landforms of the portion of the high plateau of south-central Africa, designated the Kalahari Plateau. Moore *et al.* (2012) focused on the Pilo-Pleistocene history of the rivers, using details of landform evolution, climatological, archaeological, and biological evidence to inform key aspects of their synthesis. These major relict dunes with rough east-direction reflect episodes of pronounced aridity across the Mega-Kalahari sand sea, presumably when annual rainfall was well below 250mm, and thus, significantly below the average modern precipitation. Thus, the degraded east west orientated linear dunes indicate former episodes of extreme aridity, while fossil drainage lines provide evidence of a once well-watered environment. Locally these old drainage areas are referred to as *omuramba* (singular) and *omurimba* (plural) (Mendelsohn & Roberts, 1997).

Several observations point to the linear dunes being the oldest of the fossil landforms in the Kalahari landscape. Fossil evidence from Ethosha Pan brackets the ages of the linear dunes in northeast Namibia at between 4 to 2 Ma (Miller *et al.* 2010).

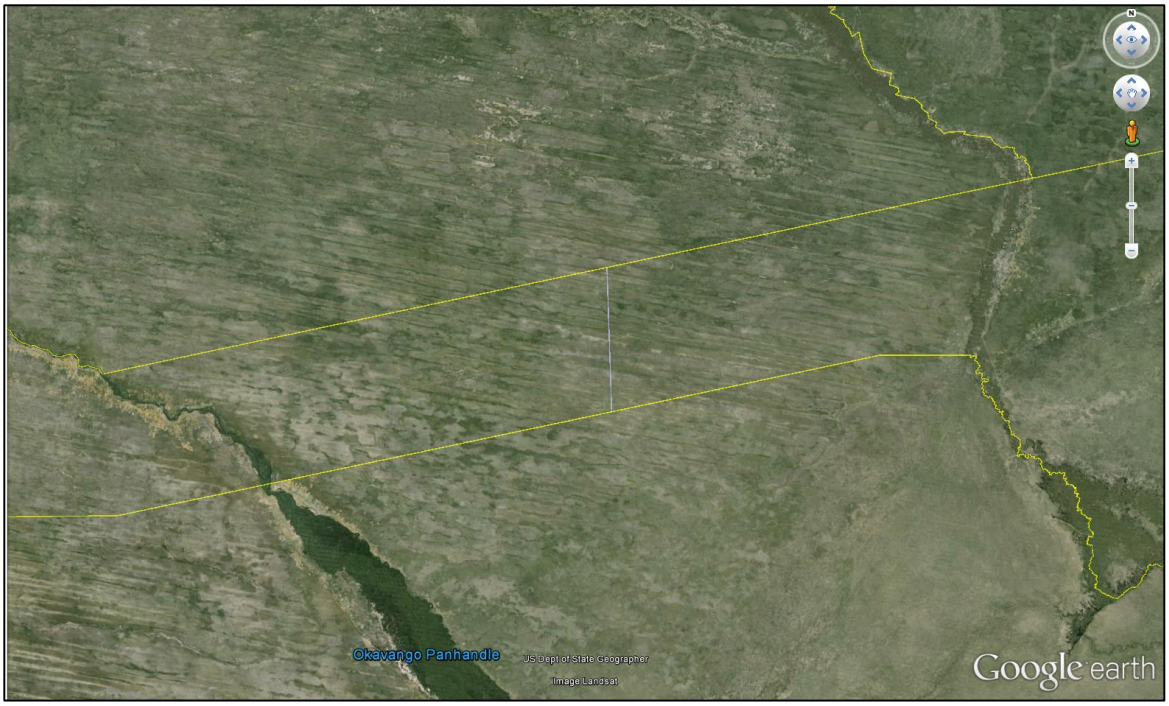


Figure 6: Google image showing the major relic dunes stabilised by vegetation in the BNP (Google, 2014).

5.1 Namibia's fire history

The most frequent and intensive fires occur in the north, orientated by a rainfall gradient approximately SW to NE direction (Trigg & Le Roux, 2001). Burned area mapping in Namibia dates back to the mid-1990s when a National Oceanic and Atmospheric Administration Advanced - Very High Resolution Radiometer (NOAA-AVHRR) receiving station was installed at the Ethosha Ecological Institute (Le Roux, 2010). Data was processed to analyse a 10 year period from 1994 to 2003. Generally, the fire affected areas in Namibia are confined to the central and north-eastern regions of the country, and follow an east to west rainfall gradient, with the consequential increase in fuel loads (i.e. grasses) – the ignition for fire in these savanna woodlands (Le Roux, 2011). Fire is a natural and regular occurrence, and has a fundamental role in the vegetation, wildlife and land use of the region (Beatty, 2011). The Kavango east and Zambezi region within KAZATFCA has experienced the same pattern of repetitive fire regimes for at least 17 years with late dry season fires (August – October) dominant throughout the region (Beatty, 2011). Communal lands have experienced low fire frequency around settlements and higher frequencies away from settled areas (Beatty, 2011). Beatty's (2011) observation is more than likely associated with human activities such as land use and clearing and an increase in barricades to fire (e.g. roads, fire breaks) in the area, which reduces combustible material around homesteads and communal areas. This observation concurs with Archibald's *et al.* (2013), and it is significant that the occurrences of fire observations are being made at finer (north-east Namibia) and much wider scales (African Continent). This iterates the importance of discerning when, why and how and where Namibian people burn vegetation for this particular study, versus the fuel laden grassland regions within the surrounding national parks in the KAZATFCA. Following the instigation of the Namibia–Finland Forestry Programme (NFFP) Integrated Fire Management (IFM) program in the late 1990's; the invested efforts saw a 54 % reduction in burned areas annually, and also a decrease in fires by 70 % (Moore *et al.* 2002). Furthermore, a survey examining local people's

perceptions in controlling fires in their communities showed that the positive effects of better fire control on the natural resource base were widely recognised (Virtanen, 1998).

More recent data collection for the area by Le Roux (2011) has revealed the locale to be currently characterised by a fire regime with a return period of every one to two years, with the burn season typically extending over 2 – 6 months of the year. The Kavango region has experienced significant increases in fires prior to and following 2006, when an early-dry season mosaic burn policy was instigated through a combined effort by governmental fire managers and a Namibian Non-Government Organisation (NGO) (Pricope & Binford, 2012). Pricope & Binford (2012) study showed that fire frequencies increased over all land use types with an increase in September irrespective of the fire management policy. A 71% increase was observed within communal, protected areas, including wildlife conservation [conservancies], and areas primarily used for agriculture and grazing areas (Pricope & Binford, 2012). Similarly Van Wilgen *et al.* (2004) found a comparable trend where fire frequencies in the Kruger National Park (KNP) stayed the same irrespective of the fire management strategy implemented over a 50 year period, however human ignitions strongly influenced the seasonal and spatial patterns of fires. Specific to the Kavango East Region, Pricope & Binford (2012) suggested that the underlying causes for the changes in the frequencies in the region to be attributed to climatic changes and variability, particularly in dry years and warm ENSO phases (Gaughan & Waylen, 2012). Figure 7 below shows the concentration of fires in the north-east of Namibia for the duration of 2012 (Ministry of Water, Agriculture, Forestry, 2013). The actual cause of the fires in the Kavango Region, as elsewhere in the world, where there is an abundance of fires is attributed to human practises; however state of the art satellite data are currently revealing opposite trends, where larger scale fires are being located in depopulated areas.

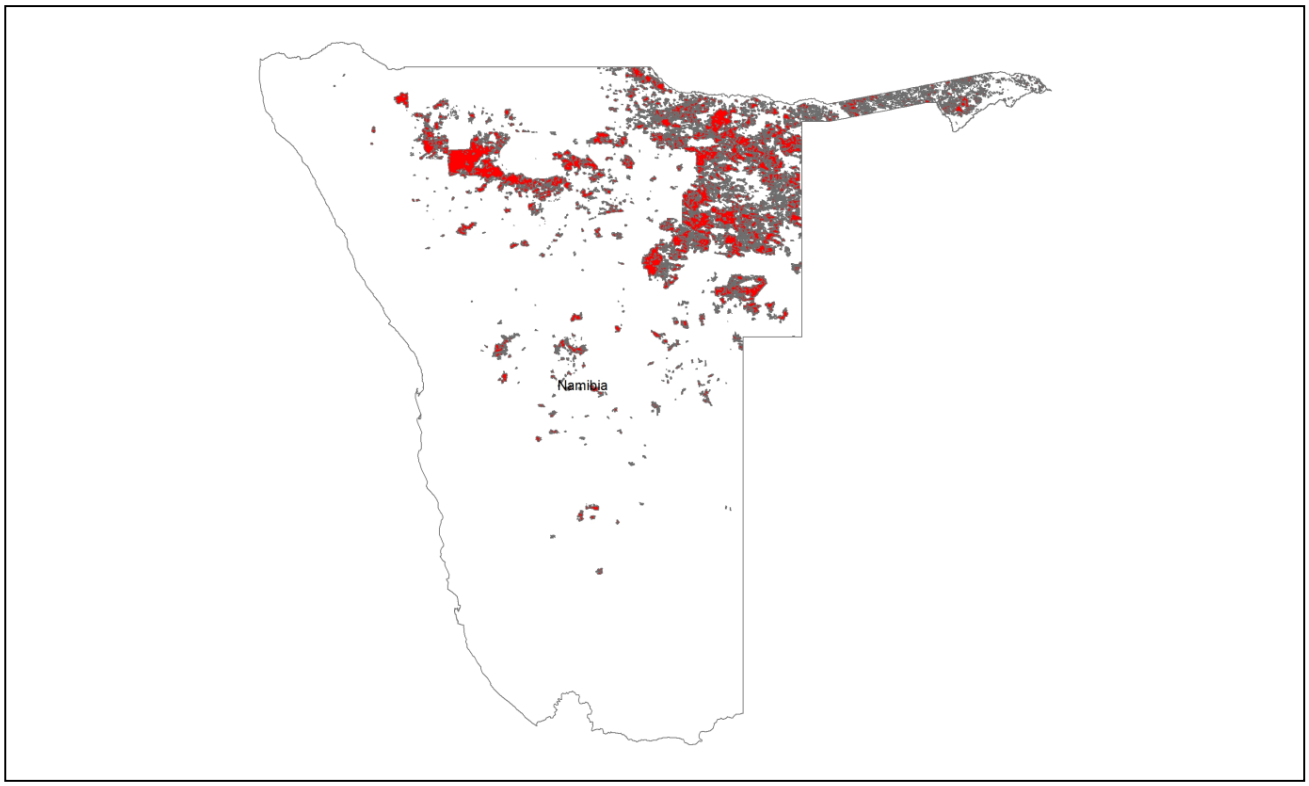


Figure 7: Map of Namibia showing the concentration of the fire regime in the north-east of the country, 2012 (Ministry of Water, Agriculture, Forestry, 2013).

A review of Moderate Spatial Resolution Spectroradiometer (MODIS) satellite data (2012) provides an indication of burned areas and extent in the BNP between the Okavango and Kwando Rivers (Figure 8). A distinctive burning pattern is evident with large fires occurring in the west, and small patchy burns in the east. The striated lines of burned area evident in Figure 8 may indicate the burning of the grass laden omurimba's, versus the tree lined dune crests. However, fine scale observations of the spatial burned area pattern in the BNP is undocumented on the ground.

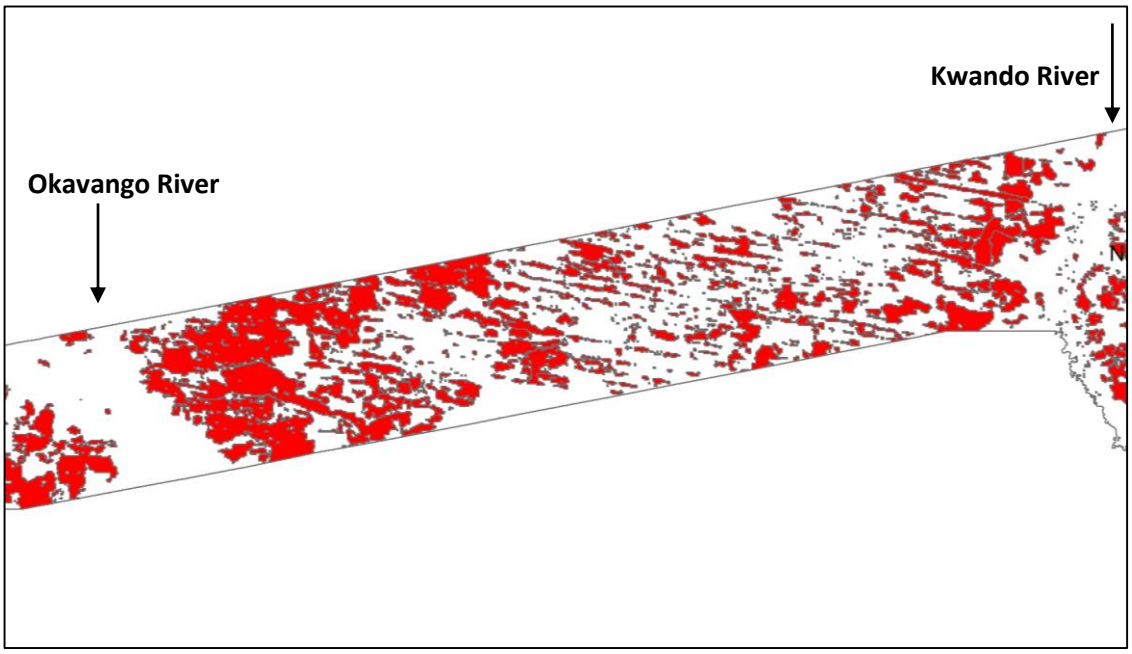


Figure 8: Map showing burned area (MODIS MCD45A data), 2012 (University of Maryland), and the distinctive pattern of large fires in the west, and small patchy burns in the east of BNP.

6.1 Fire policies: past and present

Namibia has been subject to Eurocentric forestry policies since the first inscribed policy in 1888. German colonial power (1890 – 1914) (Fisch, 1999) had significant and long lasting effects through the definition of boundaries and became crucial in rendering illegal activities (Boden, 2009). To date Namibia has received input from Germany, Finland, Australia and South Africa concerning fire management policy and implementation.

The first policy established under the rule of the *Deutsche Kolonialgeselllshaft fûr Sûdwestafrika* (1888) banned all fires because of the notion that deliberate burning destroyed forests and vegetation (Goldammer, 2001, Le Roux, 2011). In 1998 the Namibia Finland Forestry Programme (NFFP) was assisted by the Global Fire Monitoring Centre (GFMC) to develop ''National Fire Policy and Guidelines on Fire Management in Namibia'' (Goldammer 1998). The GFMCs objective was to bridge technology transfer to fire management and policy development in collaboration with a fire ecology research group. The NFFP formulated the first national guidelines called the 'Eastern Caprivi Integrated Fire Management Project' to emphasise fire, as a sustainable tool, if carefully timed and used (Goldammer, 2001). The foundation of the policy was to improve the environment and the living standards of local people (Beatty, 2011). Contrariwise, it was unclear if the project was effective in improving rural livelihoods in the East Caprivi. Kamminga, (2001) acknowledged that it is difficult to quantify the impacts of wildfires and the benefits of improved fire control among the communities.

