Integrated Range Assessment of Hainaveld, Lake Ngami Catchment and NG2 Project Pilot Areas

FINAL REPORT

For
The United Nations Development Program, under Contract
PR0003/2016
UN Building
PO Box 54, Gaborone

September 8th, 2016

By
Ecosystem Solutions for Africa
P.O. Box HA 77 HAK
Maun

Summary

‗Mainstreaming Sustainable Land Management (SLM) in Rangeland Areas of Ngamiland District Landscapes for Improved Livelihoods' is a collaborative Project between the Government of Botswana and the United Nations Development Programme (UNDP). The Department of Forestry and Range Resources is the lead Government Department within the Project which involves a diverse array of Stakeholders at the District level. The Integrated Rangeland Assessment (IRA) Project is being undertaken by Ecosystem Solutions for Africa (ESA) and involves a multi-disciplinary team of experts and a number of reporting milestones and activities. The primary aim of the Project is to establish best practice with regards to SLM in three focal areas of Ngamiland District - NG2, Lake Ngami and environs and the Hainaveld Farms. For each Focal area local knowledge gained through community participation and key Stakeholder consultation will be combined with ecological expertise to ensure improved decision making, ecological resilience and improved livelihood opportunities. Range Management and Rehabilitation Reports, together with a Scoping Report and Land Use Plans were developed for each Focal Area along with Reports for the key activities undertaken during the IRA Project, such as the development of a MultiStakeholder Platform. This Draft Final IRA Project Report provides an overall synthesis or summary of all previous reports and is broken down into eleven chapters.

Range management is defined here ‗*as the care of natural grazing lands [and] planning and administering the use of rangeland to obtain maximum livestock or game productivity consistent with conservation of the range resource*' (Stoddart, 1967; p.304). It is therefore important for SLM in Ngamiland District to consider both livestock and wildlife populations in order to fully identify all the threats, challenges and opportunities for improved range management in the District.

The idea of land degradation cannot be separated from that of sustainability. A form of land use is sustainable if it can continue indefinitely, and sustainability therefore depends on properties both of the resource and the way it is managed. The quality in a resource that renders its use sustainable is its resilience, which may be defined as the ability of the ecosystem to recover from perturbation (e.g. extreme seasonal and cyclic variation in rainfall) or a change in land use. The bigger the shock absorbed, the greater the resilience. A recurrent shock in dry lands is drought, and it is usually drought that brings land degradation or desertification to notice. The anxiety behind rangeland ecology is that the resilience of semiarid areas is being damaged, to the extent that land use systems may be unsustainable, and if stressed may collapse.

Chapter 2 - Legislation

The holistic nature of the Integrated Rangeland Assessment Project means that legislation relating to agriculture, veterinary services and animal welfare, wildlife conservation, biodiversity, rare and endangered species, veld fires, forests, noxious weeds as well as the Administration of Tribal Land must all be considered. The Tribal Grazing Land Policy of 1975 led to the demarcation of ranches, typically 6,300ha in size, in the Hainaveld with the primary objective of improving range management and animal productivity. It is a Policy that was extended into the communal areas through the National Policy on Agricultural Development (NPAD), with the Game Ranching Policy of Botswana now particularly relevant to the

Hainaveld where many of the southernmost Farms have converted to game, as well as in NG2 where some isolated game farms exist. A number of past Management Plans including the ODMP, Lake Ngami Management Plan, the Strategic Environmental Assessment (SEA) and Strategic Environmental Management Plan (SEMP) and ODMP Implementation Strategy have also been considered, with the threats and opportunities they identify used to develop sustainable land management scenarios for each Focal area.

Chapter 3 and 4 – Biophysical and Socio-Economic Background

The climate of Ngamiland District is classified as semi-arid and tropical, with highly variable and unreliable rainfall. Rainfall is concentrated in the summer months from November to April and typically falls in high intensity convectional showers that are often very localised. Winters are very dry, usually with no precipitation at all in July. Annual rainfall is normally less than 500mm per annum, the average annual rainfall for the three nearest meteorological stations are Ghanzi (435.6mm) (n=47), Maun (446.8mm) (n=47) and Toteng (296.2mm).
Drought is endemic due to the interior's peripheral and topographically isolated location in respect to the region's northern and eastern rain bearing air masses.

- **NG2**

NG2 does not feature prominently in past reports, partly as it has no biophysical, social/cultural or even land use justification to its boundaries and is relatively inaccessible apart for the calcrete road along the fossil dry river valleys. NG2's integrity as a land use planning unit has also been compromised by the fact that the Ikoga Fence bisects it. Elephants and zebra move throughout NG2, with a number of wild ungulates such as kudu, eland, wildebeest, hartebeest and impala also found there. Concern surrounds the ability of water dependent ungulate such as zebra to survive in western Ngamiland in general, and NG2 in particular, once the natural pools have dried up, as their route back to the Delta is likely to be blocked by settlements, lands and infrastructure.

The current situation in NG2 whereby large areas (>100,000 hectares) of the dry Kalahari sandveld burn regularly and do not contribute meaningfully to rural livelihoods is not desirable and is exacerbating unsustainable land management practices in adjoining areas. The open cattleposts in NG2 suffer from Human Elephant Conflict and depredation, losses due to Mogau (*Dichapetalun cymosum*) and the limitations imposed by saline aquifers. The importance of the interface between the Okavango Delta system and the dry Kalahari, or the boundary between the Zambezian and Kalahari Highveld phytochoria, is identified as a critical component of wildlife management in NG2 at the landscape level.

The only settlement in NG2 is Nxaunxau village which in 2001 had a population of 330 people and in 2011 an estimated population of 672 people. The Nxaunxau area was originally inhabited by Basarwa, but today other tribes such as the BaHerero, Bayei and Hambakushu also reside there. Livestock keeping is based on the open cattlepost system and limited by available groundwater, which is typically saline, with shallow wells tapping into perched aquifers along the dry river valleys, together with some deeper drilled boreholes. Seasonal pans can hold water all the year round in good rainfall years and are used by cattle and wildlife. The poisonous plant Mogau occurs throughout and is a major problem to livestock, with cattlepost farmers also reporting a problem with Pasturella. Veld fires often sweep through NG2, with water dependent wildlife such as zebra and elephants moving between NG2 and the Okavango Delta, although this connectivity is increasingly threatened by settlement expansion along the Panhandle and western fringe of the Okavango Delta. There is one fenced game farm in the south-eastern portion of NG2 and there can be little doubt that the maintenance of perimeter fences following damage to them by elephants is a major problem

- **Lake Ngami**

The Lake Ngami area is situated in NG/38 and a portion of NG/9 south of the main Maun to Ghanzi A3 road. It includes the villages around the lake of Toteng, Legothwana, Mogapelwa, Bothothogo, Bodibeng, Kareng and Sehithwa, and the villages' further north-west of Tsau, Semboyo, Makakung / Kgakgae and their grazing areas. Sehitwa is the main Service Centre followed by Toteng, with the latter affected by the 2010 development of a Copper/Silver Mine 45kms to the south-east by Discovery Metals Limited (DML). Following bankruptcy in 2014 Boseto Mine has been taken over by Khoemacau mine, along with the Toteng Housing Estate and all mine infrastructure.

The return of water to the Lake following inflows over the last five years has served to provide an abundance of fresh water for people and livestock, as well as opportunities relating to fishing and tourism, but has also restricted access between Villages and led to the proliferation of kraals and overgrazing. The latter has on the one hand also being accentuated by the erection of the veterinary cordon fence between Makalambedi and Kuke which has reduced the overall grazing area, but on the other effectively removed the problem of dual grazing rights by preventing the movement of cattle from the Hainaveld Farms to the Lake. All Farmers decried the situation relating to marketing and sales of their livestock and the complex of issues that surround it, which had contributed to the overstocking in the area and high mortality in the late dry season.

Lake Ngami is a remarkable feature and testament to the spatial and temporal variability of ecosystem functioning in semi-arid savannahs and the need for management to be adaptive, cross-sectoral and integrated. In the early 1980s Lake Ngami was a dustbowl with boreholes and cattle kraals concentrated in the bush thickened dry lake bed and domestic stock foraging outwards into the surrounding savannah. After nearly thirty years of being dry, the Lake began to receive inflows from the Kunyere and Nhabe Rivers in 2009 and filled to such an extent that the majority of tall *Acacia tortilis* trees within it have died. Kraals now ring the dry shorelines up to several kilometres away from the surface water, with domestic stock now foraging towards the Lake. The Lake bed itself is infested with *Xanthium strumarium* (Common Cocklebur) and the surrounding pastures heavily grazed and trampled to the extent that there is no grass for several kilometres outwards from the Lake. The invasive annual *Cenchrus biflorus* occurs in the area and was observed between the Lake and Bodibeng.

The wildlife linkages that existed in the past with the western Gcwihaba WMA and the broader Okavango Delta are likely to be increasingly tenuous due to the high density of kraals and residences around the Lake. No wild ungulates were seen during the field survey in Lake Ngami in stark contrast to the mid-1990s when springbok and wildebeest could readily be seen and counted. It is a tragic indictment of the failure of communal range management around Lake Ngami that a positive development such as the Lake filling again with water should result in unparalleled overgrazing and range degradation, bans on fishing due to environmentally unsustainable practices and the absence of previously abundant wild ungulates, probably due to poaching. The carcasses of dead cattle scattered throughout the Lake bed depressingly reminds us that domestic stock populations will crash again in the late dry season due to an absolute lack of forage.

The potential of the recently formed Lake Ngami Trust to deal with the various Management issues was welcomed although doubts surrounding its legitimacy and capacity were also expressed. The need to link socio-economic and ecological systems via an integrated and holistic natural resource management approach in and around resource rich Lake Ngami has never been greater

- **Hainaveld**

The Hainaveld Farms are situated between the CKGR and the Okavango Delta in an area that is characterised by a Mixed Mopane/Acacia Tree savannah (Weare and Yalala, 1971). A broad contrast can be made between a dominantly *Terminalia prunioides/Acacia* tree savannah in the north and a medium/high density bush savannah dominated by *Terminalia sericea* and *Lonchocarpus nelsii* as one moves towards the Kuke Fence. *Catophractes alexandrii* characterises areas with shallow soils and calcrete outcrops, overlapping with species such as *Acacia mellifera* and *Dichrostachys cinerea*, around waterpoints due to heavy livestock grazing pressure. Several kilometres away from the waterpoints on most Hainaveld Farms there is an abundance of grass as the range is ‗over-rested' and prone to veld fires. Several Hainaveld farmers reported that *Cenchrus biflorus* is spreading at an alarming rate and damaging the grazing resource as well as the health of their animals.

