

AMBIO

Electronic Supplementary Material

This supplementary material has not been peer reviewed.

Title: "How changing fire management policies affect fire seasonality and livelihoods".

Table S1 Timeline of historical events affecting the Khwe, Mbukushu and the Government of the Republic of Namibia (GRN) in Bwabwata National Park (1795 – 2016).

Year/s	Historical event
Prehistoric period	Presence of hunter-gatherer cultures [San] in the region
1795 -1800	Arrival of Bantu-speaking tribes in the region ¹
1830	Khwe were subject to slave raids that extended from the Angolan coast to northern Namibia ²
1840 -1850s	First recorded encounters of the Khwe with Europeans ³
1852	First map produced of north-east Namibia by the Swedish hunter and explorer, Sir Charles John Andersson ⁴
1850s	Settlement of Mbukushu along the Kwando and Okavango Rivers in West Caprivi
1884	Establishment of Namibia as a German Protectorate (Deutsch Sudwestafrika) as German South West Africa (SWA) ⁵
1900s	Hunter-gather societies were exposed to Bantu tribes and introduced to stock farming and agriculture
1886	Delineation of Germany's northern boundaries in an agreement called the Portuguese-German Convention drawn up between Portugal (Angolan colony) and Germany
1888	Banning of all fires by law under the German Colony of South West Africa (Deutsche Kolonialgesellschaft für Südwestafrika)
1890	West Caprivi under the jurisdiction of German administration through an agreement, the Anglo-German Agreement was signed between Britain and Germany
1896-97	Rinderpest epidemic affects wildlife and livestock in the northern Kalahari and Namibia, killing between 80 to 90 % of cattle, and together with drought, led to great hardship
1908	Caprivi strip was referred to as 'German Barotseland' or the 'German Zambezi region'
1900 -30	The period 1900-30 brought considerable displacement, migration, and resettlement of both Khwe and Mbukushu in what are now Angola, Namibia, Botswana, and Zambia
1911-1915	Bushman Plague in northern Namibia: included attacks by German troops, police and settlers on San communities (San genocide) and forcing of San men into labour ⁶
1914	Beginning of First World War: German colonial period ended when South African army troops invaded Namibia
1915	Germany surrenders territory of South West Africa to South Africa
1919	After 1919 Versailles Peace Treaty, the League of Nations declared South West Africa (SWA) a South African protectorate
1915 - 1921	Caprivi came under South African Defence Force (SADF) military administration
1929	Administration of the west Caprivi was handed to the South West African Administration (SWAA) by the Bechuanaland Protectorate
1929	Correspondence refers to the prohibition of Mbukushu migration from Angola, as well as cattle into West Caprivi

¹ Tinley, K. 1966.

² Battistoni, A. & J.J. Taylor 2009.

³ Hitchcock, R.K. 2012.

⁴ Blomstrand, C. 2008.

⁵ Hitchcock, R.K. 2012.

⁶ Gordon, R.J. 2009.

1930	Rife cattle epidemics in the Kavango area resulted in the administration ordering that natives and cattle be cleared from West Caprivi. People were wither moved to the west bank of the Kavango River or the east bank of the Kwando River
1940	West Caprivi was made a livestock free territory
1940s-1960s	Khwe were used as contract labourers on the Gold Mines on the Witwatersrand in South Africa
1945	Tsetse fly invasion, and resident Mbukushu, Mafwe and Mayeye tribes move out of low-lying areas of the park
1947	SWAA commenced a scheme to bring the 'bush people' under greater protection
1949	The SWAA established a Commission for the Preservation of the Bushmen
1949	Rundu Native Commissioner employed 'pure Bushmen' policies, of which the official policies were to 'tame' the wild bushmen and bring them under administrative control and into the settler economy
1949	Economic exchanges of food, goods and labour were in place in West Caprivi between the Khwe and Mbukushu ⁷
1960s	Mass slaughter of indigenous wildlife by the SADF in the region
1960	Formation of South West African Peoples Organisation (SWAPO) under the majority of the Ovambo people
1961 -1975	Angolan War of Independence
1963	South West African Administration declared the 'Odendaal Commission' for the purpose of creating 'native reserves' for non-white people; Process of apartheid planning for Namibia, however Bwabwata National Park (BNP) was excluded (West Caprivi), thus a Homeland for the Khwe for traditional hunting and gathering purposes was dismissed
1963	Formation of West Caprivi Nature Park (BNP) between the Okavango and Kwando Rivers (Proclamation No. 67 of 1963, Schedule Caprivi nature Park, in the official Gazette of South West Africa No. 2513 of 15th October 1963), and as a result, the hunting of wild animals in the region was declared illegal
1966	Ecological Assessment of the Caprivi Nature Park by Ken Tinley to determine whether any valuable resources would be lost to South West Africa (SWA) ⁸
1966	Caprivi Nature Park was administrated by the Bantu Affairs Department
1966-1989	Namibian War of Independence/ War of Liberation / South African Border War: Namibian Government restricted from area; Khwe were banned from using fires; removal of the responsibility of Fire management from the Traditional Authorities; further implementation of fire prevention
1966-1990	Khwe were restricted from using fire, and collecting veld food resources in BNP, and were settled in South African army bases
1968	Caprivi Nature Game Park renamed to Caprivi Game Reserve
1966-1989	Khwe used as trackers and soldiers for the SADF during the War of Liberation
1974	SADF Battalions were established in central western Caprivi (provision of wages, supplies, food, clinics, and housing for the Khwe), which included 7 major camps
1975	Independence of Angola
1975	Mbukushu were removed from the western Caprivi (BNP) by the SADF ⁹
1975 - 2002	Angolan Civil War