The Directorate of Forestry (DoF) currently regulates fire management through the Forestry Act (2001) (Government of Namibia, 2001). Emphasis on fire suppression and prevention is pervasive in Namibia's Forest Act of 2001 and the *National Veld Forest and Veld Management Policy* – 1st draft (DoF-NFFP, 2004). As yet, there is no proposed statement on the use of prescribed controlled burning in either of these documents, and to date there is no forest fire policy for Namibia, although DoF produced a draft version in 2004 in collaboration with the NFFP (DoF-NFFP, 2004, Le Roux, 2010). These policies revoked local burning practises and control of fire by the traditional authorities in the region (Beatty, 2011), and as a result, recognition of the importance of seasonal burning to communities as part of their local land management calendar was overlooked (Le Roux, 2011). For example, the Namibia Forestry Strategic Plan (MET-DoF, 1996) states ''the occurrence and severity of uncontrolled and accidental forest fires has to be reduced, and the policy of burning of patches to improve hunting grounds should be changed to one of only using fire as a controlled tool under specific circumstances''. Communities in the region subsequently requested for the renewal of their community decision-making influences to carry out controlled burning in the region (Beatty, 2011). Yet, the policies objective was to strengthen the coordination of fire prevention and suppression among government, private and community stakeholders (DoF, 2005, Beatty, 2011). Implementation activities constituted discouraging burning through: education and awareness campaigns, firebreak networks and community training in wildfire suppression (Beatty, 2011). Consequently, in the mid-1990s, even though controlled burning was acknowledged as a fire management tool, it was rarely integrated into planning or implementation in the region at this stage of policy development. The lighting of fires on communal land was designated as illegal without authorization from the DoF (Beatty, 2011), and if people were caught lighting fires they were then fined by DoF authorities. Starting a fire and allowing it to spread to a classified forest or protected area (PA), or failing to put out a fire under instruction of an official or as dictated in a fire management plan (FMP) could result in the offender being fined up to $4000 (Namibian dollars) or up to 1 year in jail, or failing to put out a fire when legally in instructed under a FMP ($2000 and or to 6 months imprisonment (DoF, 2001).

In 1999 the NFFP was technically reviewed by southern Africa's fire ecologist, Professor Winston Trollope. Trollope & Trollope (1999) highly recommended that the Integrated Forest Fire Management (IFFM) be changed from fire suppression at the district level to a fire management program which includes controlled burning as an ecological necessity under certain circumstances. Further, it was recommended that the public awareness campaigns be adapted to differentiate between harmful effects of indiscriminate fires effecting the vegetation and the ecological necessity of using controlled burning. Trollope & Trollope (1999) stated that this would help restore the credibility of traditional knowledge developed over millennia concerning ecologically acceptable use of fire for managing natural vegetation.

In 2006, an Integrated Fire Management (IFM) programme was implemented within the context of Community Based integrated Fire Management (CBiFM) by the local NGO operating in the region, the Integrated Rural Development and Nature Conservation (IRDNC). This program resulted in the Caprivi Region Draft Integrated Fire Management Strategy and was developed by the DoF and Community Forest in North Eastern Namibia (CFNEN) in conjunction with the IRDNC Fire Management Specialist (Beatty, 2011). It was successfully carried out between 2007 – 2011 with the objective to support communities, national parks and forestry in the Caprivi Region. The CBiFM project entailed devolving the responsibility of fire management to the rural land owners in the region to enhance the adaptable strategy that

embraces wildfire hazard reduction, maintains and enhances land use, and ecosystems and biodiversity (Beatty, 2011).

The BNP Management Plan's objective concerning fire is to the use it as a management tool for actively maintaining and rehabilitating all habitats in the park (Ministry of Environment and Tourism, 2013). The plan acknowledges adaptive fire management specific to different habitats in the BNP, and stipulates the use of early burning as a management strategy to reduce the hot late season fires (MET, 2013).

Currently, Namibia, within a regional context, adheres to the Southern African Development Community (SADC) Protocol on Forestry (2010), advocating cross border co-operation in fire management. In 2011, MWAF published the 'A Forest Research Strategy for Namibia (2011 – 2015) and identified the following key focus areas related to sustainable forest management (SFM): fire as an ecological phenomenon, and the the social use of fire. To address these issues the strategy identified the following strategic forestry focus research areas, of which are relevant to this study: i. vegetation (forest and rangeland) monitoring; ii. forest products (value–added) research; iii. ecological research; iv. economic, policy and sociological research and management of information, amongst other key areas (MWAF, 2011 pg. 4). Furthermore, Namibia, bar the strides of advancement in the development of the community-based forest reserves, has acknowledged the need for improved technical and appropriate organisational development at both the national and community levels. One of the key actions stemming from the Namibian Forest Research Strategy is the identified focus area to monitor fires, including seasonal variation, timing, severity and extent to understand the dominant regional fire regime; and to understand the communities' interaction with fire, including attitudes towards fire (MWAF, 2011).

Social component

7.1 Overview

Although there is considerable research on the ecological effects of fire in sub-Saharan Africa, research on traditional fire management practices is very limited and the consequences of changes to historical fire regimes have not been adequately explored. This component examines historic and contemporary uses of fire as a land management tool among people residing within the BNP, and explores the potential impacts of changing fire management and fire suppression over the last century in savanna-woodland vegetation in north-east Namibia. Village members and key governmental ministerial staff were interviewed about historical and current practices, reasons for burning, the history of land use, and their perceptions of fire. Additional Participatory Rural Appraisal tools [PRA] (e.g. seasonal calendars, maps) were used to explore the current and historical context of the area and the use of livelihood resources within the park with community individuals and at focus group meetings. I hypothesize that local ecological knowledge will enhance the understanding of the use of fire, the importance of ecosystem services and the social-ecological complexity of fire management in the BNP.

8.1 Aims and objectives

1. To obtain oral histories, and the communities' perceptions of how they understand the role of fire and use fire in the BNP.
2. To determine what proportion of fires are accidental or natural, deliberately lit for agricultural purposes or stem from prescribed management burns inside and outside of the BNP.
3. What other techniques e.g. grazing or vegetation management are used to manipulate spatiotemporal patterns of fire?
4. To quantify what natural resources in the BNP improve local livelihoods and determine the role of fire in managing those resources inside the BNP.
5. Investigate if there are cultural/ethnical differences in the beliefs (Khwe San and Mbukushu) in the use of fire (e.g. how do different cultures think about and use fire as a practice?).
6. To obtain an understanding of the stakeholder perceptions of the fire regime in the BNP.

Community perspectives

9.1 Research Questions

i. How often, when, where and how much do local people use fire inside and outside the BNP, and for what purposes?
ii. What resources are important to people's livelihoods, and how are these resources impacted by fire in the BNP?
iii. To what extent do deliberate management and / or livelihood objectives determine the fire regime through fire ignition, suppression and manipulation of vegetation in the BNP?

Stakeholder perspectives

The objective was to gather stakeholder perceptions on the following fire related aspects in the BNP:

i. Fire management practises with a focus on early wet season and late dry season fires;
ii. Causes of fire in the landscape;
iii. Vegetation and fire regime change in reference to the past policy of fire suppression;
iv. Traditional and current use of fire by the local communities' resident in the BNP.

10.1 Methods (2014 – 2015)

Data collection involved a mixed approach of participant observations in the field, qualitative methods in the form of participatory rural appraisal (PRA) methods (Chambers, 1994), e.g. focus group meetings / informal discussions and quantitative methods, in the form of formal surveys (questionnaires); including secondary data: climate (rainfall), and fire seasonality data (MODIS MCD45A shape files) processed using ArcGis v10.

Semi-structured qualitative interviews and discussions formed the central part of my research. In total 60 interviews and 3 focus group meetings were carried out between 2014 and 2015. The objective of the community surveys was to obtain the communities' opinions and perceptions of how they understand the role and use of fire, historically and currently and how fire impacts on their livelihood resources in the BNP (Appendix: Table 1: Community questionnaire). Semi-structured / open-ended questionnaires, and seasonal calendars were used to elicit local knowledge about historical and current land use activities,

reasons for burning, including the timing, season and frequency of fire use and control, as well as observed fire and vegetation changes over time. Formal surveys with governmental ministry and council staff, BNP park management and staff were carried out and addressed aspects of their understanding of the use of fire in different seasons in the BNP, perceptions of early wet season and late dry season burning in the BNP, drivers of the fire regime (ecological and /or social factors), and past fire suppression policy implications (Appendix: Table 2: Stakeholder questionnaire).

11.1 Data collection (2015)

Data was collected intensively over a 4 month period in 2014 and 2015. This field work period occurred within the two main fire seasons in BNP: early season (May – July) and late dry season burning (September – November) periods. This time frame allowed for observations in the field of when, how and where people use fire in the region. For the duration of the community data collection period I camped within the villages, and usually in close proximity to my translator's home or to the village headman's homestead. My observation strategy entailed walks with the villagers in the community areas and presented me with the opportunity to observe land management practises, recent burns, historical burnt patches, and possible differences between early and dry season burnt patches, and environmental determinants in the landscape. During interviews in the town of Katima Mulilo, I stayed with local residents which provided me with the opportunity to network and locate other stakeholders of interest within the Ministries and in the surrounding area.

I extended my survey area to include stakeholders' from the Zambezi region (former eastern Caprivi) due to the history of the DoF Namibian Finland Forestry Programme (NFFP) that was initiated in 1996 that subsequently resulted in a change in policy concerning fire management in Namibia. The Zambezi and the Kavango east regions have been exposed to external influences concerning fire management, which subsequently resulted in the instigation of fire management modifications at different time scales in Namibia. Even through forest fire management strategies differ vastly from savanna-woodland fire management, I focussed on the forestry and BNP stakeholders' fire management perspectives, as one of my fundamental objectives was to investigate and understand the scale of the implementation of fire management in the region. Secondary data sources consisted of the reports published in the region by governmental departments, NGOs, and archival records obtained from the Namibian Scientific Society, and relevant newspaper and radio reports concerning fire in Namibia.

12.1 Community Data

Thirty six community in-depth semi-structured interviews were carried out with Khwe and Mbukushu participants from 8 villagers in the MUA, in the east, central and western areas of the BNP (Figure 9). The questionnaire was divided into 4 categories and included: i) cultural practises and beliefs; ii) land use practises; iii) vegetation and fire history, and iv) livelihood resources. Twenty six Khwe inhabitants (72%), and 10 (28%) Mbukushu were interviewed. A well respected non-political translator was selected in the community with the assistance of the IRDNC. For all the interviews a translator was present to translate each question and response. Due to the sensitive nature of the use of fire in general, interviewee names will be withheld to protect people's identities from retaliation from local authorities (Butz, 2009). Typically the interviews lasted approximately an hour, and in total 35 hours constituted the interview time period.

The male of the homestead is regarded as the head of the household among the Khwe and Mbukushu, thus the majority of the interviews were carried out with men (81%), and 19 % with females in the BNP community. Culturally recognised adult age class community members were selected to ensure a broad range of experience of traditional fire management was captured. Over 90% of the respondents were over the age of 60 (Appendix: Table 3). Twenty six open ended questions were asked pertaining to fire and land use, the current fire regime, reasons for burning and their applied land use burning techniques and perceptions of fire. All interviews were conducted with the consent of all individuals present, and prior to the interview permission to record the dialogue was requested. Interview sessions were recorded with a recorder to ensure that all ideas are accurately and completely captured. Responses were used to create a database of when, how, where and how frequently fire is used and for what purposes fire is used in the BNP.

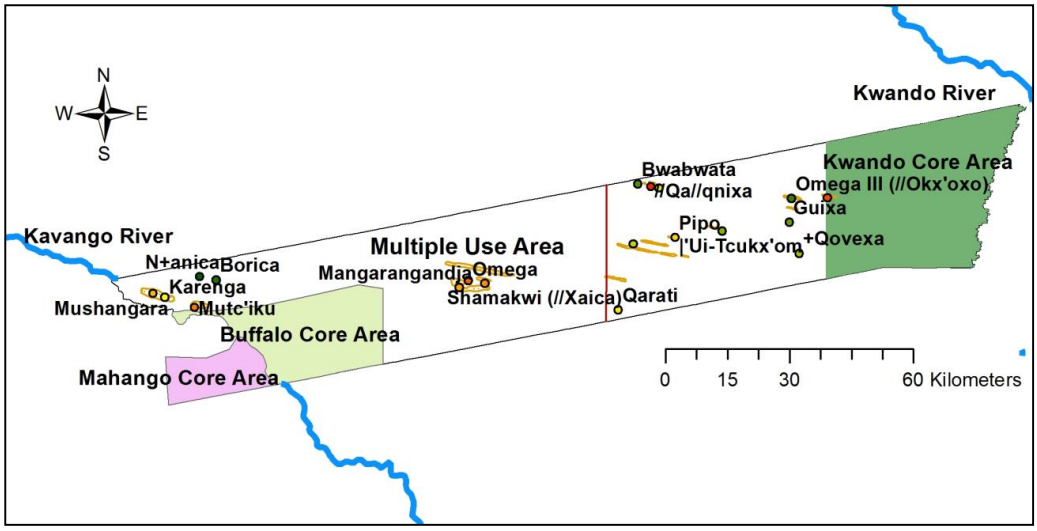


Figure 9: Map showing the BNP cores areas and community settlements in the Multiple Use Area (MUA).

13.1 Stakeholder Data

Twenty four in-depth semi-structured interviews were carried out during the two field visitations during May – July (2014), and in September and November (2015). Fourteen open ended questions were used in the questionnaire and held with representatives from the Ministry of Environment and Tourism (MET), Ministry of Agriculture, Water and Agriculture (MWAF), Directorate of Forestry (DoF), Non - Governmental Organisational (NGO), the Integrated Rural Development and Nature Conservation (IRDNC) staff members, BNP natural resource managers (i.e. BNP east and west chief wardens, BNP community game guards (CGG), BNP field rangers, academic staff from the University of Namibia (UNAM), and Polytechnic of Namibia (PoN), the state veterinarian, independent ecological consultants, and with regional local stakeholders (e.g. tourism operators). My objective was to interview in country representatives from diverse disciplines and key governmental departments involved in fire management to investigate their perceptions of fires, fire management practises and use of fire in the region. All interviews were carried out in the BNP in proximity to the core park stations (Buffalo and Mahango Core Areas), in the capital (Windhoek) and in the town of Katima Mulilo in the Zambezi region. One interview was carried out in Cape Town. Twenty eight percent of the respondents were representative of MET, 21 % of DoF, 18% of private consultants, 11% IRDNC, and 14% were from academia, and 7% were other (State veterinarian and lodge owner). In total 22 males and 2 females were interviewed.

Table 1: List of semi structured interviews and their locality in Namibia [2014, 2015].

Summary of Interviews

No	Type	Location
24	Stakeholder Interviews	Windhoek, BNP and Katima Mulilo, Cape Town
26	Khwe-San interviews	Mutijuku, Pipo, Chetto, Mashambo, Tokoloshi, Omega III
10	Hambukushu interviews	Mut'ijuku, Diye, Mashshane
3	Focus Group Meetings	Chetto

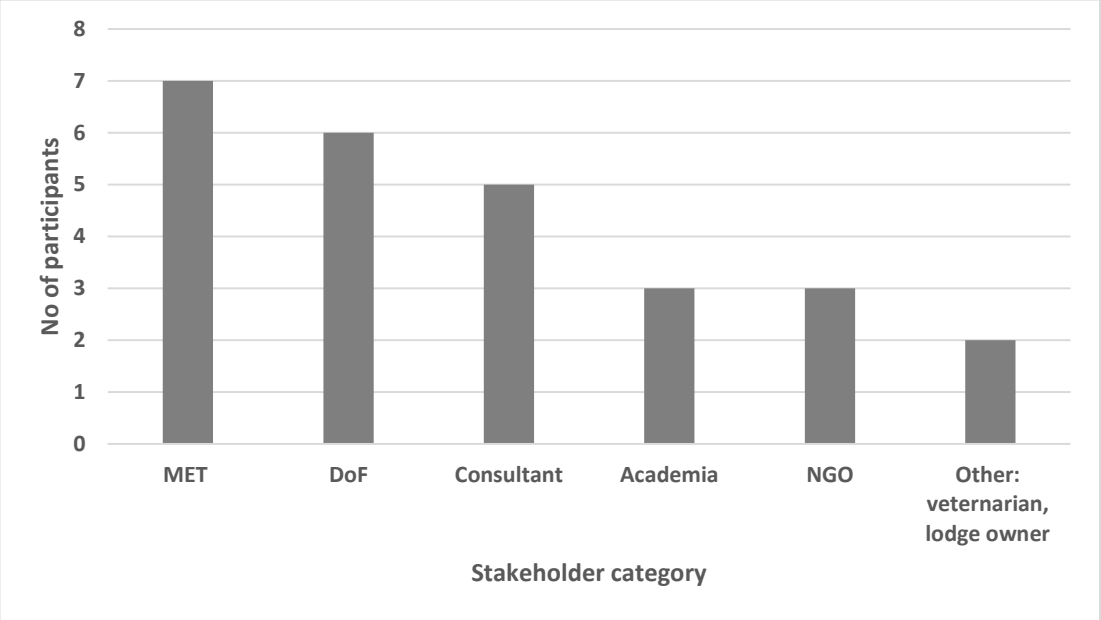


Figure 10: Number of interview participants within each stakeholder category [n=24]. * MET (Ministry of Environment and Tourism); DoF (Directorate of Forestry); NGO (Non-governmental organisation).