The Hainaveld farming block was originally zoned for commercial ranch development under the Tribal Grazing Land Policy of 1975. Successive phases of ranch allocation have steadily increased the number of ranches over time, although quite how many have been allocated, occupied and operated is not known, with many from each wave of allocation still undeveloped due to the lack of groundwater. Consequently, it is difficult, if not impossible to estimate the number of people residing in the Hainaveld as well as the numbers of domestic stock and game. DVS cattle crush data for 2013 provides an estimate of 32,550 and the DWNP (2012) aerial surveys show livestock to be concentrated in the westernmost and northern blocks of the Hainaveld Farm Block.

The southernmost tier of Hainaveld Farms (those adjacent to the Kuke Fence) are dominated by game and now operate as Game Ranches. It appears that while some Farms have never been developed, others were never re-occupied following the eradication of all cattle following the outbreak of CBPP. Indeed, the hardships of livestock and game farming in the Hainaveld, relating to the lack of markets, poor groundwater supplies, inaccessibility due to their remote location, elephant damage to fences and presence of predators, amongst others, should perhaps not be under-estimated. The designation of the Hainaveld Ranch Block as a Red Zone continues to affect livestock and game ranches alike and while the specifics are different in each case the end result is the same. Indeed disillusionment over the whole off take and sales situation was pervasive and the frustration of the Farmers considerable.

Chapter 5 - Remote Sensing Analysis

In more homogeneously vegetated ecosystems such as forests and prairies, remote sensing techniques such as the normalised difference vegetation index (NDVI) provide useful broadscale information on vegetation quality and quantity. To properly understand rangeland quantity, satellite imagery in savannahs has limited use as it captures primary productivity and not biomass so it is not possible to identify whether this is grassy or woody vegetation. However, by exploiting the seasonal differences in senescence between grassy and woody species it is possible to infer what proportion of the NDVI signal is likely to be due to grass species rather than woody species.

The EVI analyses undertaken for this project serve to capture an important component of the rangelands which is that there is considerable year to year variance in primary productivity. This is likely due to highly localised variation in rainfall. Based on the seasonal differences in NDVI it is of concern that only approximately 20% of both the Hainaveld and Lake Ngami areas are open grassland. In Lake Ngami in particular approximately 40% of the rangeland area is dense shrub or woody species.

Using a library of NDVI remote sensing data covering a 10 year period from 2001 through to 2011 on the Okavango, downloaded from the MODIS terra and aqua satellites, the SAREP/USFS Project, created a time series analysis for the 1st Nov and the 1st of May every year from 2001 through to 2011. Such an analysis provides an indication of the direction of change in reflectance scores of this time frame and identifying the geographical location in which observed changes were occurring. The data provided by the USFS/SAREP Project was re-analysed for the IRP SLM Project with May 1st used throughout as this is the time when primary biomass or greenness (NDVI) can be expected to be at its highest point.

The SAREP/USFS analysis defined ‗land degradation' as a long-term decline in ecosystem function and productivity, driven by land cover change or climatic change. Spectral vegetation indices derived from the NDVI product as provided by the Moderate-resolution Imaging Spectroradiometer (MODIS) can thus be used a proxy for land degradation, with local knowledge of the ecosystem used to attach some causal links to the observed patterns in NDVI.

The data analysed from the SAREP/USFS study shows negative trends to the west of the Delta around Gumare, as well as some of the core Delta areas and the Hainaveld commercial fenced ranches. The latter is more pronounced in November, while the positive trend in and around Lake Ngami seems likely to reflect the dominance of the invasive exotic cocklebur (*Xanthium strumarium*), rather than ‗useful' herbaceous biomass. The high negative values around Lake Ngami and Tsoe in May image are borne out on the ground by the absolute lack of grasses in these areas due to high stocking rates.

Analysis of MODIS data reveals that several hundred thousand hectares of Ngamiland District can burn in any one year. The total seasonal burn areas of Ngamiland can exceed a million hectares, ranging from 10-20 per cent of the entire District. It is clearly a significant impact for over a million hectares of rangeland to burn at any one time, with the loss of timber, veld products and biodiversity this represents, undocumented, but likely to be substantial. Trollope *et al* (2006) make a number of recommendations for fire management in Ngamiland, such as ‗reduce fire frequency to a rate of one in 3-5 years and promote cool burns'.

Forest loss in the Hainaveld over 2001 – 2014 is largely attributable to the development of Boseto Mine rather than veld fires, which are in fact relatively infrequent. The MODIS analysis undertaken by SAREP/USFS showed that most fires occur in the dry season between July and September, with wet season (Jan-March) fires concentrated in the Okavango Delta and rare on the dry sandveld areas of Ngamiland District. The Hainaveld Farms show relatively high fire occurrences in the period Oct-Dec.

Chapter 6 - Ground Based Survey

A field based range assessment was carried out following the end of the growing season (June 2016) and so the vegetation present represented the only available forage until the start of the next wet season (Oct – Dec). The low volume of available forage across much of the livestock farms within the range was striking and with little herbaceous material available livestock will become increasingly reliant on browsing. There was significant evidence of overgrazing and overbrowsing across the assessment range with large areas of bare soil, large inter plant distances, little vegetative litter as well as evidence of soil erosion.

There were noticeable differences observed between farms when accounting for management practices. Unfenced farms had the highest proportion of bare ground and lowest forage availability although the grazed paddocks of fenced farms were comparable. However, farms which are fenced have a forage reserve in the rested paddocks, allowing them to move livestock to these rested paddocks during the dry season. Unfenced farms do not have this luxury and will face significant challenges in providing sufficient forage resources to livestock at the end of the dry season.

On farms where paddocks were utilised, which allow for one or more paddocks to be rested at any given time, there was increased forage availability in the rested paddocks. However, both rested and grazed paddocks were dominated by annual grasses. Due to the general levels of over-stocking across the region, combined with recent years of low rainfall, paddocks are not able to rest and recover sufficiently which would allow perennial grasses to establish.

Unfenced farms with a medium to low stocking density had more herbaceous than woody ground cover whilst also supporting the largest volume of forage availability. The herbaceous grassed vegetation was dominated by perennial grasses at a ratio of 2:1. It is likely that the low stock density has allowed for the establishment of perennial grasses across the farms but the free-roaming nature of the livestock will still lead to areas of over-grazing near to kraals and waterpoints.

- Noticeable differences in ground cover, species availability and diversity as well as total forage availability are observed when accounting for farm management practices
- Unfenced farms with a high stock density had more bare ground with less herbaceous vegetation and low forage availability with less than half the required number of stock days of forage available for the remainder of the dry season
- Farms which followed a strict rotational grazing policy allowing paddocks to rest during the growing season had a greater diversity of species and increased proportional availability of established perennial grasses

- The sacrifice zone surrounding central kraals or water points extends for between 500m and 1km with a subsequent change in vegetation at 2.5km from the central point. Grazing reserves remain in the corners of farms or paddocks, 3-6km from the central point, but with no active herding taking place to push livestock towards these areas
- Annual and weak perennial grasses dominated across the Hainaveld with established perennial grasses in the majority at only 10 of 36 sites
- Browse contributes significantly to the diet of livestock across the Hainaveld as herbaceous vegetation is utilised quickly leaving bare soils
- Soils were frequently exposed with large spaces between plants and low vegetative litter on the surface of soils leading to erosion of the top soils
- Bush encroachment through localised dense stands of *Dichrostachys cinerea* were recorded on all farms to varying extents. On one farm where grasses had been able to become established they were seen to be out competing *Dichrostachys cinerea* shrubs causing the shrubs to die
- Farmers reported that farms were overstocked with negative effects on rangeland quality but they were unable to reduce numbers due to marketing challenges
- The relatively low stocking density on the game farms resulted in double the forage availability evident on livestock farms
- Apart from the game farms along the southern boundary of the Hainaveld there is insufficient herbaceous biomass to allow for fires to establish and spread across the region

There were notable differences in vegetated ground cover and the composition of this cover across the Ngamiland region with the NG/2 study area providing the greatest availability of forage with the highest proportion of perennial grasses and a broad diversity of woody species.

Across the communal areas the free-ranging nature of livestock has resulted in significant areas of degradation in concentrated locations near to water points and human settlements as rangeland is never allowed the time to rest and recover, even in the wet season. The current dearth of available forage in and around Lake Ngami will result in heavy mortalities of domestic stock in the late dry season.

Management practices across the Hainaveld farms have a noticeable impact on rangeland quality and forage availability but farmers may not feel able to follow their preferred management route through external constraints such as a lack of markets for their livestock which consequently affects the time and resources they are prepared or able to invest in their farm.

Chapter 7 - Consultations

All farmers bemoaned the situation relating to the sale, marketing and transport of their animals all of which were stated to be wholly inadequate and to negatively impact upon their livelihoods. Many past reports, such as Sandford (1980) have emphasised that sustainable land management cannot be considered in isolation from the workings of the internal livestock marketing system and have bemoaned the lack of priority and responsibility given to improving them.

Assuming Ngamiland has a population of 400,000 cattle increasing at an annual rate of 20 %, the combined current off take capacity of Ngamiland Abattoir and BMC is woefully inadequate, with a slaughtering capacity deficit of at least 20,000/yr. Consequently livestock numbers tend to grow fast in good rainfall years and crash precipitously in a drought. There is a complex hierarchy of issues surrounding marketing and sales of livestock and game, not least the designation of Ngamiland's livestock keeping areas by the Department of Veterinary Services as a red zone, the dominance of the EU beef market and the monopoly of the BMC. These structural constraints are in turn linked to the current functioning of the marketing system from sourcing, off take, transport, payment, sales etc., all of which need to be drastically improved.

It was clear from our discussions with Farmers during this Project that many were keen to improve their operations, but bemoaned the state of markets and the lack of meaningful extension advice to them. The latter included all aspects of livestock keeping from husbandry to technological aspects such as solar pumps and efficient and reliable reverse osmosis systems. Many Farmers felt isolated, if not abandoned, and realised that their knowledge base was limited and their operations could be greatly improved. The Multi-Stakeholder Platform developed during the IRP could be used as an active forum to disseminate this information and develop such demonstration ranches in the Hainaveld to ‗show case' Holistic Management and the substantial improvements that can be gained from its adoption.

Without the marketing and range management improvements at either end of the chain of production attempts to improve animal production will be short-lived and counter-productive as they will result in more poor quality animals on the range, rather than less. The demonstration ranches are expected to lead to a change in traditional attitudes and provide a basis for acceptance of more radical change in the management of the veld and livestock that places an emphasis upon planned grazing with sufficient recovery periods rather than simply continuous grazing or even rotational grazing. Livestock AND range management will be necessary if SLM is to be achieved in the Hainaveld.

Chapter 8 – Rangeland Rehabilitation

There are factors such as fire and key wildlife movements that need to be managed at a District or even Regional Scale, particularly if the impacts of climate change are to be mitigated effectively. Mobility of wildlife, and even livestock populations, is critical, with the key wild ungulates requiring connectivity with the Okavango Delta and ideally with the broader KAZA-TFCA. The boundaries of the latter have created a spatial mismatch between the red line fence in Namibia and the equivalent in Botswana, which has resulted in Khaudom National Park and the Nyae Nyae Conservancy in Namibia, standing in isolation, as well as the whole of western Ngamiland being an effective ‗island'. Owing to the lack of suitable groundwater in these areas and the abundance of mogau (*Dichapetalum cymosum*) they contain few livestock, while wildlife cannot get there due to the lack of connectivity because of disease control fences. Consequently, an ecosystem that was once driven by large herbivores is now driven by fire and contributes little or nothing to wildlife conservation and/or rural livelihoods.