⁷ Taylor, J. 2008.

⁸ Tinley, K. 1966.

⁹ Suzman, J. 2001.

1978	! Xun and Khwe relocated by SADF from Caprivi (BNP) to West Bushmanland to work as soldiers
1920s -1980s	Mbukushu were dominant and disparaging of the Khwe
1980s	Fires were intensively used for strategic purposes during wartimes particularly in the north-eastern part of Namibia ¹⁰
1980s	Omega formed the largest SADF base, home to 4500 Khwe and! Xu ¹¹
1989	End of the War of Liberation
1989	Proclamation of Mahango Game Reserve on the border of Botswana (Mohembo) ¹²
1990	Namibia gains Independence on the 21st March
	Emergence of Community Based Natural Resource Management (CBNRM) programmes in Namibia
1990	Occupation of Caprivi Game Park for conservation purposes and the Ministry of Environment and Tourism (MET) resumes management
1990	Namibian non-governmental organisation (NGO), the Integrated Rural Development and Nature Conservation (IRDNC) assisted Ministry of Wildlife, Conservation and Tourism (MET) to involve local people in conservation efforts in West Caprivi
1990	The Namibian government settled the Khwe in agricultural schemes in the western part of the caprivi strip
1990	Relocation of! Xun and Khwe soldiers and their families to Schmidtsdrift, South Africa by the SADF
1990	After the SADF left Namibia, the Mbukushu (approx. 1 000 people) moved back into the area and settled along the Kavango and Kwando River courses following the 1945 Tsetse fly outbreak
1994	Namibia's Secessionist movement occurred within the Caprivi Strip; formation of the Caprivi Liberation Army (CLA; rebel group); several Khwe fled to Botswana as they were viewed as perpetrators supporting the movement ¹³
1994	Social-ecological survey of the Caprivi Game Park which recommended that the people living in the park should be allowed to remain there. In terms of the CBNRM principles, it was recommended that any conservation plans for the area should involve and benefit the people ¹⁴
1995	Outbreak of lung plague among cattle across the border in Botswana, resulting in the government's destruction of 320,000 head in Namibia
1995	Traditional Authorities Act No 17 of 1995: 'act to provide for the establishment of traditional authorities, the designation and recognition of traditional leaders; to define their functions, duties and powers; and to provide for matters incidental thereto'
1995	The Government of the Republic of Namibia (GRN) made the decision to build a prison farm on the banks of the Okavango River with permission form the Mbukushu Traditional Authority (TA). The Khwe strongly objected these plans as it was officially on a tourism site, which provided employment to the Khwe community
1996	The Working Group of Indigenous Minorities (WIMSA) founded, a San advocacy group

¹⁰ Burke, 2001.

¹⁰ Suzman, J., 2001.

¹² Ministry of Environment and Tourism (MET).2010.

¹³ Rousset, K., 2003.

¹⁴ Tinley, K. 1966.