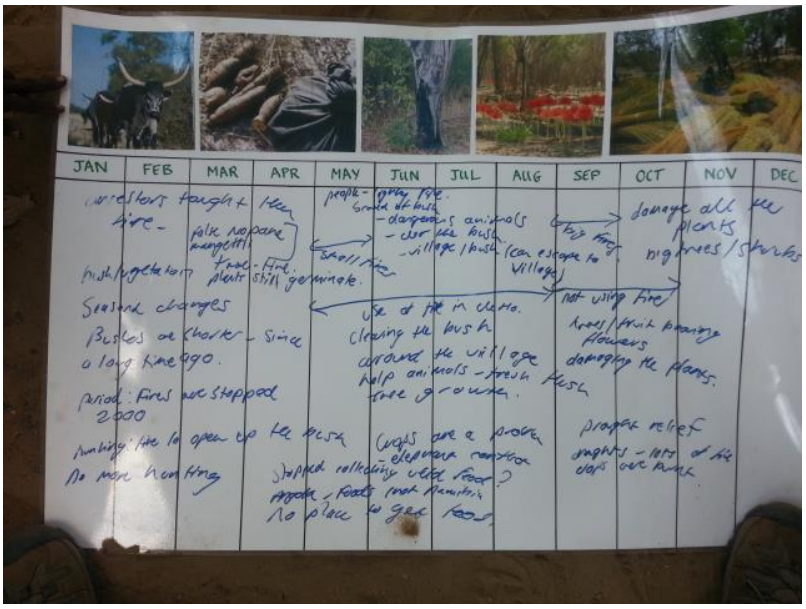
14.1 Focus group meetings

In addition to the individual interviews, three unstructured community focus group meetings were held in Chetto village at natural informal gatherings in the MUA to engage a larger audience, build rapport within the community, and clarify conflicting information (Butz, 2009). A seasonal calendar with columns for each month was used to address the seasonal use of fire and resource use in the BNP. Thus, the seasonal calendars were used as tools to carry out the focus group meetings in Chetto village. Following the interviews, I used the seasonal calendar to clarify my questionnaire and validate the answers to my questions with individual participants. Frequently the family of the participant would join in during this activity, which resulted in debate and discussion concerning fire and resource use in the community. The community questionnaires were used as guide to base my questions concerning the communities' use of resources in relation to fire.

Photograph 1: Focus group meeting in Chetto village involving the discussion on the use of veld food resources in the BNP.

1.1.1.2 Seasonal calendars

Indigenous ecological calendars, also known as seasonal calendars used in social research were used to document people's knowledge of seasonal patterns and ecological time (Prober *et al.* 2011) in the study area. Seasonal calendars are typically explored together with individuals or groups of people with the use of either illustrations and/or statements of characteristics associated with major seasons or months over an annual period (Photograph 2). Seasonal calendars were used to explore annual environmental and seasonal land management changes with the following themes: fire regime; climate, land use, resource harvesting and cultural practises with members of the community. The calendar method was presented to participants and informal groups to elicit seasonal information concerning the themes noted above.



Photograph 2: Example of a seasonal calendar following an individual interview within the BNP.

15.1 Additional method: use of visual aids

A locality map (1: 250 000) was used as visual aid during the questionnaires to assist with the identification of where small and large fires occur in the BNP (Mistry, 1998) (Photograph 3).

Photograph 3: Example of using topographical maps to question the locality of large and small fires in the BNP.

16.1 Data Analysis

My data analysis is centred on qualitative data techniques. The content of the interviews was explored to make preliminary reflections and gather ideas and knowledge about the community and their perception of fire, which involved re-reading the texts several times. Interview transcripts and field notes were thereafter systematically coded for emergent themes using a grounded theory (Glaser & Strauss, 1967) analytical approach. The interpretative process involved summarizing the data and organizing and integrating observations into separate meaningful sections, through organizing the data into thematic codes using a pre-defined list of codes developed from the emergent themes in the data (Figure's 11 & 19). I grouped similarly themed categories to identify instances where participants described their perception of, use and role of fire in the BNP. Results were verified, contextualized and triangulated by referring back to full transcripts, interview summaries, and field notes. In dealing with large amounts of transcript interview qualitative data, computer assisted qualitative data analysis (CAQDA) programs assist one in systematically structuring and organizing the data for further analyses. Throughout my field work I kept detailed notes on my interviews, field observations, and research reflections which amounted to over 45, 000 words. With the use of CADQA, pieces of text (i.e. interview responses), which indicate people's perceptions and beliefs were coded through continuous interpretation and analysis. The process is iterative, and involves the continual refinement of the emerging themes/codes within the data, as further insights are gained. The identified codes are then aggregated into categories, which facilitate the conceptualization and development of theory. This process was enabled by Atlas.ti (Version: 7.5.10), a

qualitative software program that facilitates systematic analysis of data and assists in the process of categorization and coding, developing themes, and organizing data segments (Creswell, 2007). Coding forms an important part of the analytical process (Namey *et al.* 2008).

17.1 Conceptual model

With the use of the exploratory analysis, and the code co-occurrence table I derived a conceptual model based on associations/relationships between codes for the community and stakeholder data. The final stage of the model led to the use of main codes and sub-codes (Figure's 11 & 19), which were used to create a conceptual model showing the associations between the codes explaining the patterns and linkages between codes. This facliltated an understanding of the phenomena described by the the community concerning their use of and current perception of fire in the BNP. The benefits of using a grounded theorterical analysis framework based on a data driven approach, allows one to use the emergent themes and create a network of linkages to provide a theorectical explanation of the data.

Preliminary Results

18.1 Community perspectives

The exploratory qualitative approach to this research was firstly aimed at eliciting i) why, when, where and how often inhabiting communities use fire in order to determine the historic and present land use practises associated with fire in the BNP landscape; ii) to determine what veld food resources are important to people's livelihoods, and how these resources respond to and/or impacted by fire; iii) To determine to what extent do deliberate management and/or livelihood objectives determine the fire regime in the BNP landscape; iv) to determine the perception of the community of change in the fire and vegetation in the region.

Analysis of the combined responses of the community interview data led to the emergence of 14 main codes, and 72 sub-codes (Figure 11). In the analysis, seven significant themes pertaining to the historical and current context of fire use by the Khwe-San and Mbukushu emerged, of which will be discussed in this section. The themes were: traditional fire practises (n=36), veld food resources (n=35), early burning (n=33), knowledge transmission (n=33), hunting (n=31), land clearing/field preparation (n =30), and historically, the use of fire to aid tracking an animal during the course of a hunt (n=24); Figure 12.

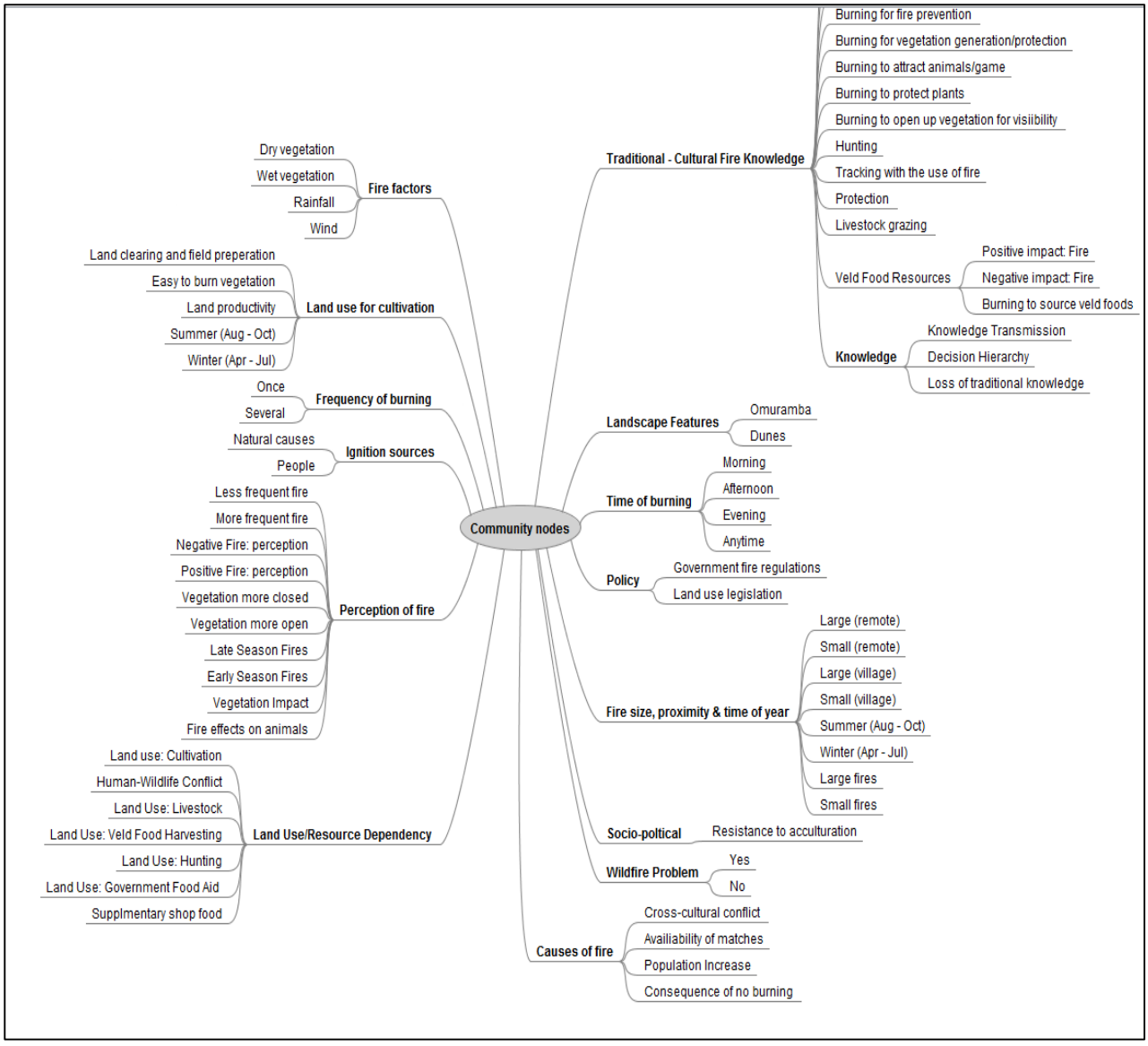


Figure 11: Map showing the main [n = 14] and sub nodes [n= 72] categories based on thematic content analysis of interview data (n = 36) for the BNP community.

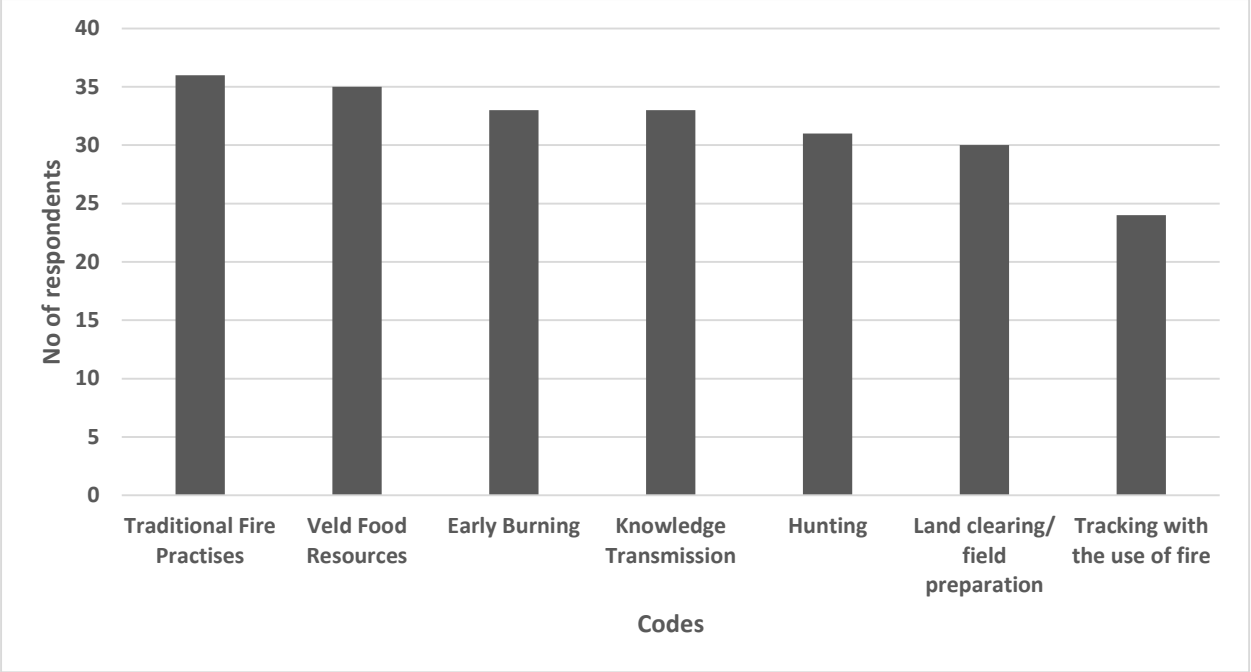


Figure 12: Thematic prevalence of codes associated with the use of fire described by the BNP communities. *Note the numbers on the y axis refer to the number of respondents who provided each response.

19.1 Historical and current burning strategies

The first questions posited to the individual participants in the questionnaire were orientated to gather an understanding of the use of fire since respondents could remember, and thus, the earliest accounts of the use of fire in the community emerged. Historically the use of fire in the earlier months of the year was central to the Khwe- San fire knowledge base and was described as a fire that was lit between April and July. Several participants identified two distinct phases of savanna fire seasons: the earlier seasons conductive to wetter and cooler conditions, and the later season fires with dry, hot conditions. The early season fires were described as small, and controlled fires. The Khwe-San used early burning in the landscape as a deliberate management strategy as a planned and organised part of their burning system. Three significant traditional activities related to the Khwe-San's early burning strategies emerged, of which were veld food resource gathering and hunting and tracking activities. The use of fire in association with hunting and tracking has significant consequences for understanding human interactions with the fire regime.

The Mbukushu participants made reference to the use of early burning strategies for stimulating the germination of grasses for livestock grazing purposes (Figure 13).