There is an important fundamental difference between the management of free ranging wildlife populations and those populations on game ranches that is in danger of being forgotten in the literature and debates surrounding the contribution of each type of management to wildlife conservation. Free ranging ungulates rely heavily upon their mobility in order to survive on open unfenced rangelands. They respond in particular to the green grass that follows spatially and temporally highly variable rainfall and fire events, as well as a diverse array of key resource areas, ecotonal boundaries and an ability to utilise a diverse array of habitats – pans, dry river valleys, dunes and plains, all of which are key to understanding how these wild ungulate populations are able to survive in the harsh Kalahari environment. The complexity of wild ungulate movements related to dietary preferences and requirements are of course influenced by predators and in turn the need to reproduce and produce offspring that will survive and enhance the fitness of the population.

Rangeland management at a scale above the ranch level is necessary to address widespread veld fires and bush encroachment. The main objective of fire management is to reduce the frequency and extent of veld fires in western Ngamiland. Fire frequencies should drop to Trollope et al‘s (2006) recommendation to a rate of one in 3-5 years and cool burns should be promoted. It is recommended that this is achieved through the:-

- Establishment of Community Based Fire Management Teams – to maintain firebreaks and undertake pre-emptive burns.
- Pre-emptive burns in the early dry season to fragment fuel loads across extensive rangeland areas.
- Targeted ‗hot fires‘ in extensive areas of bush encroachment in order to rehabilitate these areas.

Game ranches deal with relatively small numbers of isolated game populations and provide them with water, and often supplements, in an environment that is typically without predators, with the populations of even nomadic or migratory species such as the key Kalahari ungulates of blue wildebeest, red hartebeest and eland becoming sedentary around the waterpoints and water dependent. Mobility is no longer the key to survival and opportunities to breed are of course restricted, often leading to mutations and genetic drift.
The idea that such game populations can be used to ‗re-stock‘ the free ranging ungulates in the Kalahari System therefore needs to be exposed as fatally flawed. Once released into the wild the populations from fenced game ranches will perish as the essential behavioural adaptations to survive in the harsh Kalahari environment that includes, droughts, predators and fire will simply have been lost.

Populations of game on ranches can play an important role in terms of multi-species production systems and the diversification of income streams, and also the conservation of rare and endangered species, but they should be viewed separately from the free ranging wild ungulate populations. It is the latter that are best adapted to survive climate change and have endured for millennia, but for some key ungulate populations (wildebeest and hartebeest) are in danger of being effectively lost from the Kalahari System. There is therefore an urgency to the need to keep rangeland systems open and the wild ungulates within them mobile, which should not become clouded by the mistaken belief that the populations on game ranches can contribute in any meaningful way to the conservation of free ranging wild ungulates by simply being re-introduced into the System.

This is an important distinction and serves to emphasise the fact that game ranches should not be allocated in areas where they threaten the mobility of free ranging ungulates between ecotones or key resource areas - because their populations are not interchangeable. The movement of wild ungulates between the Okavango Delta and western Ngamiland via the _gap' in the Buffalo Fence is one such example.

In the Hainaveld, Game ranches are becoming amalgamated to make up larger swathes of rangeland for animals to move across. However, this does not overcome the problems inherent with game ranches. The movement of predators such as lions between the CKGR and the Hainaveld is a dynamic that is unlikely to be sustainable, particularly for the neighbouring livestock farms. The wisdom of fencing up large blocks of land such as the Hainaveld into cattle ranches, to see many of them go through a conversion and amalgamation into fenced game ranches, with all the attendant problems that brings, needs to be questioned. Indeed with the CKGR adjoining the fenced game ranches and the Kuke Fence largely destroyed by elephants an opportunity to connect ecosystems through the provision of migratory corridors is being overlooked.
Climate change scenarios in Namibia indicate a retreat in C4 grass-cover over time in a north-easterly direction, with vegetation projected to suffer some reductions in cover and reduced Net Primary Productivity (NPP) throughout much of the country by 2050 (exacerbated by 2080) (UNAM, 2008). Another important factor is forage quality, with it suggested that warming would significantly decrease the non-structural carbohydrate concentrations and digestibility of rangelands, and that elevated CO_2 concentrations coupled with warming may exacerbate nutrient deficiencies in those systems which are already deficient in nitrogen (UNAM, 2008). Fire frequencies are also expected to increase due to climatic changes and variability, particularly an increase in dry years and warm ENSO phases in the region (Pricope and Winford, 2012).

The livestock sector is not going to fare well under the predicted impacts of climate change. Increased heat and water stress on grazing or browsing livestock is likely to result in decreased feed intake, milk production, and rates of reproduction. Increased demand for water, due to increased temperatures, will increase the herbivore use intensity around water points and exacerbate land degradation.

Livestock mobility is recognised as an important production strategy to harness the high spatial and temporal variability of fodder resources in the rangelands. Successful pastoral production hinges on the selection of grazing areas that have above average quality and quantity of forage. This is how the animals may have the best available energy and nutrient intake possible throughout the year. Planned herding is the grouping together of livestock in a single herd. The herd is then moved through an unfenced grazing area according to a grazing plan, imitating a herd of migrating grazers. In this way, grasses are allowed the necessary rest period and the impact of the herd is used to restore degraded land (van Oudtshoorn, 2016). Moving animals strategically to appropriate forage areas is the paramount management tool in pastoral systems to keep them ecologically and economically viable and is possible in the three focal areas IF there is a move to active herding.

In order to maximise the economic returns and further wildlife conservation both nationally and regionally game ranches in Ngamiland need to capture, hold and translocate such valuable species as roan, sable and tsessebe. There is also potential to establish a disease free herd of buffalo as has been achieved at the Nyae Nyae Conservancy in Namibia and throughout South African Game Ranches. Apart from sound economic reasons to distribute disease free buffalo in Botswana, it would also maintain the Northern Conservation area gene pool, with the disease free herds acting as nuclei for repopulation of this zone, should it ever be required.

Chapter 9 – Ranch Rehabilitation

The ‗Ranch Rehabilitation Plans' detailed in this report are not intended as a ‗one size fits all' approach to livestock keeping in Ngamiland. Instead the report presents a number of ways in which management can improve the existing situation across the entire ‗chain of production', enabling the livestock owner to choose aspects that can be improved based on what is possible and within the management reach and circle of influence of the farmer. The report has been structured so as to address all the key management issues affecting livestock keeping at the ranch or cattlepost scale across the entire chain of production.

The cattleposts and ranches in NG2 and the Hainaveld appear to be characterised by absentee owners. When visiting ranches or cattleposts in the day one is quite likely to find nobody around except for cattle hanging expectantly around the waterpoint, and quite possibly calves still in the kraal. The owners themselves may be encountered at weekends, or more especially, end of the month weekends, but outside of that they will probably be operating their own businesses in Maun or from other settlement centres. Ranch or cattlepost residents/workers may, or may not be around and the best time to catch them appears to be early in the morning or late afternoon. At these times they are at their busiest, watering and kraaling livestock in the late afternoon, and letting them out to graze in the morning. As Abel et al (1987) pointed out it is a system that is designed to avoid working in the heat of the Kalahari and is based upon the minimum expenditure of energy. Coupled with the instilling of the kraal – waterpoint axis into cattle as their ‗home range', and the overall permanence of kraals, it raises considerable scepticism as to the role that active herding can play in the system. Currently herding activities are very limited.

Current range management in Botswana has been heavily influenced by the work of Field (1975) who usefully identified the potential livestock carrying capacity of the whole country. Most of Ngamiland has an identified potential carrying capacity of 16ha/LSU which appears to have led to the mistaken belief that if the stocking rate for the ranch is less than this, there will be no range degradation problems. Underlying this attitude is undoubtedly the equally misplaced view that it is water that limits livestock production and not grazing, the latter being limiting only during a ‗drought'. Moreover, there is a tendency to ignore range condition indicators that trigger a loss of livestock condition and instead only act to destock when the latter becomes apparent. Coupled with a dearth of markets and lack of offtake opportunities the tendency to overgraze or over rest the rangeland is largely explained

Limitations on borehole provision due to poor groundwater supplies and the high costs of fencing and reticulating water, have resulted in many ranches being operated as open cattleposts. In western and northern Ngamiland the occurrence of *Dichapeatalum cymosum* (Mogau) limits livestock expansion while in many parts of the Hainaveld and around Lake Ngami invasive species such *Cenchrus biflorus* and *Xanthium strumarium* (cocklebur) are problematic.

Current ecological thinking in terms of sustainable land management has revisited Holistic Management (HM) philosophy and placed considerable emphasis upon certain key elements within it. In many ways it has been a ‗back to basics' shift with a renewed emphasis placed upon intact and fully functioning water and mineral cycles, which in turn will lead to healthy ecosystems and the maximisation of secondary production (See also Hoffman, 2003). The loss of mobility of livestock and game at the ranch scale is linked directly to areas around the waterpoint being overgrazed, while areas much further away are overrested. The latter are in turn associated with a lack of concentrated trampling that breaks up soil crusts and creates leaf litter, with consequent negative impacts on the water (reduced rainfall effectiveness due to higher evaporation) and nutrient (less organic matter, excreta and decomposition occurring on the soil surface) cycles.

Such HM principles have for example being fully integrated into Namibia National Rangeland Management Policy (June 2012) which as a result are all about ways in which high impact grazing (HIG) using concentrations of ungulates can be re-introduced into rangeland management in order to improve the water and mineral cycles. While there is an ongoing (heated) debate about the length of rest and recovery periods most suitable for semiarid rangeland systems, and more especially the desirability of fencing and rotational grazing systems in achieving such mobility, there is convergence of opinion in that both overgrazing and ‗overresting' are seen as a form of range degradation.

Recovery periods are therefore essential to ensure that plants are not overgrazed, with the ideas of the French biochemist and Farmer Andre Voisin, emphasising that plants are overgrazed when animals stay for too long in one area or come back too soon after being grazed. Overgrazing is not so much a function of the number of animals, but rather the length of time they spend grazing a patch of rangeland. On this basis it is possible to plan grazing effectively and ensure that perennial grasses have time to recover.

One of the most simple methods of ensuring rest and recovery is to graze half the Farm one year, and the rested half the next. This gives a full growing season of rest which a number of ecologists see as pivotal. Indeed, multi-paddock rotational grazing systems based on SDG, HIG, ‗mob grazing' or short periods of rest (6-10 days) are seen by some as contributing to range degradation by depleting the root stocks and soil seed banks of the palatable perennial grasses.