1996	An application from the West Caprivi community (i.e. Khwe) for a conservancy to be established was denied by the MET due to the status of the area as a Game Park
1998 - 2000	Several Khwe people were harassed by the Namibian Defence Force (NDF) soldiers, and fled the West Caprivi because of the alleged involvement with Angola and UNITA
1998	The Ministry of Local Governments and Housing in a policy statement (not formally decided by the Cabinet) would take over the responsibility for rural fire control
1998	The Directorate of Environmental Affairs, Ministry for Environment and Tourism (MET) clearly indicated that it would support future intersectoral policies in fire management
1998	Namibia's Ministry of Environment and Tourism (MET) introduced a conservation and development plan for the West Caprivi Game Park, called the MET Vision for Caprivi/Bwabwata National Park Plan
1998	Formation of Multiple Use area (MUA) and zonation of two core wildlife areas (Kwando and Buffalo core areas)
1998	Khwe restricted from hunting, and collecting veld food resources in the core conservation areas of BNP
1998	1000 Khwe fled to Botswana due to the expansion of the Angolan conflict (War)
1999	The GRN permitted Angolan government armed forces to use the West Caprivi to launch a counterattack on UNITA rebels on southern Angola
1999	Technically no cattle are allowed in BNP as per a Namibian cabinet decision in 1999 for conservation and veterinary reasons. Today there are cattle in the villages of Bagani and Omega 1. The Mutc'iku, Bagani and Omega 1 villages were meant to be deproclaimed from the park, but this never occurred ¹⁵
2000	Cabinet approved the change in status from a Game Park to a National park
2000	Mass exodus of people from West Caprivi due to the Caprivi Secessionists
2000	Traditional Authorities Act No 25 of 2000
2001	National Resettlement Policy: Historically disadvantaged groups such as the San be granted access to land
2004	Kyaramacan Residents Association (KA) established for all resident people in the bounds of the park; involves the collaborative wildlife and natural resource management involving the resident communities and the neighbouring communal area conservancies
2006	Community Based Integrated Fire Management (CBiFM) pilot project was adapted into the Bwabwata National Park Plan
2006	Inclusion of BNP and the eastern Zambezi Region into the Kavango Zambezi Transfrontier Conservation Area (KAZA -TFCA)
2007	Re-proclamation of Bwabwata National Park (BNP), which included Mahango Game Reserve, and the Kwando Triangle an area of the river previously excluded from the park
2013- 2014 to 2017/18	BNP Management Plan (control or suppression of fires will only take place under certain circumstances)
2012	Development of the Kyaramacan Association (KA) for the representation of all people living in Bwabwata National Park
2013	Official publication of the GRN document of the National Policy on Community Based Natural Resource Management (CBNRM)
2016	The MET recognises traditional burning practises in BNP for the first time in history in the 'Fire Management Strategy for Namibia's Protected Areas' document

¹⁵ Brown, B.T, & Dieckmann. U. 2014.

Table S2 List of semi-structured questions: Community stakeholder (Khwe and Mbukushu) interviews.

i) Cultural practises

1. Do you use fire as a traditional practise in your culture? How?
2. What are your cultural beliefs about fire?

ii) Fire management: How, where, when and how often fire is used

3. Do you have a problem with fire in your area?
4. How do the fires start? Natural fires (lightning), by accident, or started by humans?
5. Why are the fires started? Is it important to burn?
6. Are there small or large fires in your area? Where are the small and large fires in the Park?
7. In what months are the fires are there big fires and small fires?
8. What is/are your primary land use practise/s?
9. Do you use fire to manage your land (How)? What months of the year do you use fire? What time of day?
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?

iii) 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?

iv) 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).

Table S3 List of semi-structured questions: Government and non-government stakeholder interviews.

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 (Robin Beatty).
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 influenced 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?