> *''Early season burning is good for the vegetation, the grass is germinating for the cattle, but you must watch the wind'' (CASE 33: Mbukushu)*

The main difference between the Khwe-San, and the Mbukushu is that the latter use early burning for managing grazing areas for their cattle [n=7]. Although, the Mbukushu made reference to the act of hunting [n=7], no references were made to the use of fire for tracking purposes. When asked whether early burning strategies were still being employed, a number of Khwe referred to a past early burning

system, and others stated that they still use early burning today. The historical and recent socio-political situation of the region is intricately embedded in understanding the role and use of fire by people in the landscape today, as I will late draw focus to.

Analysis of the combined interview responses resulted in the identification of ten associations of historical and current use of fire use to early burning strategies in the landscape (Figure 13). The participants' use of early burning was associated with burning for vegetation regeneration and protection of plants [n=21] for veld food resources [n=14], and was related to burning to open up the vegetation for visibility [n=9], for the sourcing of food plants on the dunes [n=17]. Participants spoke frequently of the maintenance of the productivity of veld foods in relation to fire and keeping the environment healthy, so the trees, and smaller shrubs keep producing fruits with the use of early burning [n=14]. The Khwe-San refereed to the use of early burning to protect the plants, and frequently it was stated if one burns late, the plants will be destroyed. Local inhabitants typically burn to remove the grass beneath specific trees (e.g. false mopane) to easily locate the fallen fruits on the ground, and would burn to remove vegetation for their protection [n=23] from dangerous animals whilst out collecting veld foods.

> *"Very different now; open areas/omuramba's or the pans there you can burn as there are no important plants there, but in the forest you cannot burn as there are many different types of food (tsinge,tse, Claya,), so you don't kill other people by burning". Too much fire is killing our people. (CASE 7: Khwe).*

> *''No fire use in the late season because it destroys the environment / trees/ shrubs in Sept/October - prevention of that they used to -burn earlier rather'' (CASE 23: Khwe)*

Burning earlier in the year was coupled with burning to open up the vegetation for visibility for the purpose of hunting activities [24]; [n= 22] [n=11], and for tracking with the use of fire to remove grass to facilitate ease of finding an animal's tracks whilst on the hunt [n= 21]; (Figure 13).

> *''Khwe burn because of the thick bush, or grass, because you cannot see the tracks of the animals - important to burn before grass is too thick, cannot see tracks - other tribes anytime; if you burn the grass then you have to burn early '' (CASE: 5: Khwe)*

In combination with burning for tracking purposes, the Khwe San men burnt dense vegetation for the protection of women whilst they are collecting veld foods close to the village to increase the visibility of possible dangerous predators in the vicinity [n=10]. Further, if during the hunting trip, the hunters detected Mangetti trees en-route, they would return the next day to burn the area to detect the fallen seeds. Men typically move further away from the village for hunting trips, whereas the women stay closer to the village.

> **"***Using fire when we go hunting , the old grasses and thick bushes are burnt on my way and if I find Mangetti trees; I go back and discuss and then go burn the next day and collect the seeds'' (CASE: 23: Khwe)*

Traditionally the decision to burn a particular area was based on instructions from the elders within the community, and carried out by the younger members of the population typically during a hunting trip. The elders were informed by the younger men of the status of the vegetation, and thereafter instructions

were issued to selected individuals to return and burn designated areas. Fire knowledge is transmitted through observation and practise. Punishment for accidental fires was carried out by the *induna* (chief of the village) and consisted of a fine of livestock (e.g. cow), but this system no longer exists in the community.

> *''Any person cannot burn, and the elder people choose people to go and burn, so the older people. Elect people to go and burn'' (CASE: 7: Khwe)*

> *"Patch burning: starts in April surrounding the village, and in May patch burning in the bush. This is from the ancestors''. Patch burning start with the elder people tell the young people to put fire close to the village and where to burn, and to be careful, and that the fire should not go further, and that they should stop it. Around for many years'' (CASE 15; Khwe).*

Currently, the BNP communities associate early burning activities with government fire regulations being carried out by the game guards on patrol in the BNP [n=8]. Nowadays, the Khwe-San are hesitant to use fire due to the instilled government fire regulations and associated policies opposing burning of any kind, and subsequently, the communities have been warned not to burn.

> *''Long ago people used more fire than today; government is saying we cannot keep burning the forest- so people are scared to use fire now'' (CASE 26: Khwe).*

Twenty of the participants' referred to a loss of traditional knowledge concerning the use of fire. The communities attributed a breakdown in fire knowledge due to the recent government fire regulations, and the ensuing effect of not being able to practise their traditional fire practises, which has resulted in the breakdown of communication between the elders and the youth concerning the use of fire. Nonetheless, whilst in the field (2015), I observed a number of early season fires which were in proximity to the village areas in the months of May – June, particularly on the dune crest ridges. Participants associated a deterioration of the appropriate timing for the use of fire to a breakdown in traditional norms, the elders no longer communicating their fire practises to the youth, an absence of interest amongst the youth about local bush knowledge due to the attendance of school, parental restrictions in the villages enforcing the youth to stay in proximity to the homestead, and to a shift in the youth towards western needs. There is concern among the communities that the loss of traditional knowledge, and the frequency and timing of fires is affecting the veld food resources.

> *''They were using their forefathers rules but now because of MET people are realising that the veld fire is destroying our vegetation- now they used to come with their programmes telling the community to stop burning - they listened to the Ministry'' (CASE: 22: Khwe)*

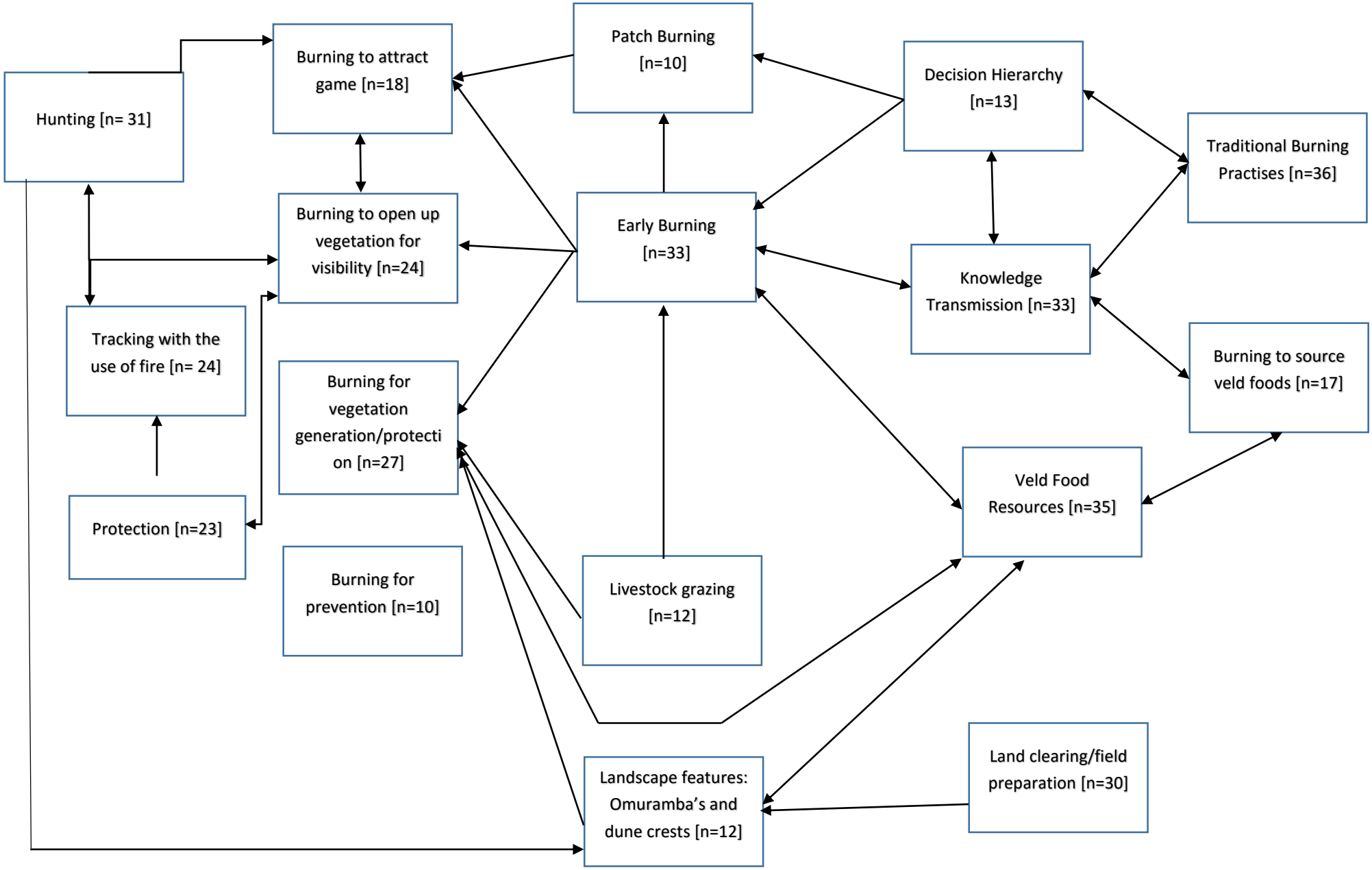


Figure 13: Conceptual model showing the associations between historical and current traditional-cultural practises by the BNP communities. *The numbers in parentheses refer to the number of participants who provided a response for each theme.

20.1 Community perspectives of fire

Twenty four of the interview participants' had a preference for using early season fires versus burning later in the season. Reasons associated with a preference for early season burning were related to the negative impact fire has on veld food resources [n=20], and on vegetation [n=18], due the late season fires [n=19] (Figure 14).

> *''Sometimes burning has a negative side as the fires kill of veld foods; when the fire comes to the food plants - it will kill the food plants itself and you won't find that type of plants anymore (CASE: 22: Khwe) .*
>
> *''Keep to the right month ; fire is good at the right time; late season burning destroying the vegetation - veld foods; late burning in late months - it destroys'' (CASE: 25: Khwe)*
>
> *''Fire is not good for the veld foods if you burn late - need to burn early before they start germinating'' (CASE 22: Khwe)*

Participants were equally positive [n=28] and negative [n=27] about fire, however most were of the view that the late season fires should be stopped because of the detrimental effect on veld food resources [n=35].

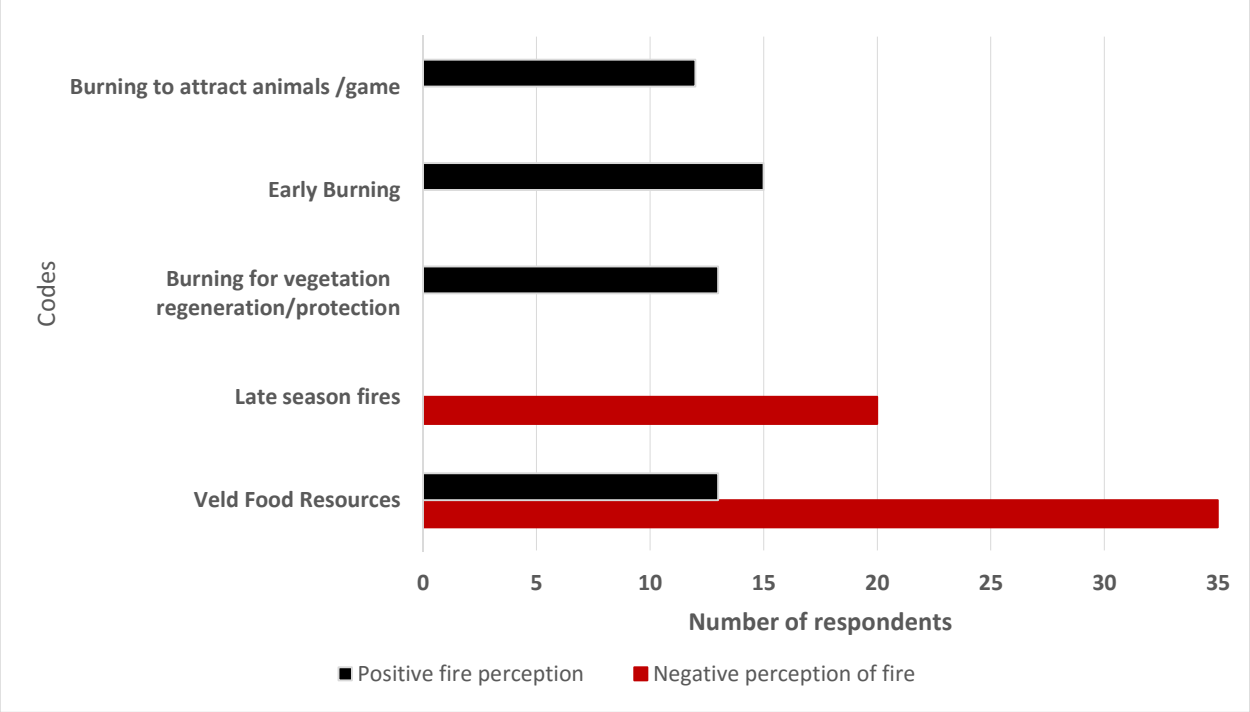


Figure 14: Number of node co-occurrences associated with a positive and negative perception of fire within the BNP community.

Some of the tree species that were most frequently mentioned to have decreased or disappeared from their gathering sites on the dunes include *Pterocarpus angolensis, Strychnos pungena*, *Strychnos cocculoides, Schinziophton rautanenii*, *Grewia retinervis, Dialium engleranum, Acaia flekii, Vigna vexillata, Tinospora fragosa, Baphia massiensis, Terminalia prunoides, Guibourtia coleosperma, Garcinia livingstonei, Bechemia discolour, Ximemia Americana, Dioscores sp., Ochna pulcra, Garcinia livingstonei,* and *Burkea africanum*. Many of these trees are sought after as food (i.e. fruits and leaves), medicine or wood. Although some of the older specimens are still found, people observed a lack of regeneration of the younger plants. Plants which

are important particularly to the Khwe-San were *Diospyros chamaethamnus,* and *Terminalia sericea,* however appear to not be impacted by fire (perss.observation). *D. chamaethamnus* is particularly abundant after the early burns, and appears to be one of the first species to flourish following the onset of an early burn in the landscape. *Harpagophytum procumbens* commonly known as 'devils claw' is largely sought after for its commercial value (medicinal properties) and there is a harvesting programme in the region where by the community profits from the collection of this plant. Although, the stakeholders and community members mentioned that frequently fire is used in September and October to locate this plant by burning the vegetation in the vicinity.