Currently many ranches in the Hainaveld are overstocked with livestock, including unproductive old female animals that have little or no value. The lack of markets and opportunities for offtake is a key factor, but the end result is many animals wandering around the kraal-waterpoint axis and overgrazing. Offtakes and markets must therefore be addressed urgently and once this has been done sustainable improvements to range management can be made by imposing effective periods of rest and recovery on the rangeland.

It appears that Farmers tend to watch and monitor the condition of their animals rather than that of the grazing, whereas in fact both are important if management actions such as destocking are to be taken effectively. A simple method of managing the ‗flow' of forage within a Ranch, known as the STAC method is suggested as a useful means of Farmers being able to quickly and effectively assess the amount of grazing, or ‗stock days' the Ranch has. Assessments are made in the early dry season by simply walking through the veld and assessing where the available grass reaches on one‘s leg (sole, toe, ankle or calf) together with the overall patchiness of the forage resource – which is used to refine the number of stock days available for the dry period.

This study concludes that there is a hierarchy of key actions that need to be taken urgently to redress the current unsustainable situation that exists throughout the entire chain of production. The tendency for inventory to build up in the wet years and crash precipitously in dry periods and droughts has been accentuated by the lack of markets and offtake opportunities, and has put unnecessary, and indeed pointless, stocking pressure on the rangeland. Higher net cattle prices and improvements to the marketing system are likely to favour better range and animal management. Better dissemination of market information is particularly important. A narrowing of BMC inter-grade and seasonal price differentials is recommended with BMC buying from all areas at any time so as to avoid the temptation to illegally move livestock to areas targeted for delivery to BMC at any one time. The development of new abattoirs, markets, especially those for deboned beef, and sales appears critical if the current desperate situation concerning the lack of offtake/marketing opportunities is to be addressed. Incentives such as transport subsidies and entitlement to restocking loans are also recommended but only as supports to special campaigns designed to reduce stock numbers and improve the rangeland resource.
Long term improvement in productivity will require more than changes in pricing or marketing systems. It is recommended that, attempts to improve animal production should be directly linked to range management and rehabilitation through the voluntary adoption of simple veld management principles and planning procedures. It is recommended that the UNDP SLM Project fund Farmer visits to those Farms in Ghanzi District that have successfully practiced Holistic Management (HM). The owners permitting such Farms could become ‗learning ranches‘ (for training and extension visits) that are used to broaden Farmers knowledge across the entire chain of production as well as a number of technological issues, pertinent to farming in remote areas.

Game ranching is becoming increasingly important in the Hainaveld Ranch block with many of the southernmost tier of ranches, those just above the Kuke Fence, converting from livestock to game (See Figure 2). Some game ranches have also assimilated other ranches into bigger 10,000 – 15,000 hectare operations. A few ranches run both game and cattle although there are reports from game ranchers that the DWNP has requested that they choose one or the other resource.

Contrary to common belief, the condition of the veld on many game ranches is in a poor state due to:-

- Overstocking – the recommended ratio between low (e.g. zebra and buffalo) and high (impala and blue wildebeest) selectivity grazers is 40:60, but this rarely attained due to the need to have animals visible to people and difficulties in selling/marketing animals from small game ranches.
- Sedentarisation - game populations tend to become sedentary around water points, even in the case of populations of eland and blue wildebeest, species that do not need to drink (except for blue wildebeest in the event of a drought).
- Lack of predator effect – in the absence of predators animals tend to concentrate too long in one place and cause area selective overgrazing. Even in cases where large predators such as lions are present, the tendency for large herbivores to stay around

waterpoints and the resultant _canteen effect‘ means that there is no real _herd effect‘ as there is in _natural‘ systems.

- Lack of trampling effect - large herbivores moving over the rangeland in concentrated herds serves to flatten the grass and cover the soil surface with mulch and dung, thus allowing biological decay before the next growing season and the grassland to rest during long durations. The surficial tillage by animal hooves, which loosens the soil and increases water infiltration in soils is also believed to stimulate seed germination and plant growth.

Chapter 10 – Livestock and Wildlife Potential

In order to adequately explore all options in the three focal areas a range of scenarios will be subjected to a comprehensive SWOT analysis in the Final Scoping Report.

Focal Area	Scenarios
NG2	
1.	Multi Species Production Systems – Unfenced cattleposts and Unfenced _game ranches‘
2.	Fenced Commercial ranches and fenced cattleposts
3,	Status quo
Focal Area	**Scenarios**
Lake Ngami	
1.	Lake Ngami with water
2.	Lake Ngami without water
3.	Integrated management
Hainaveld	
1.	Commercial ranches and Game ranches
2.	Cattlepost system and Game ranches
3.	Status quo

The results of the SWOT analysis reveal:-

- Unfenced cattleposts and unfenced ranches with wildlife connectivity to the Okavango Delta is the best option in NG2
- Integrated management is the best option at Lake Ngami.
- The cattlepost system and fenced game ranches is marginally the best option in the Hainaveld.

The SWOT analysis shows how once the rangeland becomes fenced up into ranches options, and the differential between various options, becomes very slight. Indeed, the results for NG2 show clearly the comparative advantage of keeping wildlife free ranging on extensive areas of unfenced rangeland. Fencing up NG2 into game or cattle ranches would therefore be a retrogressive move, with the stand out option, reconnecting NG2 to the Okavango Delta and allowing wildlife populations to move between the two ecosystems.

Chapter 11 – Land Use Plans

In many key respects land use planning and management in Ngamiland District is at a crossroads. The three focal areas cover a complex mosaic of tenurial arrangements and natural resource management regimes, that include cattleposts and fenced livestock ranches, arable agriculture, fenced game ranches and connectivity in terms of the movements of key wild ungulate species and predators between WMAs and protected areas (the Okavango Delta System and the CKGR). A review of past management plans for the District has highlighted the lack of any implementation of any one Plan due to a general failure to resolve these complex and often conflicting issues.

The focus in all cases has been to attempt to Plan land use at the landscape scale and reconnect ecosystems and wildlife movements through the establishment of wildlife corridors, without damaging the livestock sector but rather establishing a balanced Platform upon which both the wildlife and livestock sector can develop sustainably. The Land Use Plans take into consideration the key constraints to livestock production – poor groundwater resources, drought, mogau (*Dichapetalum cymosum*) and the impacts of climate change as well as the opportunities to develop western Ngamiland through the development of cattleposts and wildlife based economies on open unfenced rangeland. Except for the Hainaveld Farms (which would be developed as an EU export zone) the livestock industry would be developed within a CBT framework, rather than one based upon geographic FMD control. With Northern Botswana‘s burgeoning elephant population the continued pursuance of geographic methods of disease control through veterinary cordon fencing is felt to be a fatally flawed and extremely costly mistake. High levels of Human Elephant Conflict and depredation currently experienced throughout Ngamiland relate to the need to realign land use planning and management with the realities of today rather than those of the 1970s when many key Policies and Strategies that guided land use plans were developed.

Landscape level connections are therefore recommended at the scale of the KAZA-TFCA and between the ODRS and western Ngamiland. The proposal to link the Game Farms in the Hainaveld with the CKGR and strengthen FMD control through an electrified fence along their northernmost boundary appears as a particularly appealing option, that would reduce HEC and depredation problems, as well as reduce elephant damage to disease control fences. Unfortunately for Lake Ngami without a radical shift in the way in which the natural resources in and around the Lake are managed, namely through a Community empowered Trust that manages ALL resources, there is little that can be done and the current boom and bust nature of resources, domestic stock in particular, will continue.

A key objective of the Hainaveld Game Farms could be to re-focus its priorities to rhino conservation, in light of the fact that the live and meat sales of their antelope populations are severely restricted and the idea that these antelope populations could one day be used to restore the biodiversity of the Kalahari is a bit of a misnomer in light of the water provision and game ranching environment.

The key factor that seems likely to make the difference over the next 5-20 years is climate change with reconnecting ecosystems and restoring essential ecosystem goods and services a critical part of increasing ecosystem resilience and improving rural livelihoods. As such the land use plans recommended are felt to be quite visionary and in line with international best practice and scientific thinking.

TABLE OF CONTENTS

List of Acronyms

AfESG	African Elephant Specialist Group
AIDS	Acquired Immune Deficiency Syndrome
ALDEP	Arable Land Development Programme
ARAP	Accelerated Rainfed Arable Programme
ARB	Agricultural resources Board
AVHRR	Advanced Very High Resolution Radiometer
AWP	Artificial Water Point
BTO	Botswana Tourism Organisation
BRIMP	Botswana Range Inventory Monitoring Project
BSAP	Biodiversity Strategic Action Plan
CA	Conservation Agriculture
CBNRM	Community Based Natural Resources Management
CBO	Community Based Organisation
CBPP	Contagious Bovine Pleuro Pneumonia
CE	Critically Endangered
CFDA	Communal First Development Area
CHA	Controlled Hunting Area
CITES	Convention on International trade in Endangered Species
CKGR	Central Kalahari Game Reserve
CSDA	Communal Second Development Area
DAP	Department of Animal Production
DD	Data Deficient
DFRR	Department of Forest and Range Resources
DSM	Department of Surveys and Mapping

DWNP	Department of Wildlife and National Parks
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
ENSO	El Nino Southern Oscillation
ENVISAT	Environmental Satellite
ESA	Ecosystem Solutions for Africa
ETM	Enhanced Thematic Mapper
FAO	Food and Agriculture Organisation
FCB	Forest Conservation Botswana
FCS	Forest Conservation Strategy
FGD	Focus Group Discussion
FIMP	Fuelwood Inventory and Monitoring Project
GIS	Geographical Information Systems
GoB	Government of Botswana
HD	High density
HEC	Human Elephant Conflict
HIV	Human Immunodeficiency Virus
HRM	Holistic Resource Management
HWC	Human Wildlife Conflict
IFFM	Integrated Forest Fire Management
ISPAAD	Integrated Support Programme for Arable Agriculture Development
IUCN	International Union for the Conservation of Nature
KAZA	Kavango Zambezi
LC	Lease Concern
LD	Low density
LUCIS	Land Use Conflict Identification Strategy
MD	Medium density
MERIS	MEdium Resolution Imaging Spectrometer
MEWT	Ministry of Environment, Wildlife and Tourism
MFMP	Makgadikgadi Framework Management Plan
MOA	Ministry of Agriculture
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MPNP	Makgadikgadi Pans National Park
MSP	Multi-Stakeholder Platform
NAMPAAD	National Agriculture Master Plan for Arable Agriculture and Dairy Development
NASA	National Aeronautics and Space Administration
NBSAP	National Biodiversity Strategy and Action Plan