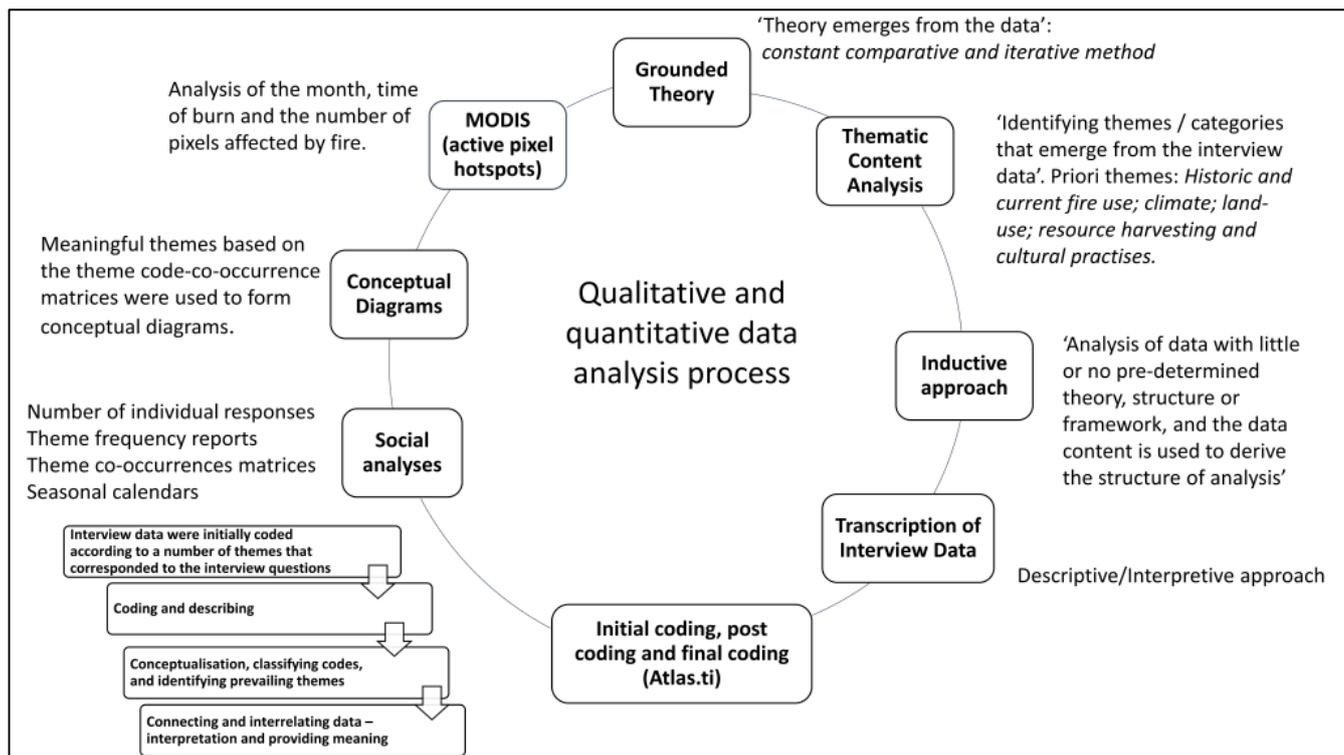


Fig. S1 A schematic diagram showing the use of grounded theory in this study as a theoretical framework and the resulting cycle of qualitative and quantitative data analysis for the stakeholder interview data beginning with the transcription of the interview data (2014 and 2015).