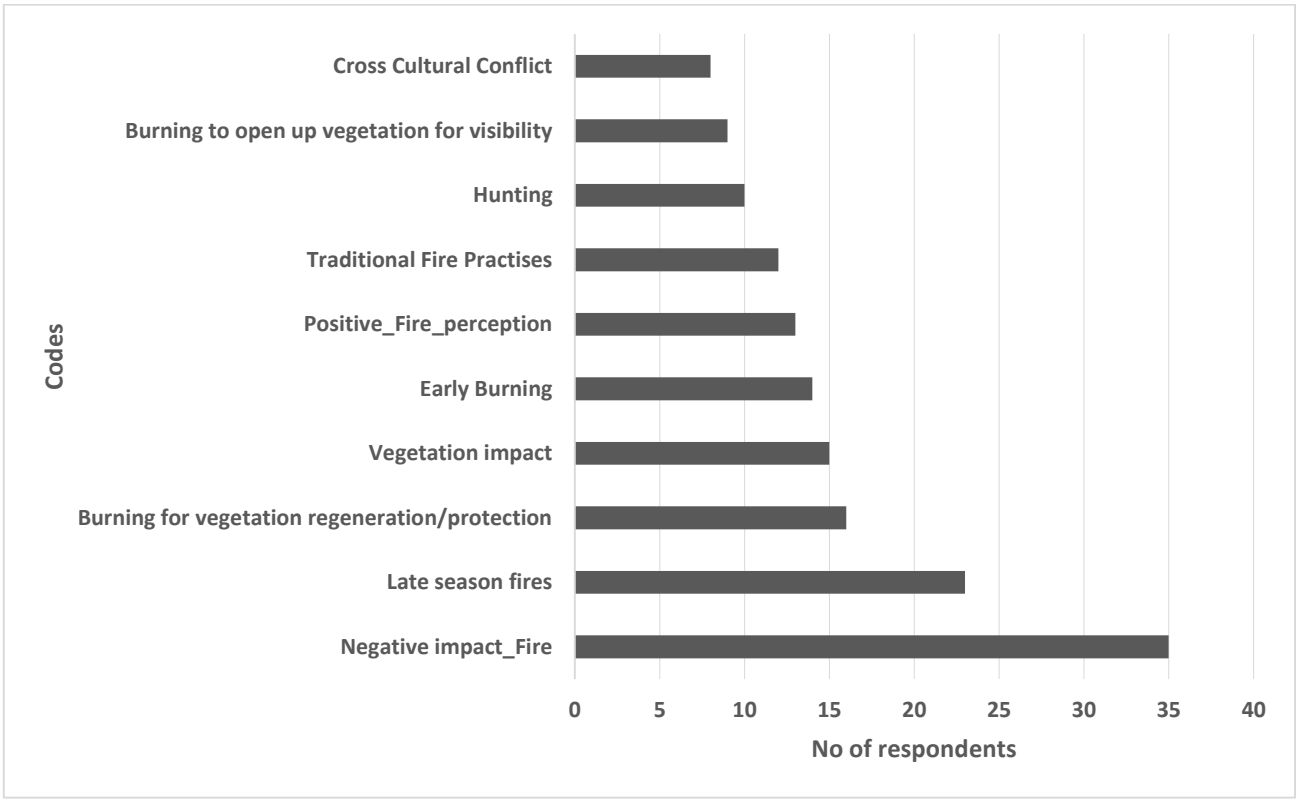


Figure 15: Intensity of node co-occurrences in association with veld food resources in the BNP community [n=36].

For the people, burning without purpose and benefit is seen as a negative use of fire. All of the respondents associated people with the cause of fire [n=36], although 9 respondents also referred to the occurrence of natural causes (i.e. lightning) and fire as a natural phenomenon in the landscape.

> *''Not only humans, and natural, after the rainy season the fires start. Rain clouds causes the fires, natural fire can also kill people and come into your village. If fire comes in your direction you hide under the fallen tree'' (CASE 17: Khwe).*

21.1 Cultivation, fire & livelihoods

A need among Namibian fire stakeholders is to understand why, when, where and how is fire used by resident communities in the BNP landscape. Fire is used to manage the brush piles remnant from field clearing in preparation for the cultivation of crops consisting of old branches from trees and dry grass [n=30] (Figure 13), prior to the rainfall season in October and November [n=19] (Figure 18). Inhabitants also stated that due to the brush piles being dry, it is easier to burn at this time of year as the fire, and fires are typically of short duration [n=8], and only typically burn once prior to planting crops [23]. Burning at this time of year is also related to increasing the soil productivity, which beneficial to the growth of crops [n=12]. Although, a few participants referred to the occurrence of runaway neighbour fires due to fires created for cultivated purposes. The late hot season fires (Aug –Oct) subsequently coincides with the community use of fire for their livelihoods based on cultivated crops (Figure 16, 17 & 18). The Khwe-san accounted of their use of fields and fire and stated that there fields were typically far from villages and were left for long periods of time, however there has been in an increase in wildlife conflict, and for this reason a few Khwe currently use cultivation as a form of subsistence. Khwe-san were resistant to this change in livelihood subsistence from resource dependency to being sedentary with cultivation practises (code: resistance to acculturation) [n=9]. The Khwe stated the importance and their dependence on veld foods resources as part of their current livelihood options. Due to an outbreak of teste fly in the 1960s their cattle were confiscated by government, as such few Khwe-San currently own cattle. The cattle owners in the region are the typically the Mbukushu (pastoralist community). When asked about resource dependency, the participants indicated that land use of both cultivation crops and veld food resources were important for their livelihoods, however the Mbukushu stated that the late season fires generally impact their grazing resources for their cattle. Most of the community is reliant on a combination of land use for cultivation and for gathering veld foods, as indicated by the occurrence of these themes [n=14].

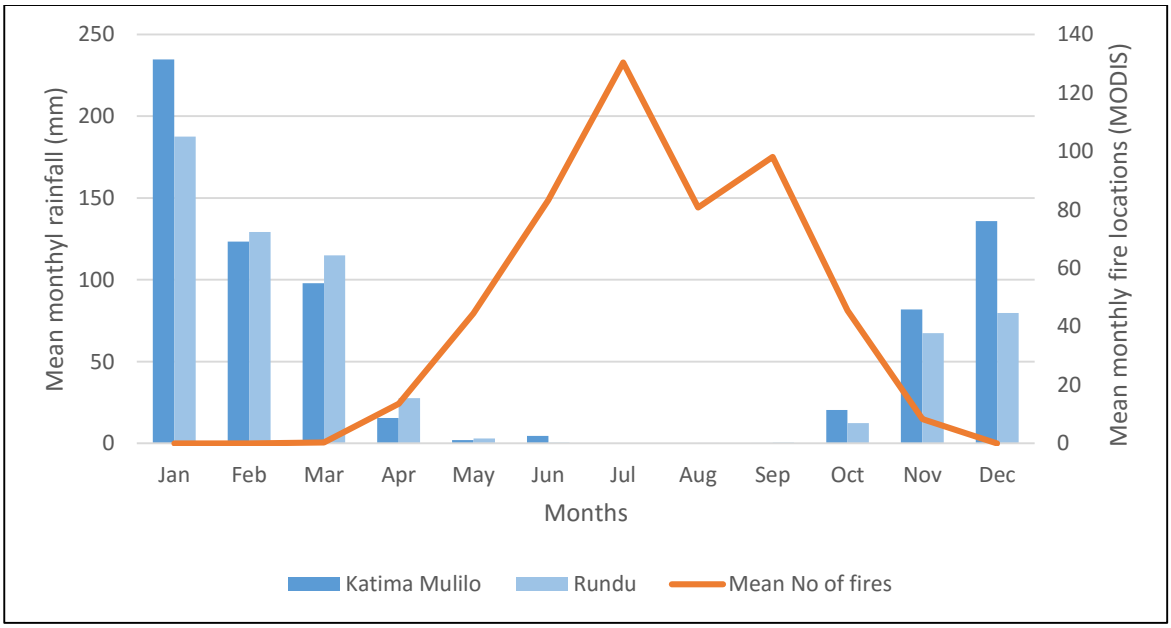


Figure 16: Mean rainfall and number of mean monthly fire locations in BNP (2000 – 2015) (Rainfall data from Namibia's Meteorological station [Windhoek]; and MODIS MCD14ML (30 – 80% confidence) [FIRMS [University of Maryland].

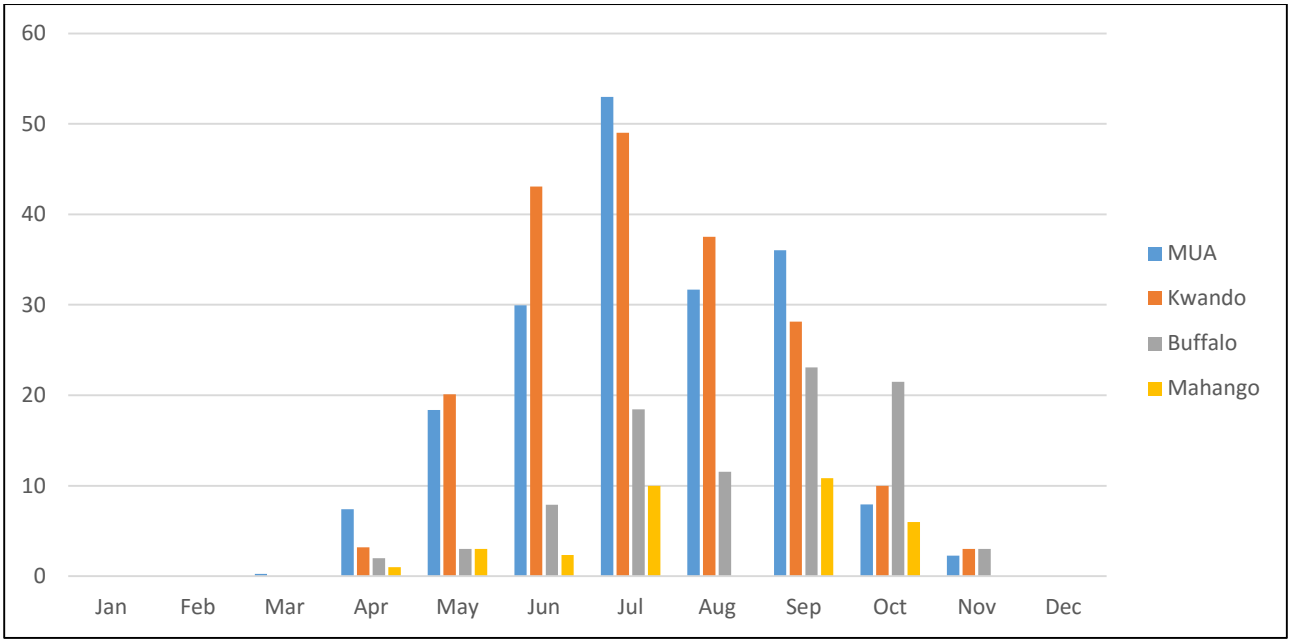


Figure 17: Mean number of monthly fire locations per unit area (2000 – 2015) in the wildlife core areas (Buffalo; Kwando; and Mahango) and within the Multiple Use Area (MUA) [MODIS MCD14ML [FIRMS [University of Maryland].

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Season						**Dry**					**Wet**
				Vegetation dries out							
			Early season fires				**Late season fires**				
							Field preparation				
							Clearing and burning: brush piles				
Growth period: Crops							**Burn once a year**				
			Harvesting of crops				**Easy to burn brush piles**				
		Early season harvesting of veld foods					**Dry season harvesting of veld foods**				
			BNP early burning								
				Use of fire on dune crests (May): Veld food Harvesting							
					Use of fire in Omuramba (June - July): Hunting						
			Forefathers early burning/patch burning								
Hunting of smaller species all year round in the BNP											

Figure 18: Seasonal calendar showing activities in relation to fire on the BNP community.

Summary statements: Community perspectives

1. The Khwe-San used early burning in the landscape as a deliberate management strategy as a planned and organised part of their burning system.
2. Three significant traditional activities related to the Khwe-San's early burning strategies emerged, of which were veld food resource gathering and hunting and tracking activities.
3. The Mbukushu participants made reference to the use of early burning strategies for stimulating the germination of grasses for livestock grazing purposes.
4. Community participants' use of early burning was associated with burning for vegetation regeneration and protection of plants for veld food resources from late season fires; to open up the vegetation for visibility and protection from perceived dangers of predators and wild animals; sourcing of food plants on the dunes; hunting and tracking; prevention of late dry season fires and livestock grazing (specific to Mbukushu community).
5. Historically burning strategies were associated with a decision hierarchy from elderly community members, and thus knowledge transmission was an integral part of burning practises.
6. Fires used within the community during October to September were purposely for land clearing and field preparation for cultivation purposes.
7. Presently, the BNP communities associate early burning activities with government fire regulations being carried out by the game guards on patrol in the BNP. Nowadays, the Khwe-San are hesitant to use fire due to the government fire regulations. However, early season burning is evidently being used in and around the village areas (pers. observation).
8. Loss of local fire knowledge and use is a major concern amongst the community respondents'.
9. The BNP community has a preference for the use of early wet season fires versus the use of fire during the late dry season.
10. A negative perception of fire is associated with the negative impact on the availability of the veld resources in the BNP landscape.
11. The historical and recent socio-political situation of the region is intricately embedded in understanding the role and use of fire by people in the landscape today.

22.1 Stakeholder perspectives

The aim of the stakeholder questionnaire was to investigate stakeholder perceptions of i) fire management practises with a focus on the use of early wet season and late season burning; ii) causes of fire; iii) vegetation and fire regime change in reference to the past policy of fire suppression, and iv) traditional and current use of fire by the local communities in the BNP.

Analysis of the combined stakeholder interviews revealed 18 main codes, and 68 sub-codes (Figure 19).

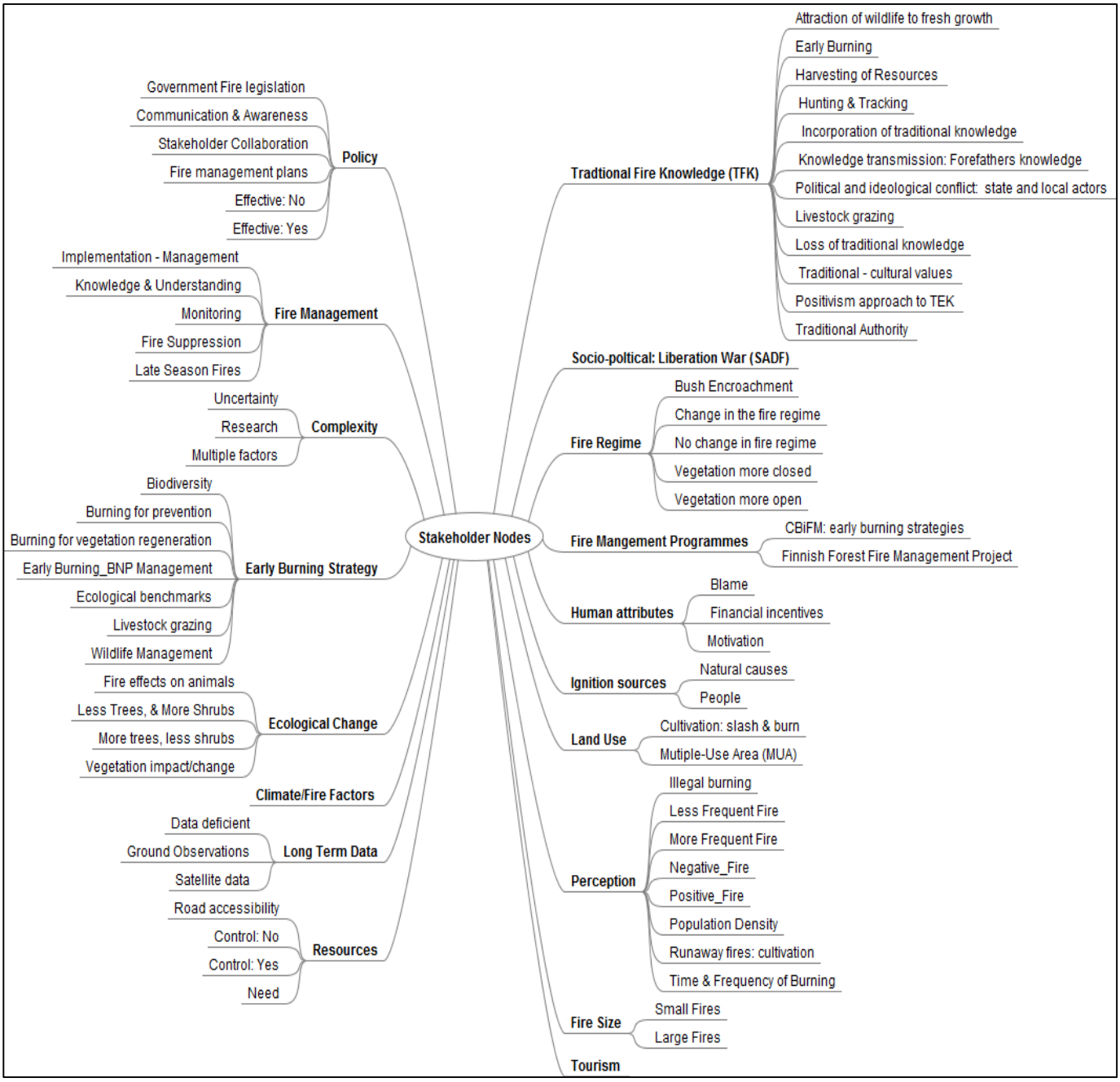


Figure 19: Map showing the main [n = 18] and sub nodes [n= 68] categories based on thematic content analysis of interview data (n = 36) for the Stakeholder data [n=24].