NDP	National Development Plan
NE	North East
NEDC	North East District Council
NGO	Non Government Organisation
NOAA	National Oceanic and Atmospheric Administration
NP	National Park
NPAD	National Policy on Agricultural Development
NPP	Net Primary Productivity
NRM	Natural Resource Management
NRMP	Natural Resource Management Project
NT	Near Threatened
NTFP	Non Timber Forest Product
NW	North West
ODMP	Okavango Development Management Plan
ODRS	Okavango Delta Ramsar Site
PIF	Pseudo Invariant Features
PTB	Permaculture Trust Botswana
RDL	Red Data List
REDD	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RS	Remote Sensing
SABONET	Southern African Biodiversity Network
SADC	Southern African Development Community
SAREP	Southern African Regional Environment Programme
SE	South East
SEMP	Strategic Environmental Management Plan
SLM	Sustainable Land Management
SW	South West
SWOT	Strength-Weakness-Opportunity and Threat analysis
TFCA	Transfrontier Conservation Area
TGLP	Tribal Grazing Land Policy
ToA	Top of Atmosphere

ToR	Terms of Reference
TPC	Threshold of Potential Concern
UNDP	United Nations Development Programme
UNFCC	United Nations Framework Convention on Climate Change
USAID	United States of America for International Development
USGS	United States Geological Surveys
USLE	Universal Soil Loss Equation
VPR	Veld Products Research
VU	Vulnerable
WMA	Wildlife Management Area

List of Tables

List of Figures

List of Plates

1 INTRODUCTION

1.1 General

The Government of Botswana in collaboration with the United Nations Development Programme (UNDP) are implementing a project called ‗Mainstreaming Sustainable Land Management (SLM) in Rangeland Areas of Ngamiland District Landscapes for Improved Livelihoods' (SLM Ngamiland). Ecosystem Solutions for Africa (ESA) (Pty) Ltd successfully tendered for the bid, to undertake the detailed Integrated Rangeland Assessment (IRA), with a multi-disciplinary team of experts. The Project involves a number of reporting milestones and activities.

The current document serves as a summary or synthesis report that brings together all the various reports and activities carried out under IRA. The Integrated Rangeland Assessment (IRA) targets three main project implementation areas namely:-

(i) Hainaveld and Maun/Toteng commercial ranches;
(ii) subsistence farming rangelands within and about Lake Ngami and; (iii)Western Ngamiland (NG2 and environs).

This Draft Final Report includes specific land-use plans for each of the targeted areas with clear management actions to be implemented by the project and other stakeholders during and after project life.

1.2 Detailed Scope of Work

The ToR requires that the following issues are addressed throughout the course of the project development process:

1. Mainstreaming SLM principles
2. Enhanced participation of local communities
3. Combining local knowledge with ecological expertise for improved decision making / improved ecological resilience
4. Rehabilitation and monitoring to be informed by the rangeland assessment
5. Assessing socio-economic and ecological risks to ecosystem resilience and land productivity
6. Ensuring recommendations strengthen the sustainable flow of ecosystem goods and services.

Range management is defined here ‗*as the care of natural grazing lands [and] planning and administering the use of rangeland to obtain maximum livestock or game productivity consistent with conservation of the range resource*' (Stoddart, 1967; p.304). It is therefore important for SLM in Ngamiland District to consider both livestock and wildlife populations in order to fully identify all the threats, challenges and opportunities for improved range management in the District.

1.3 Team Structure

In order to achieve the SLM goals of this Project ESA has put together a highly experienced team, with many decades of combined experience of working on socioeconomic and rangeland issues within the Ngamiland region.

The short term technical specialists who are otherwise independent consultants include;

- Team Leader; Environmentalist, with rangeland ecology oversight; Jeremy Perkins
- Sociologist and Land Use Planning, Oversight, Lin Cassidy
- Land Husbandry; Jozua Lambrechts and Sheldon Barnes, experts and certified Practioners in Holistic Resource Management
- Land Use Planner; Kagiso Thakudu
- Supporting Sociologist; Ms Zoe Parr All other team members are full time staff of ESA.

1.4 Details of all Deliverables

A number of individual Reports were delivered under the IRA Project and while the current Draft Final Report is intended as an overall Summary or Synthesis Report the individual Reports listed below contain much detailed information. The full set of Reports delivered is as follows:-

1. Initial meeting report
2. Workplan & Inception report
3. Multi-stakeholder Platform development report
4. Scoping report of key preliminary issues
5. Draft Final
    a. Integrated Rangeland assessment protocol
        i. Rangeland management and evaluation framework
            1. Rangeland rehabilitation plans
            2. Ranch rehabilitation plans ii. Management Oriented Monitoring (MOMS) strategy
    b. Report on socio-economic status and livelihood options
    c. Report on rangeland condition / evaluation report
    d. Assessment of and recommendations for addressing land use conflicts
    e. Specific land use plans
        i. Desk top review of the land use plans
        ii. LUCIS assessment

6. Final report – the current Report as a Draft Final

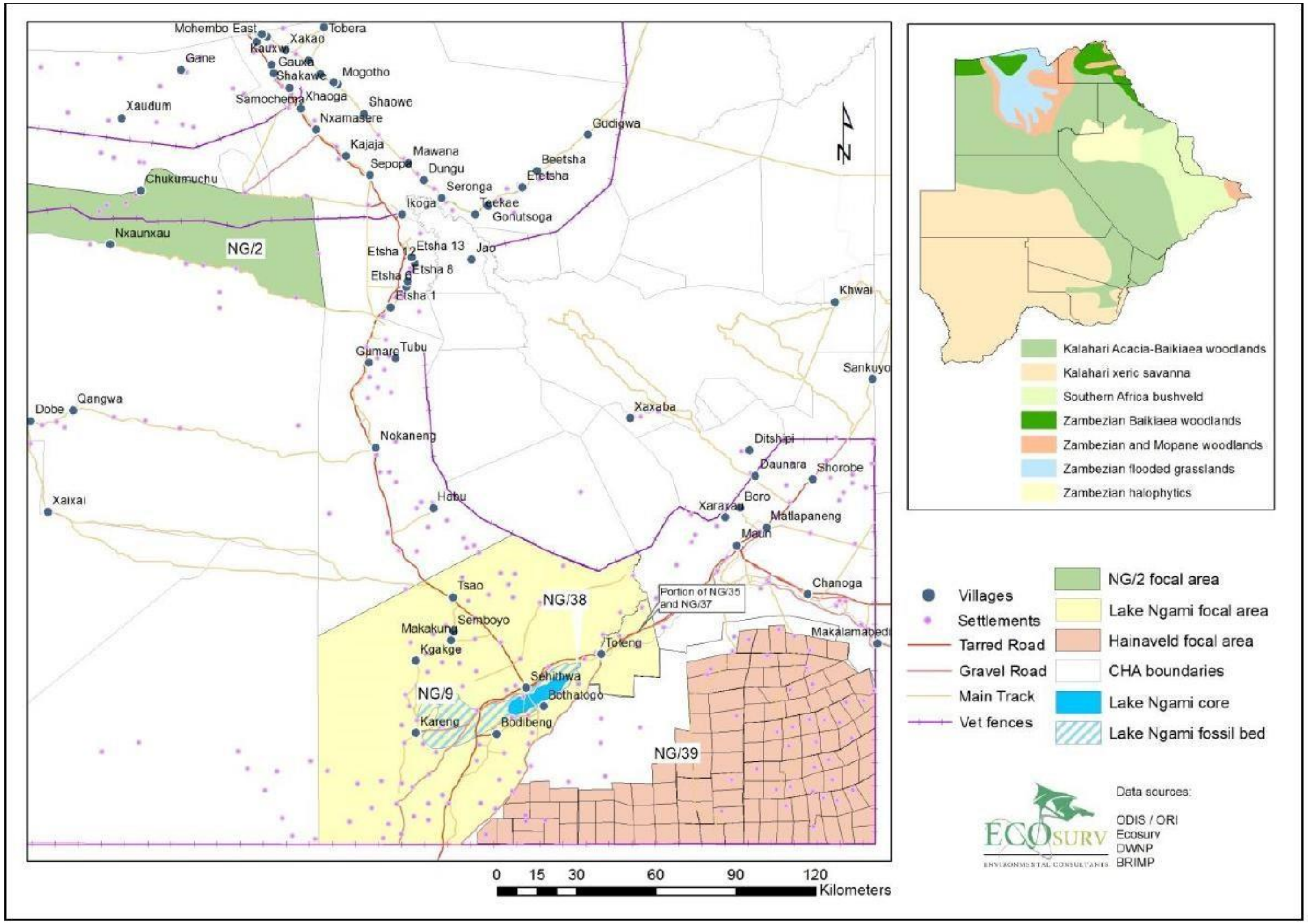

Mohembo East
Tobera
Xakao
Gane
Kauxwi
Gauxa
Shakawe
Mogotho
Samochema
Xhaoga
Shaowe
Xaudum
Nxamasere
Gudigwa
Kajaja
Mawana
Beetsha
Sepopa
Dungu
Eretsha
Chukumuchu
Seronga
Ikoga
Tsekae
Gonutsoga
Nxaunxau
NG/2
Etsha 13
Jao
Etsha 12
Etsha 6
Etsha 8
Etsha 1
Khwai
Gumare
Tubu
Sankuyo
Dobe
Qangwa
Xaxaba
Nokaneng
Ditshipi
Daunara
Shorobe
Xaixai
Habu
Boro
Xarawa
Matlapaneng
Maun
Chanoga
Tsao
NG/38
Portion of NG/35 and NG/37
Makakung
Semboyo
Makalamabedi
Kgakge
Toteng
Sehithwa
NG/9
Bothatogo
Kareng
Bodibeng
NG/39
N
0 15 30 60 90 120
Kilometers
Kalahari Acacia-Baikiaea woodlands
Kalahari xeric savanna
Southern Africa bushveld
Zambezian Baikiaea woodlands
Zambezian and Mopane woodlands
Zambezian flooded grasslands
Zambezian halophytics
Villages
Settlements
Tarred Road
Gravel Road
Main Track
Vet fences
NG/2 focal area
Lake Ngami focal area
Hainaveld focal area
CHA boundaries
Lake Ngami core
Lake Ngami fossil bed
Data sources:
ODIS / ORI
Ecosurv
DWNP
BRIMP
ECOSURV
ENVIRONMENTAL CONSULTANTS

Figure 1 Map of the generalised location of the three focal areas

1.5 Methodology

The IRA Project has relied upon a number of different methodologies including:-

(i) GIS/RS analysis of all relevant data basis and their portrayal in informative and innovative ways to clearly show the different pressures and threats on land use and the natural resource base.

(ii) Ecological Field Assessment. Field reconnaissance in early June with the Holistic Resource Management Specialists from South Africa and the ecological Team from ESA led to the prioritisation of field areas and the standardisation of field methodologies. The selection of ranches for more detailed assessment in the Hainaveld was discussed with the Chairman of the Hainaveld Farmers Association and the best ranches agreed upon. During this reconnaissance field survey every opportunity was taken to talk to cattlepost and ranch owners, as well as game ranchers, in all three focal areas.