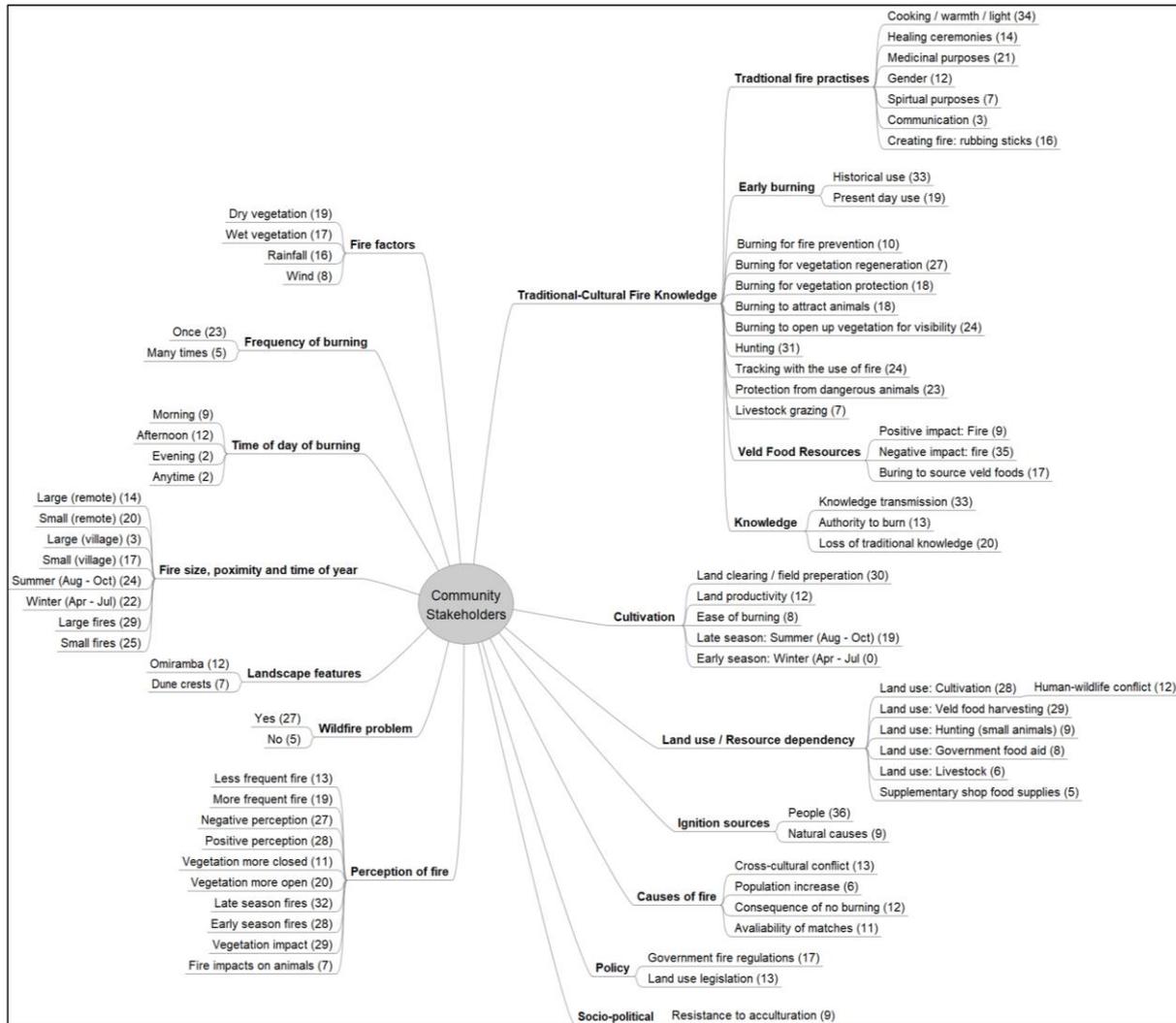


Fig. S2 Map showing the main themes (n = 18) and sub-themes (n= 75) based on thematic content analysis of interview data (n = 36) with the Khwe and Mbukushu people in Bwabwata National Park (2014 - 2015). *The numbers in parentheses refer to the number of participants who provided a response for each sub-theme within the context of the sub-theme.

Table S4 List of representative quotations: Community stakeholders (Khwe and Mbukushu people)

Traditional Fire Practises

“Medicinal purposes to burn plants are still in use today; fires are used for different purposes e.g. Fires used for treating illnesses is different to cooking and fires for warmth and sitting around; learnt from elders - up till now we use this same way” (Khwe respondent).

Early burning

"Knowledge passed on from father and grandfathers. During winter, burn dry grass (small fire); you must burn the grass when is not too dry, so that you can have a small fire" (Khwe respondent).

"Past, the fire was small because people were using patch burning, these days people are not using that system, they are burning anytime". Patch burning is when you get small dry grasses and you put the fire, and if you see the fire, then you must stop it. The part you burnt earlier the area it germinates earlier, then animals come closer to graze (Khwe respondent).

“No late season fires as you will ruin the grass for the cattle; if there is burning it is because people don't know how to use fire; burn early season for the grass for cattle; if you burn early the grass starts to germinate” (Mbukushu respondent)

Veld food resources

“In the past they were using fire in May and June months- told by grandparents and his parents; but today people burnt nearby still today; fires should burn early to get wild fruits - burning is good for the vegetation; reason for burning is looking for food, put fire and walk” (Khwe respondent).

“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” (Khwe respondent).

“Using fire when they go hunting - old grasses and thick bushes are burnt on his way he finds Mangetti tree; then they come back and discuss and then go burn the next day; collect seeds (food resources)” (Khwe respondent)

Government Fire Regulations

“Different, today and long time ago people were burning freely, but were burning in the months that they know, and burning with the purpose of collecting false mopane, but today we are controlled by the Ministry on burning - really quite different - long ago we were free" (Khwe respondent).

Vegetation change: Fire Suppression/ Consequence of no burning

“Yes, vegetation has changed; completely different now; policy of no burning destructive to regular burning” (Khwe respondent).

Hunting & Tracking with the use of fire

“Use fire for clearing thick bush and to find footprints of animals such as tortoises, monitor lizards, and duikers” (Khwe respondent).

Table S5 List of indigenous tree species used as veld food plants identified by the Khwe to be negatively impacted by fires in Bwabwata National Park.

Latin name	Khwe name (Khwé-dàm)
<i>Acacia flekii</i>	//guyi or //ge//gam
<i>Bechemia discolour</i>	tcindjere
<i>Burkea africana</i>	xei
<i>Dioscores sp.</i>	dinga
<i>Garcinia livingstonei</i>	tceuyi
<i>Grewia retinervis</i>	//quani
<i>Guibourtia coleosperma</i>	tceu
<i>Pterocarpus angolensis</i>	n/gao
<i>Schinziophyton rautanenii</i>	/qom
<i>Strychnos cocculoides</i>	/'x'oana
<i>Strychnos pungens</i>	‡quinya
<i>Terminalia prunoides</i>	kuu
<i>Vigna vexillata</i>	/'iya
<i>Ximemia americana</i>	kwa'‡ori
<i>Ximemia caffra</i>	//'axa‡'ori

Table S6 List of representative quotations: Government and non-government stakeholders

Early burning

“Early burning; how organised is that, who does it, where is it done, is it super monitored that burning or is just to say it is early burning; Yes, when it is done; partly successful, I am still sceptical about the effect of early burning during that period about the species which burn; until we know the impact on certain species; there are a lot of hypothetical questions about endemic species, or the species which depends on the species which burns - that could be a problem; conservation biology the significance of the micro environment; I am not in favour of early burning; what I favour is controlled burning, block burning to give each species a chance; during that time not all species burn; the frequency of burning will have an effect” (Respondent 12).