23.1 Early burning strategies

A shift in perspective

The management of fire in Namibia was dominated by fire suppression policies until 2006 when prescribed early dry season patch mosaic burning was implemented in the region (Beatty, 2007). An integrated fire management strategy was employed for a period of five years (2007 – 2011). The foundational objectives were to reduce the wildfire hazard, maintain and enhance land use, ecosystems and biodiversity in the Caprivi region (Mbongo *et al.,* 2011). The strategy used CBiFM as an application, and hinged on devolving the responsibility of fire management to the communities. Implementation of the burning strategy involved creating a patch mosaic pattern of burnt and unburnt areas in the landscape early in the dry season (Mbongo *et al.* 2011).

Fifteen of the respondents commented on the positive influence of the CBiFM early burning programme initiated in the Caprivi due to the influence the programme had in facilitating the motivation for the adoption of early burning strategies in the region. The CBiFM early burning programme challenged the Namibia-Finland Forestry Programme (NFFP) that focused on fire suppression as a form of forestry management in Namibia. The CBiFM programme largely influenced the GoN shift in perception from one of fire suppression to early burning fire management strategies, and stakeholders acknowledged the positive influence this programme had within the communities. Currently, early burning strategies are preferred by Namibian stakeholders as an ecological resource management activity in the BNP, and fire is seemingly applied early in the dry season to reduce and prevent [n=18] (the intensity of the late season fires in the landscape [n=23]. The emphasis on early dry season burning in the last decade has been in response to the prevailing perception of the decline in woodland, and subsequent negative impact of fire on vegetation in the region [n=24]. The BNP management plan currently specifies the objective of the use of fire as a management tool for actively maintaining and rehabilitating habitats in the park (MET, 2013). Thus, the notion of fire suppression no longer has precedence and the use of fire is currently viewed by stakeholders as an ecological tool in the Namibian landscape. Twenty three of the respondents held a positive perception of fire.

The use of early burning was positively viewed by the respondent stakeholders [n=18] due to the effect fire has in the improvement of grazing areas for wildlife, and the subsequent attraction of game into the BNP [n=17]. The identified benefits associated with early burning included the vegetation regeneration [n=10], management of wildlife [n=11], and the positive effects of earlier fires on the vegetation in the BNP [n=12]. Climate and associated fire factors [n=19] (e.g. dry and wet vegetation, fuel loads, wind and rainfall) were positively [n=14] associated with early burning strategies [n=17]. Stakeholders frequently referred to the moisture laden grass, and cool and controlled burns in the earlier months of the year, which reduces the spread of fire in the landscape.

24.1 Increase in late dry season fires: question of early burning?

The negative view of fire amongst stakeholders was attributed to the detrimental effects of late season fires on vegetation [n=10]. Fifty percent of the stakeholders identified negative effects of late season fires on the mortality of the game in the area [n=12]. There were nineteen instances where fire was negatively viewed.

Even though early burning was positively viewed as a management strategy, stakeholders still raised the concern about the observation of the prevalence of late season fires in the BNP landscape.

> *''I cannot tell a difference; because of the fire frequency; there is still a lot of late fires happening even though there has been early burning/20%- 30% of the area should be burnt early - creates the mosaic - but the late fires still came through, this happened even when Robin Beatty was still here '' (CASE 12: Stakeholder).*

> *''Data we have does not show that early burning has reduced the area that burns; no it has not reduced the frequency of burns'' (CASE 23: Stakeholder).*

25.1 Absence of fire knowledge and understanding

Not all the stakeholders held the opinion of the early burning as the best strategy for fire management in the park. Stakeholders identified an absence of knowledge and understanding [n=17] concerning the use of early burning as a fire management tool. Further, it was implied there is a need for further research [n=12] to understand the effects on early burning on species composition, and the need for ecological thresholds as points of reference on which to base decisions [n=8]. The doubt associated with the use of early burning was because of uncertainty [n=9] associated with the effect of prescribed burning without adequate research, and knowledge and understanding [n=11]. Stakeholders acknowledged that fire is complex and there are multiple factors that need to be addressed to understand the fire regime [n=12] e.g. the combination of elephants, fire and people in the region.

There was lack of consensus on the timing and frequency of burning the landscape in association with early burning strategies [n=10]. There is concern that fires are occurring repeatedly in the same location on an annual basis in the BNP, with the use of early burning strategies, together with the reoccurring late season fires in the absence of management. The prevailing stakeholder perception of the frequency and timing of fires was associated with a negative impact on vegetation [n=12].

> *''Early burning is a successful strategy; but we need to testify and more research is required; find out the benefits (pros and cons) ; currently no monitoring going on; concern of biodiversity loss; habitat destruction; the impacts are evident; however we need proof; validation of effectiveness'' (CASE 21:Stakeholder)*

> *''Fire is a natural phenomenon - but the way it is implemented here there is no good can come of it; to early burn and every year in the same place as earliest as possible - that is not a natural; but fires that start September/October that burn in patches and the nature of the burn depends on the available combustible material; 20 to 30%; rainfall dictates where one should be burning - now burning all the time - no schedule; many factors apply to a system that is changing'' (CASE 11: Stakeholder)*

26.1 Policy – fire management implementation conundrum

Stakeholders described the management of early burning fires in the BNP as *'ad hoc'* in the absence of any planning, coordination and strategic burning strategies in place based on environmental observations (e.g. rainfall, grass phenology, time since last burn etc.). The stakeholders were of the opinion that the proposed early burning initiatives would improve if it were implemented and

managed effectively [Code: Fire Management: Implementation – Management: n=21). The stakeholders identified the main reasons for the gap between fire management policy and implementation because of the lack of communication and awareness among stakeholders (i.e. collaboration) and communities necessary for policy developments [n=12] in the region. Stakeholders held mixed views concerning the effectiveness of policy in the park, as [n=13] stated that policy was ineffective, however [n=11] agreed that policy is effective.

> *''Policy is the guide, management is the lacking factor; being in a park where an integrated approach is followed - there is not much happening there'' (CASE 12: Stakeholder)*

> *''Yes, but the problem is not policy but management'' (CASE 8: Stakeholder)*

A question was posited to the stakeholders as to whether they believed that it would be beneficial if the policy distinguished between uncontrolled burning, burning for productive land use and burning for fire prevention. The stakeholders were of the opinion that is important to recognise that different habitat types require a different approach to the use of fire, of which should be based on the specific land use type (e.g. agriculture, livestock farming, management of national parks and wildlife movements). Thus, the stakeholders identified the need for defined fire management objectives for each sector relevant to a land use type in Namibia. Stakeholders reiterated that a designated role should be segregated for a focus on fire management in the park.

> *''Yes, it would make a difference if land management was distinguished and instilled according to different habitat and land use types. Policy is ineffective currently, and has not changed the system; although the government has instilled early burning practises. We need more stakeholder collaboration'' (CASE 9: Stakeholder)*

27.1 Traditional fire knowledge and government collaboration

Stakeholders identified the need for stakeholder collaboration [n=16], and communication and awareness [n=21] concerning the use of fire and the need to include the resident communities in the park knowledge base in the decision making processes [n=10]. Stakeholders referred to the need to enforce and control fire among the BNP communities, and to the effective past existence of the Traditional Authority (TA) (*Induna* or chief) of fining people within the communities for fires accidentally lit in the communal areas [n=10].

There is an awareness amongst stakeholders about the use of traditional fire cultural values of the resident communities in the BNP [n=20], however there is scepticism about the use of traditional fire strategies for the management of natural resources in a sustainable way [n=14].

Several participants referred to the Khwe-San's method of using early burning strategies [n=11] and some respondents referred to their childhood where the use of fire by elders in the community in the early winter seasons [n=11]. The Khwe-san referred to the use of a decision hierarchy in the use of early burning, which belonged to the elders within the community, and this was described by a single stakeholder. Even though there is an awareness of the early burning strategies employed historically by the Khwe-San in the region, references to their strategy arose from a marginal number of the stakeholders. There is an absence of an acknowledgement of and incorporation of traditional burning

strategies into the parks current fire management plans. Within the ''TFK: incorporation of traditional knowledge'' category' the stakeholders emerged with divergent views concerning traditional fire practises. More than fifty percent of the stakeholders stated that communities are required to be educated in fire use in the MUA as they are generally less informed, versus others that were aware of the use of the current early burning strategy used by parks as an approach that was historically used by the Khwe-San in the region. Four scenarios emerged in the BNP which involve both the communities and the stakeholders, the socio-political history of the region, and recent changes, and include: i) the absence of recognition of the communities knowledge about early burning strategies; ii) the continuous miscommunication of information about the use of fire in the region, which conveys 'fire suppression/prevention' and prohibits the use of fire amongst the communities; and lastly, iii) refutation of entitlement of the Khwe as a traditional community (TA), and thus absence of the recognition of the Khwe as a legitimate traditional community in Namibia; iv) the control of fire only by MET and park wardens. The above state of affairs has resulted in an absence of interest within the community about fire use and resistance to collaboration with the GoN. Evidence for this scenario emerged within the category: ''TFK: Political and ideological conflict: state and local actors [n=17].

28.1 Perceived changes in the fire regime

Different views emerged concerning the use of past suppression policies and the ensuing effects on the vegetation. Stakeholders associated the expansion of bush encroachment with fire suppression [n=10] and were of the view that suppression of fires has altered the vegetation in the region negatively [n=11]. Stakeholders were of the view that the cause of the late season fires is attributed to the policy of fire suppression which held precedence for 118 years in Namibia (Figure 20).

> *''A long time we have been looking at the late dry season fires over much of the area which was a consequence of fire suppression'' (CASE 23: Stakeholder)*

However, a few respondents stated that the notion of the suppression of fire was not feasible, and that fire occurrence is no different from the past, since fire will always be a part of a system with people and vegetation. Reference was made to the era of the War of Liberation, and the prevalence of fires during that time due to the use of the SADF military artillery, and the ensuing ignition of vegetation during combat. A change in vegetation structure, and an increase in dense vegetation (i.e. bush encroachment) was described as one of the effects of a policy dictating fire suppression [n=11]. The stakeholder perception of a negative change/impact on vegetation (designated category) was attributed to the occurrence of the late season fires in association with suppression [n=18].

The respondents referred to the issue of people [n=24] and illegal fires [n=12] being the predominant source of ignition for fires in the late season [n=24] versus natural causes of fires [15]. Sixty seven of the stakeholders thought fires were increasing, and that there is more frequent fire [n=16], the fire regime is changing [n=18], there is less trees and more shrubs [n=16], and the vegetation is more open [n=14]. Stakeholders attributed a change in the fire regime to a change in vegetation density in the landscape. One stakeholder identified that the predominant change in the fire regime has involved a seasonal shift from a single late fire season to a bi-annual season with the recent introduction of early burning strategies.

Summary statements: Stakeholder perspectives

1. The use of early burning strategies is currently viewed by Namibian stakeholders as an ecological tool in the landscape versus the previous policy of fire suppression.
2. Stakeholders still raised the concern about the observation of the prevalence of late season fires in the BNP landscape, even though early burning is a current fire management objective in the park.
3. Stakeholders identified an absence of knowledge and understanding concerning the use of early burning as a fire management tool. It was implied there is a need for further research to understand the effects on early burning on species composition, and the need for ecological thresholds as points of reference on which to base fire management decisions.
4. Stakeholders described the management of early burning fires in the BNP as *'ad hoc'* in the absence of any planning, coordination and strategic burning strategies in place based on environmental observations (e.g. rainfall, grass phenology, time since last burn etc.).
5. The stakeholders were of the opinion that the proposed early burning initiatives would improve if it were implemented and managed effectively.
6. The main reasons identified by respondents' for the gap between fire management policy and implementation were lack of communication and awareness among stakeholders (i.e. collaboration) and communities necessary for policy developments in the Zambezi region.
7. Stakeholders acknowledged that fire is complex and there are multiple factors that need to be addressed to understand the fire regime e.g. the combination of elephants, fire and people in the region.
8. Policy was generally perceived by the stakeholders as ineffective in dealing with the fire management requirements in the BNP.
9. Stakeholders identified the need for defined fire management objectives for each sector relevant to a land use type in Namibia.
10. Stakeholders were of the view that the cause of the late season fires is attributed to the policy of fire suppression which held precedence in Namibia for 118 years. Furthermore, the fire suppression policy was inferred for the reason for the prevalence of late dry season fires, and the subsequent negative impact on vegetation structure in the BNP.
11. A few respondents stated that the notion of the suppression of fire was not feasible, and that fire occurrence is no different from the past. Reference was made to the era of the War of Liberation, and the prevalence of fires during that time due to the use of the SADF military artillery, and the ensuing ignition of vegetation during combat.
12. The respondents referred to the issue of people and illegal fires being the predominant source of ignition for fires in the late season versus natural causes of fires in the BNP.
13. There is an awareness amongst the stakeholders about the use of traditional fire cultural values of the resident communities in the BNP, however there is scepticism about the use of traditional fire strategies for the management of natural resources in a sustainable way in the BNP.
14. There is an absence of an acknowledgement and incorporation of the resident communities' traditional burning strategies knowledge into the BNP current fire management plans.

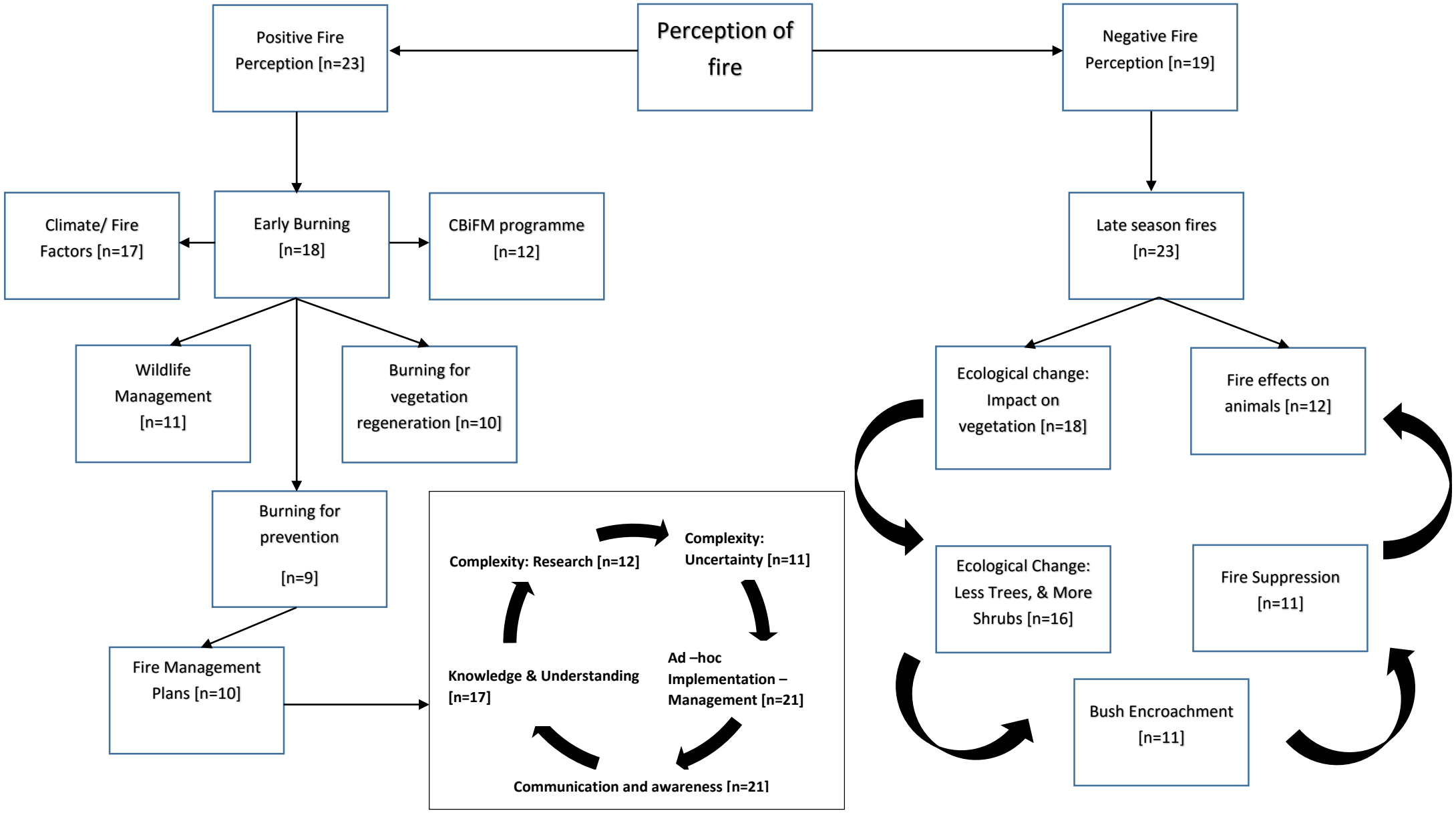


Figure 20: Conceptual map representing the stakeholder's positive and negative perceptions of fire and associate codes [n=24].