(iii)Community Consultations. Focus Group discussions were held by Zoe Parr of the ESA Team in the Villages of Nxaunxau, Semboyo, Tsau, Makakung / Kgagae, Bodibeng, Bothothogo, Toteng, Sehithwa, and Kareng. Community mapping was conducted as the primary tool during the FGDs to guide the discussion the various areas used, location of roads, fences, firebreaks, cattle posts, boreholes, wells and natural pans, quality of grazing and water quality and general livestock movements that occur. A series of semi-structured questioned were asked following the completion of the map. The questions focused around livestock husbandry methods, markets, challenges and changes in the last 20 years. Key informant interviews (KII) were conducted in Gumare with farmers with cattle in NG2, the game farm owner and manager of the game farm in NG2, The

Hainaveld Farmer‘s Association Chairman and a varied selection of farmers from the Hainaveld, as well as with the Ngamiland Abattoir (as above). The Team also met with Honourable Kgosi Tawana and ensured that his office received all Draft Final and Final copies of the various Reports. .

(iv) As per the ToR the potential role of the development of a Multi-Stakeholder Platform as a way to promote agricultural development through a shared learning process and forum for dialogue and identification of agricultural management practices. Such platforms, which are essentially a regular meeting ground for members from diverse backgrounds, are centred on a participatory approach and bring together actors from diverse backgrounds, including local farmers (as represented through their associations), researchers, government extension workers, NGOs, community leaders and others (including for example a representative of Botswana Meat Commission), who all have interests in the same aspect of agriculture, but would not normally come together to share knowledge or develop synergies. In this case, the platform would be focused on a specific idea or innovation, namely sustainable land management related to rangelands and livestock husbandry.

2 LEGISLATION

There are a number of Acts and Policies in Botswana that have a direct, and more especially indirect, influence on sustainable land management in Ngamiland District. Range management is a distinct discipline founded on ecological principles and deals with the use of rangelands and range resources for a variety of purposes, including as watersheds, wildlife habitat, grazing by livestock, recreation, and aesthetics, as well as other associated uses (http://oneplan.org/Range/index.aspis. It is therefore important for SLM in Ngamiland District to consider both livestock and wildlife populations in order to fully identify all the threats, challenges and opportunities for improved range management in the District. As such the legislation that affects both livestock and wildlife populations is detailed below.

2.1 Acts

2.1.1 Livestock and Meat Industries Act 32 of 1962

The Livestock and Meat Industries Act (1962) provides for the control of the operation of abattoirs, slaughter houses, cold storages, canning plants, slaughter poles, bone meal factories, livestock produce store, tanneries and meat processing plant. It is illegal to slaughter animals for commercial sale anywhere but a registered abattoir. The slaughter of animals at any such facility is supervised by Veterinary Officers from the Department of Animal Production and the Botswana Police – who check that the animal is not stolen.

2.1.2 Botswana Meat Commission Act (1965)

The Botswana Meat Commission Act (1965) provides for the establishment of BMC. The core activity of BMC is to purchase cattle, slaughter, prepare and sell the products or to sell on the hoof cattle so purchased. BMC has an export monopoly for beef and beef edible products to the European Union.

2.1.3 Diseases of Animals Act (1977)

The control of Imports/Exports/Intransit of animals and animal products in Botswana is governed by the Diseases of Animals Act CAP 37:01, Section 6 and other Diseases of Stock Regulations that may be promulgated from time to time. These powers are vested upon the Director of Veterinary Services (DVS). The Act and regulations are meant to prevent the introduction and spread of animal diseases in Botswana to ensure animal and human health. Ecosurv (2005) highlight the following component of the Act with regards to the movement of game.

The intention to create buffer zones along FMD high risk areas is stated as a strategy under NDP 10, with the construction of the Game Proof Fence around the western and southern boundaries of Makgadikgadi Pans National Park resulting in the area immediately to the south being recently ‗upgraded' to an FMD free zone. It is a status that will soon be extended to the Hainaveld Farms in Ngamiland District following the recent construction of a double veterinary cordon fence from Makalamabedi to the Namibian border – the so-called ‗Northern Protection Zone Fence'.

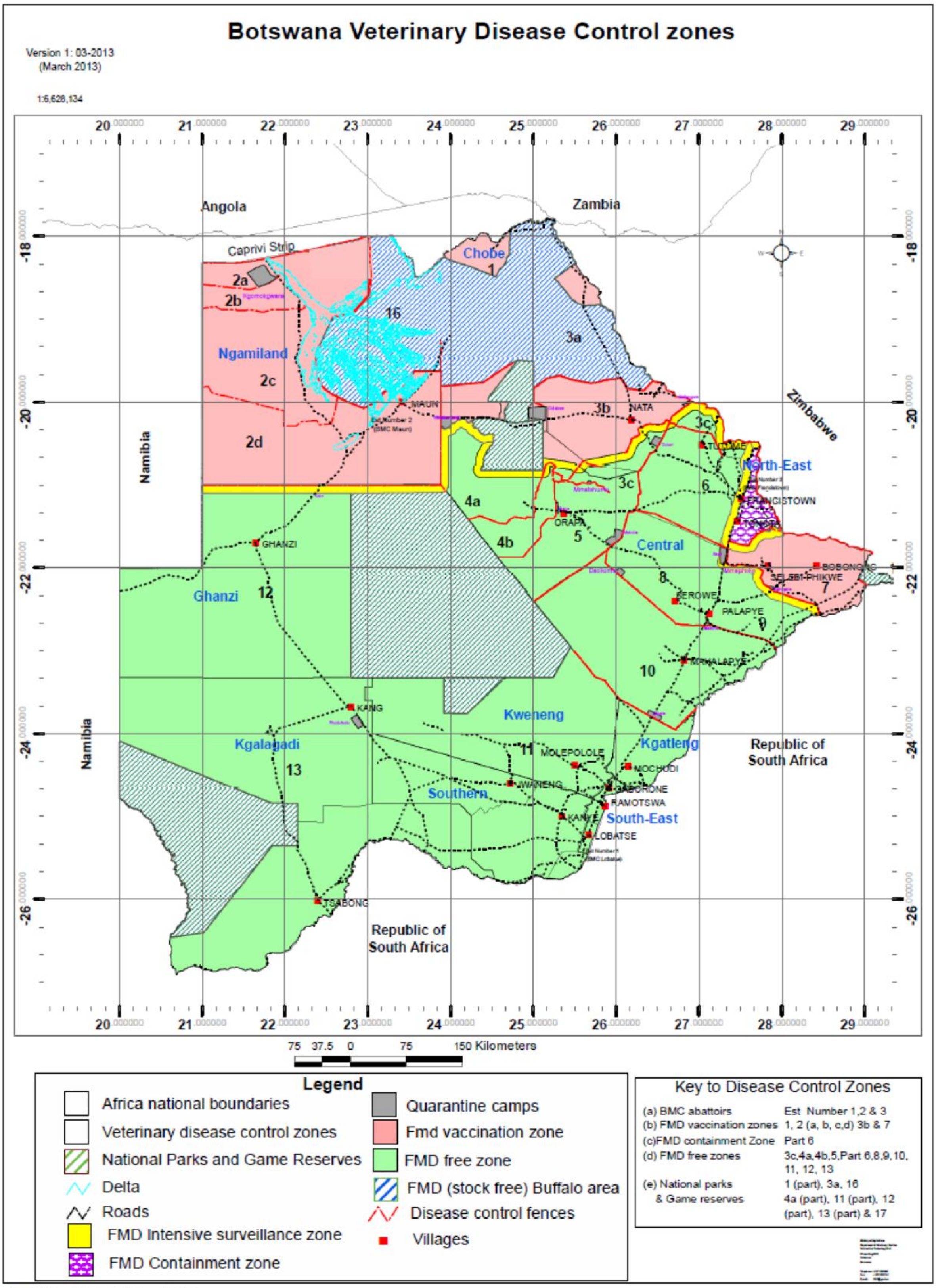


Figure 2 Botswana Veterinary Disease Control Zones

From
http://www.gov.bw/Global/Ministry%20of%20Agriculture/Veterinary%20Disease%20Control%20Zones%20Current_03_2013.pdf

Most of the legislation relating to the control of animal diseases is contained in the Diseases of Animals Act, No 9 of 1977, and its regulations, amendments and subsidiary legislation. The relevant diseases for which additional provisions apply (i.e. transboundary, other interface and zoonotic diseases) are anthrax, theileriosis, FMD, CBPP, rabies, rinderpest, ASF, trypanosomosis, and bovine tuberculosis. The most important of these diseases is FMD, since it has to be controlled to protect the beef export industry. Provision is made for the declaration and management of infected areas in the Diseases of Animals Act as well as the control of movement of animals. The actual system of infected, buffer and free zones used for the management of FMD is not described in law and is dynamic (Thomson and Penrith, 2011).

2.1.4 Veterinary Surgeons Act 35 of 1971

Veterinarians are registered under the Veterinary Surgeons Act 35 of 1971 (Chapter 61.04 of the Laws of Botswana which lists all subsidiary legislation) with the Board of Veterinary Surgeons and the necessary qualifications for registration are determined by the Minister acting on the advice of the Board.

2.1.5 The Cruelty to Animals Act of 1936

The Cruelty to Animals Act of 1936 (Proclamation 27, 1936) prohibits all acts of cruelty to animals specified in the act as well as any unspecified actions that cause unnecessary suffering.

2.1.6 Agricultural Resources Conservation Act 39 of 1972 (as amended)

The Act makes provision for the conservation and improvement of the agricultural resources of Botswana, establishes an Agricultural Resources Board and defines its powers and functions, and provides for conservation committees and subordinate conservation committees and prescribes their functions. The definition of agricultural resources includes: the animal life and fauna of Botswana including animals, birds, reptiles, fish and insects. ―Stock‖ includes cattle, horses, donkeys, mules, sheep, goats, ostriches, pigs, animals of the family Bovidae in captivity, domestic fowls, turkeys, geese, ducks, and any other domesticated or captive animal or bird which the Minister may specify by order published in the Gazette. The Board has no powers over any land constituted as a national park in terms of the Wildlife Conservation and National Parks Act.

Conservation orders may prohibit, regulate, require or control

- The grazing and watering of livestock
- The fencing of land
- The use of chemicals e.g. insecticides

2.1.7 Herbage Preservation (Prevention of Fires) Act (Chapter 38:02), 1978

This Act is to prevent and control bush and other fires.
Within it a:-

"**boundary firebreak**" means a firebreak never less than six metres in width one edge of which, throughout the length of the firebreak, is contiguous to a land boundary; "**firebreak**" means a strip of land cleared of inflammable matter to prevent the spread of fire.

This Act prohibits the burning of vegetation without the written permission of _Herbage Preservation Committees‘. Moreover under clause 6

6. Notice to be given before burning vegetation

(1) Every person, before burning vegetation on land of which he is the owner or on which he is permitted or authorized to burn vegetation, shall give reasonable notice of his intention to do so and, as nearly as possible, of the time at which the burning is to begin to all owners or occupiers of adjoining land and, where reasonably practicable, to a police officer or headman.