“What I do believe it that it has shifted the season of burn; early burning has not reduced the frequency; I don’t know if it has been successful - it depends on how you measure success; if the aim is to shift the burning to earlier in the year the to some extent that has been achieved - whether it has been monitored I am uncertain” (Respondent 23).

“Early burning helps in some way; if it is implemented properly and managed – preventing future and larger fires - over larger areas to prevent the spread of fire” (Respondent 17).

Fire Management

“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” (Respondent 9).

Perceived changes in the fire regime

“From 1990 the landscape has changed; forest to open savanna grasslands” (Respondent 16).

“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” (Respondent 23).

“Suppression of fire is a mistake - fires are natural - detrimental to vegetation ; managed systems now; during the military days fire was suppressed and after Independence the accumulation in fuel resulted in a change from forests to savannas; there were densely vegetated areas in BNP; in the military there were conservationists, although with not much training in conservation; reported to authorities - people weren’t consulted; people did not have a say; during the 1960 - 1980's they were anti-fire - military in control - 1990 independence; uncontrolled fire” (Respondent 16).

Perception of traditional fire knowledge

“No, they did not manage the veld; it was less populated then, so did not have a disastrous effect on vegetation at that time; they did not practice sustainable management; people were mobile so less damaging effect; indigenous tribes did not manage natural resources; they moved so that could not have a disastrous effects on vegetation” (Respondent 10).

“” Early burning was there all along, we copied it from the bushmen, and include it by now” (Respondent 6).

“These communal areas - the policy is only effective if your headman or Khuta/chief controlling it”
(Respondent 11).