29.1 Provisional synthesis

This preliminary analysis of the social data provides an understanding of why, when, where, and how often people make use of fire in the BNP landscape, historically and presently. An integration of this this data together with the stakeholder perceptions of fire management, has contributed to an understanding of the current fire management status in the BNP, which is deeply rooted in the regions socio-political historical past. The past social-political events in the region has and continues to influence the advance of fire management in the BNP today.

Early burning practises were deliberate and coordinated by the elders within the community. Together with the erosion of knowledge from the elder generation to the youth, and a shift to modernity/westernized needs amongst the youth, the Khwe-San's early burning knowledge system is eroding over time. There is still active management of fire in proximity to the villages, yet due to the imposed local land use legislation, and GoN fire restrictions and the hunting and gathering restrictions since Independence (1990) there has been a cessation of traditional norms. Together with the emergence of Community Based Natural Resource Management (CBNRM) initiatives, and money earning activities, and the subsequent shift in the local society to a sedentary existence of dependence on immediate resources, and the absence of focus on the Khwe's knowledge base, a breakdown in traditional burning strategies in the region has ensued in the BNP.

The use of early burning is presently viewed as an ecological fire management tool by Namibian stakeholders. This is significant as it points toward a paradigm shift from the colonial ideology of fire suppression to one of fire management with the use of controlled burning systems in African governance systems. Subsequently, fire regime heterogeneity in the form of early burning and/or patch mosaic burning, instead of fire suppression is increasingly being promoted in savannas (Eriksen, 2007). This aspect is demonstrated in this study by the stakeholders' preference for early wet season burning in the BNP. However, a failure to recognise on how much fire is relied upon by communities residing in remote regions for environmental survival is still pervasive in African governance (Eriksen, 2007). In the BNP, the change from fire suppression to controlled fire management with an emphasis on early burning was facilitated by a CBiFM programme, by a local NGO together with the DoF. The CBiFM programme hinged on devolving the responsibility of fire management to the communities, and implementation involved creating a patch mosaic pattern of burnt and unburnt areas in the landscape early in the dry season (Mbongo *et al.* 2011). It is significant that the paradigm shift from fire suppression and the incorporation of early burning strategies in the BNP management plan transpired through a CBiFM project. The Khwe-San referred to previous meetings in which early burning was discussed, and provides evidence that the communities knowledge contributed to the change in park management strategies, however the source of this knowledge is frequently excluded from the available published reports in Namibia. The absence of the recognition of the communities' knowledge, and formal recognition of the Khwe-San as a Traditional Authority (TA), and their continual marginalisation has resulted in an absence of interest within the community about fire use and resistance to collaboration with the GoN currently. However, despite the BNP community and the stakeholders' different worldviews, they demonstrated a shared common goal in the use of early burning as a strategy for similar reasons. Understanding the social context of the savanna and its importance to local livelihoods and the area's fire history is important for implementing informed management and conservation (Walters *et al.*, 2010).

In the BNP early burning strategies are applied in an '*ad hoc' (impromptu)* way with little systematic planning or monitoring being adhered to. This corroborates a recent interpretation of fire scar maps for the region whereby few fires were located, and it was subsequently stated that ''no one appears to be actively doing early burning in April, May or June'' (DoF, 2015). Stakeholders understanding of early burning is that it creates a patchwork effect of burnt, partially burnt and unburnt areas which leaves grazing material to support wildlife and livestock during the late dry season, and is essential for the maintenance of the late season fires, and wildlife management. The stakeholders still raised concern about the prevalence of the occurrence of the late season fires. The objective of early burning is to reduce fuel loads and therefore minimise the occurrence of late season fires. In the absence of any strategic planning, and knowledge and understanding of the ecological conditions in which to apply early burning, the current management approach is more than likely ineffective in reducing the late season fires in the BNP.

The reconciliation of the different viewpoints: stakeholders and communities has led to understanding of why fires are prevalent in the BNP landscape. Breakdown in social cohesion, knowledge and communication flow, combined with mixed land use [cultivation fires/national Park] (i.e. Development versus conservation trade-off) equates to prevalence of late season fires in the absence of seeming fire management structures within BNP. The results of this study indicate that knowledge, understanding, communication and governance are central to improving livelihoods and fire management strategies in the Kavango east and Zambezi regions in the BNP.

30.1 Description of research activities proposed for 2016

This section provides a brief description of the field work activities proposed to take place in 2016 , of which include the vegetation and soil survey. This data collection is proposed to take place in February 2016.

Vegetation Transects: This will involve the collection of vegetation structure and species composition data on the dune crests and 'interdunal straats', and the collection of soil samples at each of the transect sites. This data will be integrated with the available GIS MODIS MCD14ML fire intensity data and MODIS burned area (BA) product data (MCD45) from 2000 – 2015 to understand the spatial and temporal variation of fire frequencies and distribution in the wildlife core areas and MUA within the BNP.

Palaeoecological data: Laboratory palynomorph (pollen) preparation and identification, and sedimentary charcoal deposit extraction, and enumeration: a) January – end of 2015 [ongoing]; b) sub-sample preparation and initiation of data analysis protocol.

References

Alpers, F. 11th May 2013. Personal communication. Integrated Rural Development and Natural Resource Conservation (IRDNC) Project Coordinator.

Archibald, S., Lehmann, C. E. R., Gómez-dans, J. L. & Bradstock, R. A. 2013. Defining pyromes and global syndromes of fire regimes. Proceedings of the National Academy of Sciences of the United States of America 110, 6442–6447.

Atlas.ti. 7. (Version: 7.5.10). (C) 1993 – 2013. GmBH. Berlin.

Beatty, R. 2011. Community Based Fire Management: A review: CBiFM in Namibia. The Caprivi Integrated Fire Management Programme. FAO Forestry Paper (166). 1 – 99.

Boden, G. (2009). The Khwe and West Caprivi before Namibian independence: Matters of land, labour, power and alliance. *Journal of Namibian Studies: History Politics Culture*, *5*, 27-71.

Bond, W. J., & Archibald, S. 2003. Confronting complexity: fire policy choices in South African savanna parks. *International Journal of Wildland Fire*, *12*(4), 381-389.Bond & Keeley, 2005

Bond, W.J., Woodward, F.I. and Midgley, G.F., 2005. The global distribution of ecosystems in a world without fire. *New Phytologist*, *165*(2), pp.525-538.

Bowman, D. M J S., Balch, J., and Artaxo, P., and Bond, W. J., and Cochrane, M. A., Antonio, C. M D., and Defries, R., Johnston, F. H.,and Keeley, J. E., Krawchuk, M. A., Kull, C.A., and Mack, M., Moritz, M. A., Pyne, S., Roos, C. I., Scott, A. C., Sodhi, N.S. & Swetnam, T. W. 2011. The human dimension of fire regimes on Earth. 2011. *Journal of Biogeography* 38, 2223–2236.

Brown & Barnes, 1994. Results of a social-ecological survey of the west caprivi strip, Namibia. A strategic community based environment and development plan. Directorate of Environmental Affairs (DEA). Ministry of Wildlife, Conservation and Tourism, Windhoek, Namibia.

Brown, C.J. & Jones, B.T.B. 1994. Results of a Socio-Ecological survey of the West Caprivi Strip, Namibia: A Strategic community-based Environment and Development Plan. Directorate of Environmental Affairs. Ministry of Wildlife, Conservation and Tourism, Windhoek, Namibia.

Butz, R. J. 2009. Traditional fire management: historical fire regimes and land use change in pastoral East Africa. *International Journal of Wildland Fire*, *18*(4), 442-450.

Chambers, R. 1994. The origins and practice of participatory rural appraisal. *World development*, *22*(7), 953-969.

Cole, M.M 1986. The Savannas. Biogeography and Geobotany. Academic Press. University of London.

Creswell, J.W., 2007. Qualitative enquiry and research design: Choosing among five approaches. 3rd (Eds), University of Nebraska. Lincoln, USA.

Dain-Owens, S., Kemp, L. and Lavelle, J. 2010. An Assessment of Plant Resource Use and its Role in Food Security for Communities Living within Bwabwata National Park, West Kavango. 1–108. Round River Resources Conservation Report. Integrated Rural Development and Natural Resource Conservation.

Directorate of Forestry (DoF), 2001. Namibia's Forest Act and Policy. Ministry of Agriculture, Water and Forestry, Windhoek, Namibia.

Directorate of Forestry (DoF), 2005. *Draft National Forest and Veld Fire Management Policy.* Ministry of Agriculture, Water and Forestry, Namibia.

Directorate of Forestry –Namibia Finland Forestry Programme (NFFP). 2004. National Forest and Veld Fire Management Policy – 1st Draft. Unpublished. Windhoek: Directorate of Forestry MET-DoF, 1996

Directorate of Forestry (DoF), 2015. Minutes of the Zambezi Regional Fire Co-ordination Committee Meeting, Katima Mulilo. Ministry of water, agriculture and forestry (MWAF).

Erkkilä, A., & Siiskonen, H. 1992. *Forestry in Namibia 1850-1990*. University of Joensuu.

Eriksen, C. (2007). Why do they burn the 'bush'? Fire, rural livelihoods, and conservation in Zambia. *The Geographical Journal*, *173*(3), 242-256.

FAO, 1984, Agro-climatological data for Africa. Plant production and protection series no. 22 vol. 2. FAO, Rome, Italy.

Fisch, M. 1999. The Caprivi Strip during the German colonial period 1890 – 1914. Out of Africa publishers, Windhoek, Namibia.

Flasse, S. P., Trigg, S.N., Ceccato, P.N., Perryman, A.H., Hudak. A.T., Thompson, M.W., Brockett, B.H., Drame, M., Ntabeni, T., Frost, P., Landmann, T., & Le Roux, J. 1998. Remote sensing of vegetation fires and its contribution to a fire management system. 1–70. In: Goldammer, J.; de Ronde, C., eds. Fire management handbook for sub-Sahara Africa. Frieburg, Germany: Global Fire Monitoring Center, 2004. Pp. 158-211.

Gaughan, A. E. & Waylen, P. R. 2010. Spatial and temporal precipitation variability in the Okavango–Kwando–Zambezi catchment, southern Africa. *Journal of Arid Environments.* 82, 19–30.

Gill, A.M., 1975. Fire and the Australian flora: a review. *Australian forestry*, *38*(1), pp.4-25.

Glaser, B. and Strauss, A., 1967. The discovery of grounded theory. *London: Weidenfeld and Nicholson*.

Goldammer, J. G. 2001. National Guidelines on Forest Fire Management in Namibia. *International Forest Fire News.* No 25. 1 – 5.

Goldammer, J.G. 1998. Development of a national fire policy and guidelines on fire management in Namibia. *Directorate of Forestry, Ministry of Environment & Tourism, Namibia.* 1 – 39.

Government of Namibia (GoN), 2001. *Forestry Act of 2001.* Government Gazette of the Republic of Namibia No. 2667.

Grove, A.T. 1969. Landforms and climatic change in the Kalahari and Ngamiland. *Geographical Journal*, pp.191-212. Jones & Barnes, 2009

Jones, B. & Dieckmann, U. 2014. "Scraping the pot'': San in Namibia Two Decades after Independence''. Legal Assistance Centre (LAC) and Desert Research Foundation of Namibia. Windhoek, Namibia.

Kamminga, E.M. 2001. Impact of the Integrated Forest Fire Management Program on rural livelihoods in East Caprivi Region. Namibia. Namibia-Finland Forestry Program, March 2001. *International Forest Fire News* No. 25: 39-57.

Land, Environmental and Development Project (LEAD). 2006. *The Land they took: San Land rights under threat.* 1–84.

Le Roux .J 2011. The Effect of Land Use Practices on the Spatial and Temporal Characteristics of Savanna Fires in Namibia. Fridrich-Alexander-Universitat Erlangen-Nunberg, Germany. PhD Thesis 1 – 182.

Mbongo, W., Beatty, R. & Ries, P. 2011. Caprivi Region: Draft Integrated Fire Management Strategy. 2007- 2011. Integrated Rural Development & Nature Conservation & Directorate of Forestry Report.

Mbow, C., Nielsen, T.T & Rasmussen, K. 2000. Savanna Fires in East-Central Senegal : Distribution Patterns, Resource Management and Perceptions. *Human Ecology* **28**, 561–583

McFarlane, M. J., & Eckardt, F. D. 2007. Palaeodune morphology associated with the Gumare fault of the Okavango graben in the Botswana/Namibia borderland: a new model of tectonic influence. *South African Journal of Geology*, *110*(4), 535-542.

Mendelsohn, J., & Roberts, R. 1997. Environmental Profile of the Caprivi Strip. *Windhoek, Namibia* Ashley, C. & LaFranchi, C. 1997. Livelihood Strategies of Rural Households in Caprivi. Implications for Conservancies and Natural Resource Management. WWF-LIFE Programme. Windhoek, Namibia.

Ministry of Environment and Tourism, 2013. Management Plan for Bwabwata National Park 2013/2014 to 2017/2018.

Miller, R.M., Pickford, M. and Senut, B., 2010. The geology, palaeontology and evolution of the Etosha Pan, Namibia: Implications for terminal Kalahari deposition. *South African Journal of Geology*, *113*(3), pp.307-334.

Ministry of Agriculture, Water and Forestry. 2011. A Forest Research Strategy for Namibia (2011 – 2015). Ministry of Agriculture, Water and Forestry, Windhoek, Namibia.

Ministry of Environment and Tourism (MET). 2009. Fact sheet: State Protected Areas: Kavango Game Park.

Ministry of Environment and Tourism (MET). 2010. Namibia's Draft National Report to the United Nations Convention on Biological Diversity (UNCBD). *Ministry of Environment & Tourism Report.*

Moore, A. E., & Eckardt, F. 2012. The evolution and ages of Makgadigadi palaeo-lakes: consilient evidence from Kalahari drainage evolution south-central Africa. *South African Journal of Geology*, *115*(3), 385-413.