14. Offences and penalty

(1) Any person who—

(a) contravenes any provision of this Act or of an order made by a Herbage Preservation Committee under section 7 or section 10; or

(b) fails, without reasonable excuse, to comply with a requirement made under section 11(1), shall be guilty of an offence and liable to a fine not exceeding P1 000 or to imprisonment for a term not exceeding 12 months, or to both and to corporal punishment.

(2) In any prosecution for failure to comply with a requirement made under section 11(1) the court shall presume the absence of a reasonable excuse on the part of the person charged unless the contrary is proved.

2.1.8 Forest Act (Chapter 38:03) 1968

The Forest Act is meant to ensure sustainable utilisation of forest resources. It serves to declare certain areas as forest reserves and provides for regulations for such reserves. Recognition is given to the use by local communities of forest resources for firewood, building materials, medicine and utensils through the Forest (Exemption of certain villages from prohibited acts in forest reserves) Order of 1968. With the Land Board‘s consent, even some species of trees outside of State Land or Forest Reserves can be declared protected – as is the case with mukwa (*Pterocarpus angolensis*) and mukusi (*Baikiaea plurijuga*) in Chobe and Ngamiland, which can no longer be harvested for commercial purposes.

There is no single comprehensive list of threatened or endemic species in Botswana and little protection is given to flora. The Forest Act of 1968, as amended by Act No.8 of 2005, allows for the declaration of certain protected species and lists ten tree species (Table 1) to be protected. However none of these species are listed in the Southern African Biodiversity Network (SABONET) 2002 Database of Southern African Plant Red Data Lists.

Table 1 List of plant species under the Forest Act (1968)

Family	**Botanical Name**	**Status**
Bombaceae	*Adansonia digitata L.*	Protected

Ebenaceae	*Diospyros mespiliformis* Hochst ex A.D.C.	Protected
Euphorbiaceae	*Spirostachys africana*	Protected
Family	**Botanical Name**	**Status**
Fabaceae	*Afzelia quanzensis* Welw.	Protected
	Baikiae plurijuga Harms.	Protected
	Brachystegia spp.	Protected
	Guibourtia coleosperma (Benth) J. Leon	Protected
	Pterocarpus angolensis D.C.	Protected
Meliaceae	*Entandrophragma caudatum* Sprague	Protected
Rhamnaceae	*Berchemia discolor* (Klotzsch) Mensley	Protected

2.1.9 Chapter 38:03 – Forest Subsidary Legislation

The Forest (Exemption of Certain Villages from Prohibited Acts in Forest Reserves) Order applies to the villages or habitations of Kasane, Kazungula and Lesoma.

3. Exemption from restrictions

The bona fide inhabitants of the towns, villages or habitations referred to in paragraph 1 may, within the Kasane Forest Reserve adjacent to such towns, villages, or habitations, collect for their own domestic use, but not for sale or barter-

(a) firewood from dead trees provided that collection is made by donkey or head-load and not by motor vehicle;
(b) poles of the species of trees specified in Part I of the Schedule hereto for the purposes of erecting huts and cattle kraals;
(c) fruits of the species of trees specified in Part II of the Schedule;
(d) leaves of the species trees referred to in Part III of the Schedule; and (e) the underground stem of the species referred to in Part IV of the Schedule.

Table 2 Exemption of Certain Species from Prohibited Acts in Forest Reserves

(Part I – IV taken directly from the Act)

Part I

Botanical name	**Vernacular Name**
Terminalia sericeae Burch ex D.C.	Mogonono, Moguba
Croton gratissimus Burch	Mologa, Monoka
Colophospermum mopane (Kirk ex Benth)	Mophane, Ihane

Part II

Botanical name	**Vernacular Name**
Adansonia digitata L.	Baobab, Mowana, Ibozu, Mubuyu
Dialium engleranium Henriques	Mohamani, Usimba
Guibourtia coleosperma (Benth) J. Leon	Motsaudi, Tsaudi, Isibi
Botanical name	**Vernacular Name**
*Riconodendron rautanenii Schinz**	Mugongo
Berchemia discolor (Klotzsch) Hemsley	Motsintsila, Mozinsilz, Izizi
Amblygonocarpus andogenisis (Welw. Ex)	Mbaimbai
Bauhinia macrantha Oliv.	Mupondopondo, Moshanja, Kuji
Bauhinia urbaniana Schinz	Mobola
Parinari curatellifolia Blanch ex Benth	Mmola, Mola hatshe, Mobola hatshe
Parinari capensis Harv.	Mochinga, Mochingschinga
Popowia odorata Engl. and Diels	Mokamanawe, Matakwabolim, Moosomoso
Annona senegalensis Pers.	Moboroo
Annona stenophylla Engl. and Diels	Morotologana, Morotologa, Moroto,
Ximenia spp.	Morotonoga
Xylopia odoratissima Welw. ex Oliv.	Ure, Situnduwanga
Grewia spp.	Birobiro, Mogwana, Notuu, Chiriza
Sclerocarya caffra Sond.	Morula
Strychnos spinosa Lam.	Mogorogoro
Strychnos innocua Del.	Muteni
Strychnos cucculoides Baker	Mokorukoru
Vangueria spp.	Mmilo, Mopiti
Abrus precatorius L.	Mopiti, Musasasati, Gum caragi

*Now *Schinziophyton rautanenii*

Part III

Botanical name	**Vernacular Name**
Grewia spp.	Mogwana, Muhwana

Part IV

Botanical name	**Vernacular Name**
Bothriochloa glabra	Morama, Xcam, Xije

2.1.10 Noxious Weed Act (Chapter 35:04, 1916) (Extended 1968)

An Act to provide for the eradication and destruction of noxious weeds. Every owner or occupier of land within any area to which this Act applies shall eradicate and destroy any burweed (*Xanthium spinosum*) growing or being upon the land owned or occupied by him. Extension of the Act to additional 24 noxious weeds occurred in Subsidiary legislation in 1968. The species scheduled are as shown in Table 3 below.

Table 3 Scheduled Weed Species in Botswana

Specific name	**Common name**	**Setswana Name**
Xanthium spinosum	Prickly burweed	
Xanthium pungens	Cockleburr	khondorosi
Acanthospermum hispidum	Upright Starburr	Setlhabakolobe,
Specific name	**Common name**	**Setswana Name**
		sephalane, khonkhorose
Cirsium lanceolatum	Spear or Bull Thistle	
Cannabis sativa	Dagga	
Tagetas minuta	Mexican Marigold	
All Cuscutta species	Dodder	
Hakea sericea (Schrad)	Silky Hakea or Needle Bush	
Hakea gibbosa (Cav.)	Hairy Needle Bush	
Hakea suaveolens	Sweet Hakea	
Opuntia imbricata (Haw)	Imbricate cactus	
Solanum auriculatum Ait	Bugtree	
Opuntia aurantiaca	Jointed Cactus	
Datura ferox (Linn.)	Large Stramonium	mokhure
Datura stramonium (Linn.)	Stramonium	
Datura tatula (Linn.)	Purple Thornapple	
Argenome mexicana (Linn.)	Mexican Poppy	lopero
Acanthospermum australe (Kuntse)	Prostrate Starbur	
Salvina spp. and other plants of the family *Salvinaceae*	Water Fern	
Anachris spp. or *Elodea spp.* and other plants of the family *Hydrocharitaceae)*	Water Pest	
Eichhornia spp. and other plants of the family *Pontedariaceae*	Water Hyacinth	
Tribulus terrestris L.	Devil's thorn	Mosetlho, setlho
Amaranthus thunbergii Moq.	Poorman' s spinach	thepe
Alectra vogelli Benth	Yellow witchweed	Matebele, molelwana
Striga asiatica (L).	Red witchweed	Matebele, molelwana

From Government of Botswana, Noxious Weed Act (1968)

2.1.11 Mines and Minerals Act (Chapter 66:01) 1999

In Botswana subsurface rights are separated from surface rights, creating the potential conflict of a _split estate‘, whereby the surface occupier, typically practising pastoral and/or arable farming is as far as possible allowed to continue farming and is compensated for losses of agricultural (or other) resources by the subsurface operator (Mining Company). As a result the subsurface is the dominant estate and the concerns and wishes of the surface operators tend to be of secondary in importance to the _reasonable' production needs of the subsurface lessee. Large areas of the study area within this Project are currently held as Prospecting Licences by various Mining Companies.

2.1.12 Tourism Act (1992)

This Act was established to make provision for regulating the tourism industry, and to promote its development and wellbeing. It identifies different categories of operators, and makes provision for the licensing of such operators.

2.1.13 Tribal Land (Amendment) Act (CAP 32:02 – 1993)

All three focal areas are located on Tribal Land. This Act establishes tribal land boards, in this case Tawana Land Board, to serve as custodians of tribal land, and any use rights and the determination of land use zones and any zoning of activities, will need to be issued by them. The Act also allows for the determination of land use zones, and the zoning of any activities, such that the forthcoming land use plans, must take cognisance of the broader goals and aims of Tawana Land Board.

2.1.14 Wildlife Conservation and National Parks Act (Chapter 38:01), 1992

An Act to make further and better provision for the conservation and management of the wildlife of Botswana, giving effect to CITES and any other international convention for the protection of fauna and flora to which Botswana is, from time to time, a party, to provide for the establishment, control and management of national parks and game reserves, and for matters incidental thereto or connected therewith.
[Date of Commencement: 11th December, 1992].

The Wildlife Conservation and National Parks Act (28 of 1992) prohibits the presence of domestic animals in national parks and legalises their destruction if found there. It also provides for control of domestic animals in game reserves and sanctuaries and the destruction of wildlife if necessary for purposes of disease control, human safety or protection of livestock and crops outside national parks, game reserves and sanctuaries.

PART IV
Protected Game Animals (s 17)
17. Protected game animals
(1) The animals specified in the Sixth Schedule shall be protected game animals throughout Botswana.
(2) No person shall, except only under and in accordance with the terms and conditions of a permit issued by the Director under section 39 or section 40, hunt or capture any protected game animal, and any person who contravenes the provisions of

this subsection shall be guilty of an offence and liable to a fine of P10 000 and to imprisonment for 7 years:
Provided that, where the animal in respect of which the offence is committed is a rhinoceros, the offender shall be liable to a fine of P100 000, and to imprisonment for 15 years.

18. Partially protected game animals

The animals specified in Part I of the Seventh Schedule shall be partially protected game animals throughout Botswana, and no person shall, except under and in accordance with the terms and conditions of a licence or permit issued under this Act, hunt or capture any partially protected game animal.