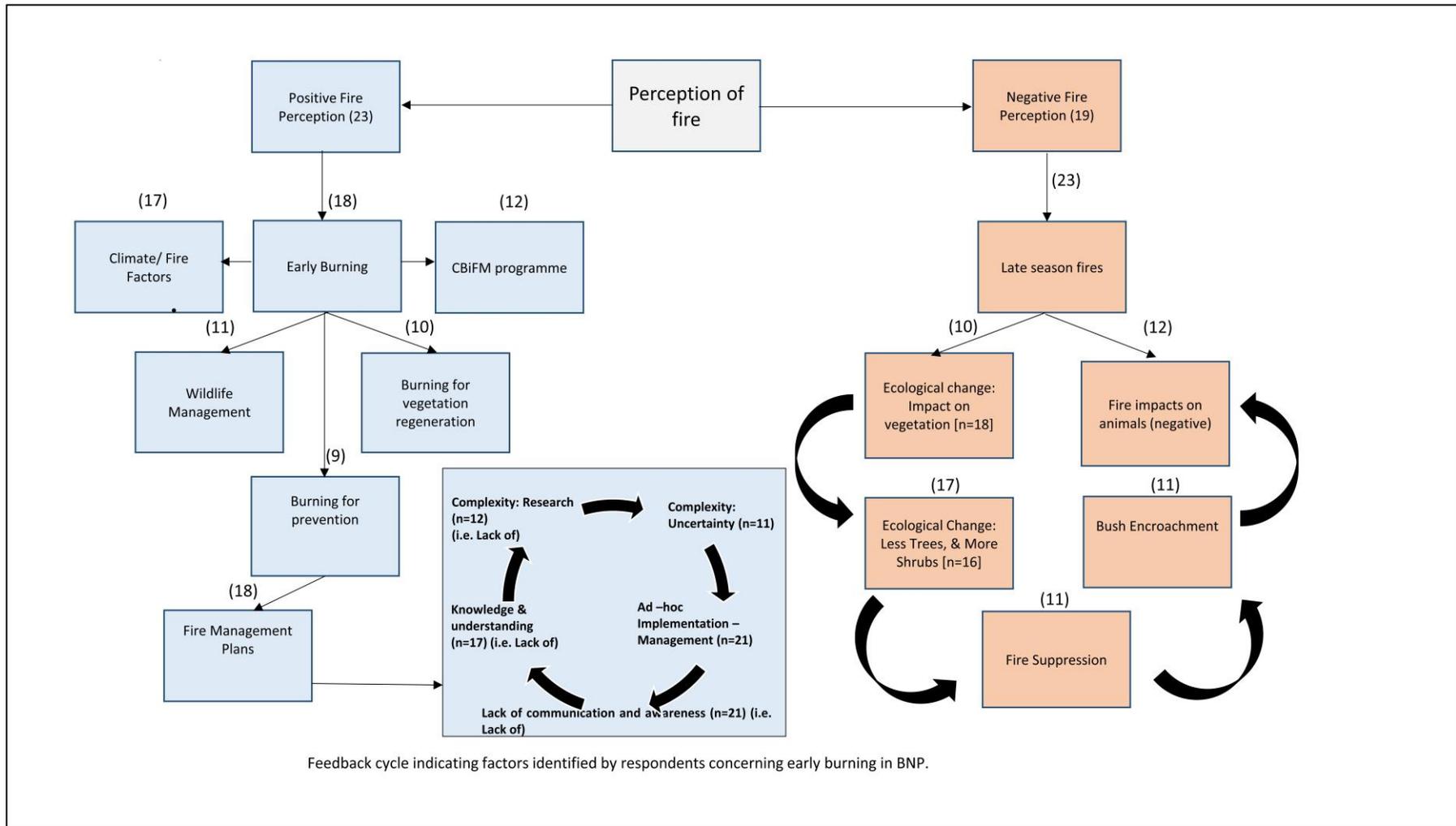


Fig. S3 Conceptual map representing the government and non-government stakeholders' positive (shaded blue boxes) and negative (shaded red boxes) perceptions of fire and associate themes [n = 25]. *The numbers in parentheses refer to the total number of theme co-occurrences.