Moore, P., Ganz, D., Tan, L. C. 2002. *Communities in Flames : Proceedings of an International Conference*. Food and Agricultural Organisation (FAO), RAP Publication, Bangkok, 2002/25

Mulonga, S. 2006. Wild Food: Use of natural resources for food in the eastern Caprivi. Department of Environmental Affairs and Tourism (DEA) Research Discussion paper. Windhoek, Namibia.

Ministry of Water, Agriculture and Forestry (MWAF), 2011. A forest research strategy for Namibia (2011 – 2015). Ministry of Water, Agriculture and Forestry, Windhoek, Namibia.

Namey, E., Guest, G., Thairu, L. and Johnson, L., 2008. Data reduction techniques for large qualitative data sets. *Handbook for team-based qualitative research*, pp.137-161.

Pausas, J. G. & Keeley, J. 2009. A Burning Story : The Role of Fire in the History of Life. *BioScience* 59, 593–601.

Pricope, N. G. & Binford, M. W. 2012. A spatio-temporal analysis of fire recurrence and extent for semi-arid savanna ecosystems in southern Africa using moderate-resolution satellite imagery. *Journal of Environmental Management* 100, 72–85.

Prober, S.M., O'Connor, M.H. and Walsh, F.J., 2011. Australian Aboriginal peoples' seasonal knowledge: a potential basis for shared understanding in environmental management. *Ecology and Society*, *16*(2), p.12.Pyne *et al*. 1998.

Pyne, S., Goldammer, J.G., de Rhonde, C., Geldenhuys, C.J., Bond, W. & Trollope, W.S.W. 2004. Introduction: In: Goldammer, J.; de Ronde, C., eds. Fire management handbook for sub-Sahara Africa. Frieburg, Germany: Global Fire Monitoring Center, 2004. Pp. 1 -10.

Sheuyange, A., Oba, G. & Weladji, R. B. 2005. Effects of anthropogenic fire history on savanna vegetation in north-eastern Namibia. *Journal of Environmental Management* **75**, 189–198.

Southern African Development Community (SADC). 2010. SADC Regional Fire Management Programme. *Draft Proposal June* 2010.

Southern African Development Community (SADC) Forestry Protocol. 2002. Food, Agriculture and Natural Resources Directorate.

Suzman, J. 2001. An Assessment of the status of the San in Namibia. Report Series. Report. No 4 of 5. Legal Assisstance Centre (LAC), Windhoek.

Suzman, J. 2006. Land, Environmental and Development Project (LEAD). 2006. *The Land they took: San Land rights under threat.* 1–84.

Suzman, J. 2002. Minorities in Independent Namibia, Minority Rights Group International. Land, Environmental and Development Project.

Taylor, J. 2007. Developing the sustainable use of Plant Resources in CBNRM: A preliminary Assessment of Devil's Claw harvesting in West Caprivi (Bwabwata National Park). Report for IRDNC and Africa 2000 Trust.

Immanuel, S. 2013. 'Caprivi no more'. *The Namibian.* 09.08.2013. http://www.namibian.com.na/indexx.php?archive_id=112767&page_type=archive_story_detail&page=72 accessed on the 9th August 2013.

Trigg & Le Roux, 2001. Fires situation in Namibia. Food and Agricultural Organisation (FAO). Global Fire Assessment, 1990- 2000. http://www.fao.org/docrep/006/ad653e/ad653e25.htm

Trollope, W.S.W. & Trollope, L.A. 1998. Technical Review of the Integrated Forest Fire Management Component of the Namibian-Finland Forestry Programme. Directorate of Forestry. Namibia-Finland Forestry Programme. Windhoek, Namibia.

Van Wilgen, B. W., Govender, N., Biggs, H. C., Ntsala, D., & Funda, X. N. 2004. Response of Savanna Fire Regimes to Changing Fire-Management Policies in a Large African. *Conservation Biology.* 18, 1533–1540.

Virtanen, K., 1998. *Survey on attitudes to forest fires: East Caprivi, Namibia*. Unpublished MSc thesis, University of Wolverhampton, Wolverhampton, UK.

Walters, G. 2007. Fire Primer for the Batéké Plateaux, Central Africa. University College London.

Walters, G., Touladjan, S., and the People of the Batéké Plateaux. 2010. Savanna burning yesterday and today in Gabon's Batéké Plateaux: foraging-fires and ecosystem effects. PhD Thesis summary report. University College London.

Acknowledgements

Foremost, I am most grateful to the people living inside and outside of the BNP that willingly shared of their knowledge of the area in relation to fire. Appreciation is extended to the BNP Park Wardens (Christopher Malesu, Chief Warden of the Muhungo Core Area), and James Sambi (Chief Warden of the Kwando Core Area) for facilitating the logistics and arrangements of working in the BNP. To the stakeholders for their interest, sharing their knowledge and their time during interviews in Katima Mulilo, Windhoek and Cape Town. I am indebted to the translators with whom I worked closely with (Thadeus Chedau, David Singonhi, Soner Geira, Sandra, Peter Msiliso and Sebastian Kamwanga) who were pivotal in translating Khwedam and Hambukushu into English during the interviews in the Mashambo, Mutijiku, Pipo, Omega III, Diye, Tokoloshi, Mashashane and Chetto villages. Thanks to the BNP Core Area Game Guards for their protective assistance, and in particular Pheedan Mpangu for helping with extensive hours of field work. I would like to thank Karine Nuulimba and Frederick Alpers of the IRDNC for providing the opportunity to engage in work in the BNP and for support and insight into working with people in the region, and for making this project possible from the start. Appreciation is extended to Carol Murphy, Volker Schiller and Helen Priest for willingly providing endless contacts of knowledgeable people in the area, and for housing support in the town of Katima Mulilo, and to Charlie and Mark Paxton for sharing their Shamvura lodge hospitality and insights into the area.

To Lise Haansen, Paul Funston and Simon Mayes for their assistance and insight into the area. Further, I'd like to thank all the people in Namibia who at the start of this project provided insight into the communities and areas where ecological research would be most valuable, and directed me towards key information, namely John Kinahan, Dave Ward, Sophie & Alan Simmonds, Barbara Paterson, Margie Jacobsohn, Johan Le Roux, Helge Denker, Chris Brown, Ben Strobach, Basilia Muntefering, Chris Weaver, Robin Beatty, Ndafuda Shiponeni, Nelao Haimbodi, Louis Liebenberg, Julie Taylor and Andy Moore. Great appreciation is extended to Round River Conservation Studies for their contribution of veld food resource GIS data from their previous work in BNP which was willingly handed over to contribute to ongoing analyses for this project. Thanks to Susie Dain-Owens, Karen Nott, Jessica Lavelle, and Lucy Kemp for helping track down the data.

Appreciation is extended to the Ministry of Environment and Tourism (MET), and notably Kenneth K!uiseb for the granting of the research permit and helpful information concerning working in the BNP. The National Herbarium of Namibia is thanked for the use of information from the specimen database: BRAHMS, National Botanical Research Institute (NBRI). Thanks to Simon Mayes, Johan Le Roux, John Mendelsohn, Sylvia Thompson, Jessica Lavelle and Robyn Beatty for sharing the GIS data for the region. To Harvey Park for providing a land cruiser for use whilst setting course in deeper Kalahari sands. Thanks to fellow students (Abraham Dabengwa, Petra de Abreu, and Carina Becker) at the Plant Conservation Unit (PCU), and Hayley Clements (UCT); and the the PCU Discussion group for constructive research input. Last of all this research project would not be possible without the financial assistance of the GreenMatter Scholarship, the National Research Foundation (NRF) Scarce Skills Scholarship, and the Applied Centre for Climate and Earth System Science (ACCESS) funding support. Lastly to thank my supervisor, Assoc. Prof Lindsey Gillson, and project advisors Dr Gina Ziervogel, Professor Timm Hoffmann and Emeritus Professor, William Bond for all their interest, encouragement, support and advice.

Appendix

Table 2: Community resource questionnaire: Use of fire and livelihood resources in the BNP (2014)

Cultural Practises

1. Do you use fire as a traditional practise in your culture? How?
2. What are your cultural beliefs about fire?
3. What do you call fire in your language? Are there different words for fire? What are they?
4. How did you learn to use fire?

Fire Management: How, where, when and how often fire is used

5. Do you have a problem with fire in your area?
6. How do the fires start? Natural fires (lightning), by accident, or started by humans?
7. Why are the fires started? Is it important to burn?
8. Are there small or large fires in your area? Where are the small and large fires in the Park? MAP
9. In what months are the fires are there big fires and small fires?
10. What is/are your primary land use practise/s?
11. Do you use fire to manage your land (How)? What months of the year do you use fire? What time of day?
12. Why do you burn? How do you use fire to manage your land? /What type of activities do you use fire for?
13. Why do you burn early in dry season? Reasons?
14. Why do you burn late in dry season? Reasons?
15. How often do you burn in a season? What are your burning (grasses/trees/scrub)? How long do the fires burn?
16. How do you know when to burn? How do people decide which areas to burn?
17. Do you think it is better for the vegetation to burn early or late in the season? Why?
18. How do you view fire? Is it good or bad for the land, or should it be stopped?

Vegetation and Fire History

19. Is burning different now than it was in the past? If so, how and why?
20. Do you think fires occur more or less than in the past/fire pattern in the area over the last 10/20/50 years?
21. Has the vegetation changed over time in your area over the last 50 years?
22. Do the big trees burn? How about the shrubs? Is there more or less trees/shrubs because of burning?

Livelihood resources: Impact of fire on plant and livelihood resources

23. Are resources that you depend on affected by fire (species name)? What are the resource attributes that makes it valuable (e.g. for charcoal, edible fruits, poles, Medicinal plants)
24. What does fire do to the plants? Is it good or bad?
25. Do you know of plants that fire is good or bad for? Have you noticed certain plants have disappeared or become more because of fire? Which plants are they? (local name)
26. How much of the food from the veld do you depend on for your livelihood? Where do you get the rest of your resources?

Table 3: Ministry Staff Interview questions (Windhoek) /MET & MWAF (Rundu, Katima Mulilo), October 2014

Fire Management (Ministry/Council/Park Wardens)

1. What is your view of the increased incidence in fires that occur in the Zambezi region (BNP)?
2. How do you think the fires start? Natural fires (lightning), by accident, or started by humans?
3. Management of fires in the BNP has been dominated by fire exclusion, protection, and suppression policies dating back several decades. What is your view on current fire management practise of prescribed early season burns (May - July) in the Zambezi region/BNP? Reference: Controlled Fire Management Programme.
4. Do you think it would be beneficial if fire policy distinguished between uncontrolled burning, burning for productive land use, and burning for fire prevention?
5. Do you think the policy of fire suppression in the past has had an effect on fire patterns in the Zambezi?
6. How do you think the policy of fire suppression/prevention has affected vegetation in the Zambezi region?
7. Do you think the community in the Zambezi region is informed about the fire policy?
8. Do you know about the use of any current traditional fire management practises in the Zambezi region?
9. Do you think the controlled burning instigated in 2007 in the eastern Caprivi has made an impact on the occurrence of fire in the region?
10. Do you think the fire regime is changing? How? Why? If so, what is causing the changes?
11. Do you think there is a difference between fires 20/50 years ago versus the last 10 years? Why?
12. How do you think fire has affected habitats in the BNP?
13. Do you think the small and or big fires can be controlled if there were resources to put out the fires? What do you think about that?
14. Do you think the high fire frequency in the Zambezi region has affected tourism?

Internet links:

University of Maryland: MODIS DATA (MCD14ML) Archive Data sourced (2000 – 2015)

https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms/active-fire-data#tab-content-6

Table 4: Socio-demographic characteristics of community member participants [n=36]

Reference	BNP locality	Village	Cultural Group	Gender	Age	Interview year
Case 1	BNP west	Mutijuku	Khwe-San	Male	65	2014
Case 2	BNP west	Mutijuku	Khwe-San	Male	70	2014
Case 3	BNP west	Mutijuku	Hambukush	Female	65	2014
Case 4	BNP west	Mutijuku	Khwe-San	Male	65	2014
Case 5	BNP west	Mutijuku	Khwe-San	Male	65	2014
Case 6	BNP west	Mutijuku	Khwe-San	Female	60	2014
Case 7	BNP west	Mutijuku	Khwe-San	Male	60	2014
Case 8	BNP west	Mutijuku	Khwe-San	Male	65	2014
Case 9	BNP west	Mutijuku	Khwe-San	Male	70	2014
Case 10	BNP west	Mutijuku	Khwe-San	Male	60	2014
Case 11	BNP west	Mutijuku	Khwe-San	Male	65	2014
Case 12	BNP west	Diye	Hambukushu	Male	40	2014
Case 13	BNP west	Diye	Hambukushu	Male	65	2014
Case 14	BNP central	Chetto	Khwe-San	Male	60	2014
Case 15	BNP central	Chetto	Khwe-San	Male	60	2014
Case 16	BNP central	Chetto	Khwe-San	Male	65	2014
Case 17	BNP central	Pipo	Khwe-San	Female	70	2014
Case 18	BNP central	Pipo	Khwe-San	Female	70	2014
Case 19	BNP central	Chetto	Khwe-San	Male	50	2014
Case 20	BNP central	Chetto	Khwe-San	Male	43	2014
Case 21	BNP east	Mashambo	Khwe-San	Male	60	2015
Case 22	BNP east	Mashambo	Khwe-San	Female	60	2015
Case 23	BNP east	Mashambo	Khwe-San	Female	60	2015
Case 24	BNP east	Mashambo	Khwe-San	Male	60	2015
Case 25	BNP east	Tokoloshi	Khwe-San	Male	60	2015
Case 26	BNP east	Tokoloshi	Khwe-San	Male	60	2015
Case 27	BNP east	Poca	Khwe-San	Male	60	2015
Case 28	BNP east	Omega III	Khwe-San	Male	60	2015
Case 29	BNP east	Mashambo	Khwe-San	Male	60	2015
Case 30	BNP west	Mutijuku	Hambukushu	Male	60	2015
Case 31	BNP west	Mutijuku	Hambukushu	Female	60	2015
Case 32	BNP west	Mutijuku	Hambukushu	Male	60	2015
Case 33	BNP west	Mutijuku	Hambukushu	Male	60	2015
Case 34	BNP west	Mutijuku	Hambukushu	Male	60	2015
Case 35	BNP east	Mashashane	Hambukushu	Male	60	2015
Case 36	BNP east	Mashashane	Hambukushu	Male	60	2015

Table 5: Socio-demographic characteristics of stakeholder participants [n=24]

Stakeholder reference	**Institution & other**	**Interview year**
Stakeholder 1	MET	2014
Stakeholder 2	Consultant	2014
Stakeholder 3	DoF	2014
Stakeholder 4	DoF	2014
Stakeholder 5	MET	2014
Stakeholder 6	DoF	2014
Stakeholder 7	DoF	2014
Stakeholder 8	Consultant	2014
Stakeholder 9	MET/SPAN	2014
Stakeholder 10	Consultant	2015
Stakeholder 11	Lodge owner	2015
Stakeholder 12	IRDNC	2015
Stakeholder 13	IRDNC	2015
Stakeholder 14	IRDNC	2015
Stakeholder 15	DoF	2015
Stakeholder 16	UNAM/Academic	2015
Stakeholder 17	State Veterinarian	2015
Stakeholder 18	DoF	2015
Stakeholder 19	MET	2015
Stakeholder 20	MET	2015
Stakeholder 21	MET	2015
Stakeholder 22	MET	2015
Stakeholder 23	MET/Academic	2015
Stakeholder 24	Consultant/Academic	2015
Stakeholder 25	Consultant/Academic	2015