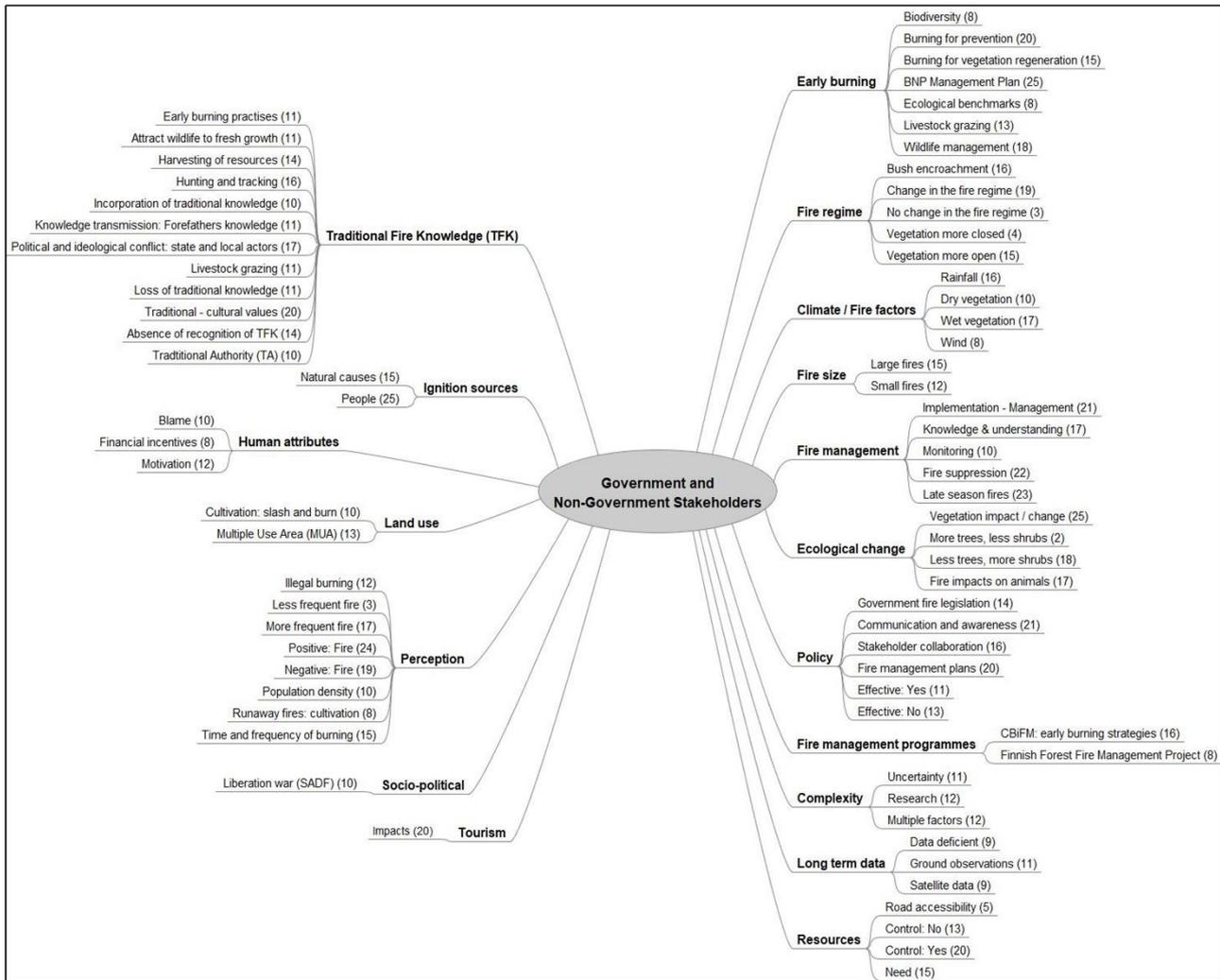


Fig. S4 Map showing the main themes (n = 18) and sub-themes (n= 68) categories based on thematic content analysis of interview data for the government and non-government Stakeholder data [n=25]. The numbers in parentheses refer to the number of participants who provided a response for each sub-theme.

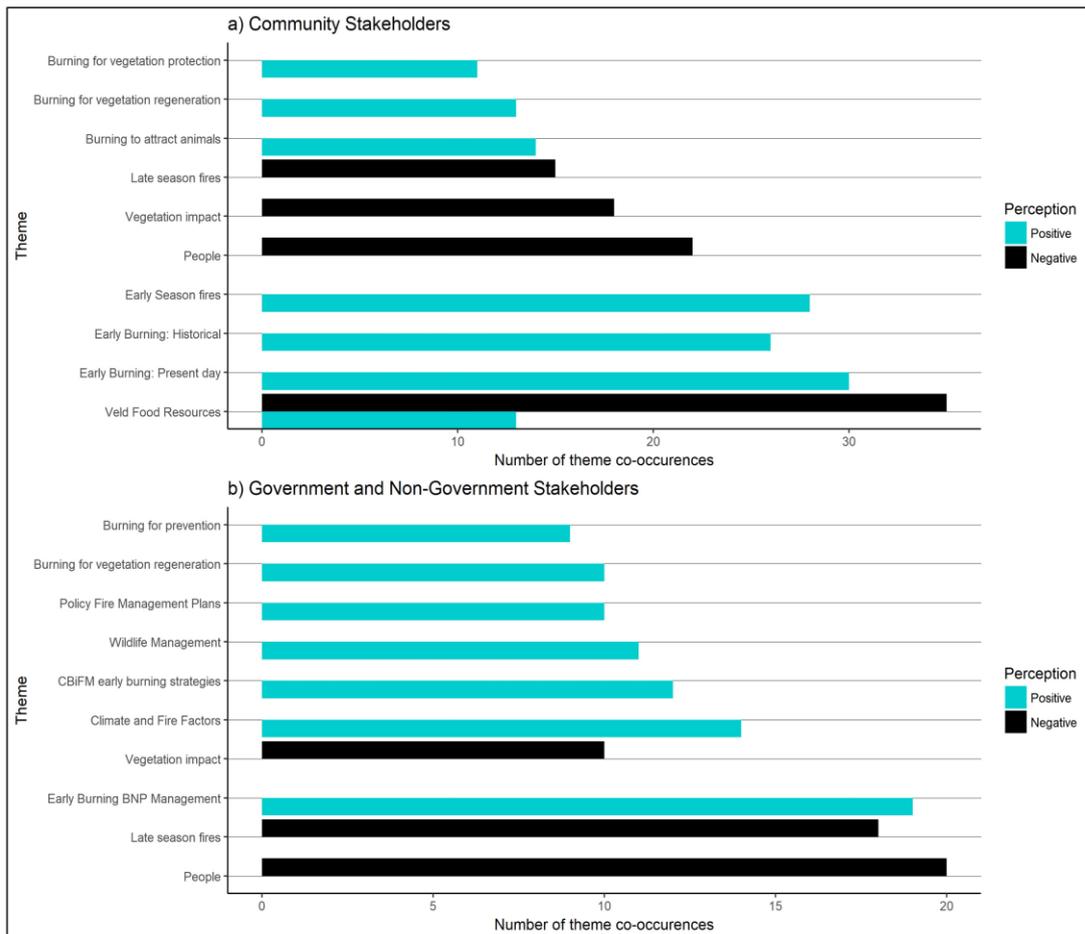


Fig. S5 Number of theme co-occurrences associated with a positive and negative perception of fire between a) community stakeholders' and b) government and non-government stakeholders' in Bwabwata National Park. * The black bar (negative perception) is situated above the line for each sub-theme, and the blue bar (positive perception) below the sub-theme line.

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