SIXTH SCHEDULE PROTECTED GAME ANIMALS

(*Section 17*)

Protected Game Animals

Night-ape, Pangolin, Aardwolf, Brown hyena, Cheetah, Serval, Blackfooted cat, Wild dog, Otter, Honey badger, Civet, Antbear, Rock dassie, Yellow-spotted dassie, Rhinoceros, Hippopotamus, Giraffe, Klipspringer, Oribi, Sharpe's steenbok, Mountain reedbuck, Waterbuck, Puku, Roan antelope, Vaal rhebok, All pelicans, All herons, All egrets, All bitterns, Hammerkop, All storks, All ibises, Spoonbill, All flamingos, Secretary bird, All vultures, All falcons, All kites, All eagles, All buzzards, All sparrowhawks, All goshawks, All harriers, All cranes, Kori bustard, Stanley bustard, All jacanas, Fishing owl, Narina trogon. Python.

SEVENTH SCHEDULE; GAME ANIMALS AND BIRDS, (*Section 18*)

PART I: *Partially Protected Game Animals*

Leopard, Lion, Elephant, Chobe bushbuck, Sable antelope, Eland.

□□□Ownership

Game animals are classified into a) protected; b) partially protected and c) those that may be hunted under licence. They are the property of the State and managed by DWNP unless on freehold, leasehold land or designated game farms or ranches when they are the property of the landowner. All buffalo are the property of the State.

1. PART 11 Section 6(g) - the Minister shall have power to sell or exchange any specimens of animal in a National Park
2. PART VI Section 24(1) - the owner of freehold or leasehold or any authorized person may apply to ranch or farm game

□□□Capture

1. PART V Section 19(1) – only under terms and conditions of licence issued under this section
2. PART IV Section 17(2) – Animals specified in the Sixth Schedule are protected game animals and may only be captured under terms and conditions of a permit issued by the Director under Section 39 or 40 – *includes roan*
3. PART V Section 18 – Animals specified in Part I of Seventh Schedule are partially protected animals and require a permit issued for capture – *includes sable 4.* PART V Section 19 (2) – Animals specified in Parts II and III of the Seventh Schedule are animals that may be hunted under licence – *includes buffalo and tsessebe*

- Conditions under which animals should be kept

1. Under PART VI Section 24(5) such game farms or ranches may be required to be fenced

2. Section 25 – Regulations made by the Minister may, in respect of game farms and ranches, include conditions under which animals should be kept (? registration of those holding buffalo and requirement for annual return of numbers)
The new Game Ranching Policy may classify these quarantine facilities as _ranches‘ and therefore the policy can direct their management
3. PART XIV Section 82(1) – no person shall keep a wild animal in confinement except under conditions of a licence issued by the Director ▪ Export of animals

1. PART X Section 62(1) – no person shall export an animal except under the terms and conditions granted to him by the Director.

Currently farmers have the right to destroy problem animals on their farms as per the Wildlife Conservation and National Parks Act of 1992 (WCNPA) section 46 and 47.

46. Killing of animals causing damage

(1) Notwithstanding anything to the contrary in this Act, the owner or occupier of land, or any agent of such owner or occupier may, subject to the provisions of this Act, kill any animal which caused, is causing or threatens to cause damage to any livestock, crops, water installation or fence on such land:

Provided that nothing in this section shall authorize the killing of an animal which is in a national park or a game reserve, or the use of any poisoned weapon, pitfall or snare for the killing of any animal.

(2) Any person who has killed an animal in terms of subsection (1) shall, as soon as possible, and in any case not later than 7 days after the event, report the circumstances of such killing, and deliver the trophies of such animal, to the nearest wildlife officer or police station.

(3) The trophies and meat of any animal killed in accordance with the provisions of subsection (1) shall be Government trophies, but where the report required under subsection (2) has been made, and it is established that the killing was in accordance with those provisions, the Director or the licensing officer may issue a permit for the sale of the meat by the person concerned:

Provided that no such permit shall be issued for the sale or other disposal of the meat of any elephant, rhinoceros or cheetah, or the meat of any animal that was killed because it was merely threatening to cause damage.

(4) Compensation may be paid, as may be provided in regulations made under the Act, to any person who satisfactorily establishes that he has suffered damage from the action of an animal.

(5) The Minister may, by notice in the Gazette, determine rates of compensation to be paid in respect of claims made under the provisions of this section, where he considers such claims and such rates to be justified.

(6) Any person who-

(a) kills any animal in defence of property otherwise than in accordance with the provisions of subsection (1);

(b) fails to report the killing of any animal in accordance with the provisions of subsection (2); or

(c) uses, retains or disposes of any trophy or meat of the animal so killed otherwise than under or in accordance with this section, shall be guilty of an offence and without derogation from his liability under any other provision of this Act shall be liable to a fine of P1000 and to imprisonment for 1 year.

47. Killing of animals in self defence

(1) Notwithstanding anything in this Act, it shall not be unlawful for any person to kill or wound any animal in defence of himself or any other person if immediately and absolutely necessary.

(2) The burden of proving that an animal has been killed or wounded in accordance with the provisions of this section shall lie upon the person who did the killing or wounding.

(3) Where any game animal is killed in circumstances such as are referred to in subsection (1) by any person who is not the holder of a licence or permit entitling or authorizing him to kill such animal, such animal shall be a Government trophy and such person shall as soon as possible, and in any event not later than 7 days after the killing, report such killing to the nearest convenient wildlife officer or police station, and shall, if so directed, deliver the animal or such parts thereof as may be specified, to such wildlife officer or police station, as the case may be, and any person who fails to comply with the provisions of this subsection shall be guilty of an offence and liable to a fine of P500 and to imprisonment for 6 months.

2.2 Policies and Strategies

2.2.1 Tribal Grazing Lands Policy (1975)

Commercial livestock rearing is practiced on ranches on the Hainaveld that were demarcated under the Tribal Grazing Land Policy (TGLP) to encourage commercialization of the livestock sector and also reduce overgrazing on communal rangeland.

The objectives of the TGLP were set out as:-

i) To make grazing control, better range management and increased productivity possible;

ii) To safeguard the interests of those who own only a few cattle or, none at all (75 WP para.20) and the right of every Tribesman to have as much land as he needs to sustain himself and his family (para. 14).

There were a number of assumptions that TGLP was based including the belief that widespread range degradation and desertification was occurring and that ‗The Tragedy of the Commons' (Hardin, 1968), or lack of private ownership was the key. Commercial ranches were also believed to be twice as productive as traditional cattleposts.

For commercial areas the White Paper made the following specific proposals:-

i) To give through renewable 50-year leases (75 WP para. 45a), exclusive rights to individuals and to groups to run commercial ranches and to apply modern management techniques – at least water reticulation and fencing (para.22). In the allocation of commercial ranches priority was to be given to groups of small owners, to those without ranches already and to those from overstocked areas (paras, 22-24 and 42f).

ii) To control the amount of tribal land occupied by any one owner (75 WP para. 41d); this control was to be exercised by individual Land Boards (para, 42g).

iii) That all cattle owners in the commercial areas would over a period of time, have to take out leases (75 WP para 42a);

iv) To ensure that all owners of livestock at present using boreholes in commercial areas will have satisfactory alternative arrangements made for them before they are excluded from them by the grant of a lease (75 WP, para 42i);

v) To use rent collected from lessees in the commercial areas as a way of redistributing income by using it to develop communal areas (75 WP, para. 28).

For the communal areas the 1975 White Paper made the following specific proposals:-

i) Each Land Board would decide on and enforce a limit (quota) on the maximum number of livestock which any individual or family could keep on specific bits of communal land (75 WP, para. 40);

ii) The construction and use of new and existing private water supplies would be restricted; new boreholes owned by individuals would normally be allowed only for cultivation and residential purposes or for watering a few livestock on arable lands; no individual would be allowed to water more than his quota of his own stock at his private waterpoint; where the grazing and watering facilities at any individually owned existing waterpoint are sufficient for more than one man‘s quota the balance would be made available to the livestock of others, with individual control and ownership of such water-points, and livestock in excess of quotas, being phased out over time (75 WP paras. 20 and 40e).

iii) Groups of small farmers, i.e. those with less than the permitted quota, would be encouraged to form and develop water supplies on ranches in the communal areas (75 WP paras. 30, 40c), provided there is full agreement to this in the community, and Government would promote the formation of such group ranches (para, 32),

iv) Where the communal areas are overcrowded they would be made bigger (75 WP, 37c).

For the reserved areas the White Paper had few specific proposals. Suitably large areas of grazing would be reserved for future use by those with only a few or no cattle at present, as well as land for wildlife, mining and cultivation (75 WP. Para 27, and White Paper No,2 of 1973, para. 56a).

(Above information adapted from Sandford, 1980; p.1-3).

2.2.2 National Policy on Agricultural Development (NPAD)

The National Policy on Agricultural Development (NPAD, 1991; Government Paper No 1 0f 1991) extended the effective privatisation of rangeland through the demarcation of fenced ranches to the communal areas. Its aim was to reduce grazing pressures and increase productivity through privatizing the commons, as the basic assumption was that communal rangelands were effectively operating as an openaccess resource and that this was leading to range degradation.

The NPAD identified the following as major causes of poor performance of the livestock subsector:

1) Poor soils and erratic rainfall,
2) Poor management – this is the most significant factor contributing to poor performance,
3) Lack of appropriate technology,
4) The pricing systems for grains,
5) Unproductive labour force – mostly unskilled,
6) Lack of diversification,
7) Non-targeted use of government subsidies,
8) Water availability,
9) High cost of energy,
10) Poorly developed physical infrastructure especially roads.

The NPAD (1991) also made the following points:-

128. The present uncontrolled management of communal grazing lands is not only unproductive but has led to unprecedented range degradation. Range degradation continues despite the reduced number of livestock in these areas. Productivity indicators such as birth, deaths, sales and cold dress mass show that performance in communal areas is far below the performance of fenced farm areas. Range degradation and soil erosion is getting worse in these areas. These are no way of either reversing the progressive range degradation together with the soil erosion or improving productivity under the present management system.

The report therefore recommended that individuals and communities be allowed to fence grazing land to improve livestock management and productivity.

The following guidelines will be followed in the zoning and allocation of livestock grazing land.

1. The Ministry of Local Government and Lands will produce a national land use map clearly defining livestock grazing areas.
2. The Ministry of Agriculture will in consultation with relevant Ministries provide information on various land resource parameters such as soils, vegetation, climate, hydrological and livestock. Information on livestock will include type, stocking rates, distribution including seasonal movement and management systems. Information on land use including conflicts, land availability and socio-economic factors will also be provided. A detailed land use plan will be developed for each area.
3. The Ministry of Agriculture will submit the proposed land use plans to the Ministry of Local Government and Lands and Land Boards for approval.
4. After approval demarcation of ranches or community grazing areas will be done by the Ministry of Agriculture.
5. Allocation of demarcated areas will finally be done by Land Board. In areas where farms are demarcated for individual or group fencing those individuals or groups with existing rights will automatically be allocated the ranches in which their boreholes areas. Only those ranches without boreholes or existing rights will be advertised.
6. Community fenced areas will be targeted for special government assistance.

Fencing in these areas should be considered both as an economic assistance programme for poorer farmers and land conservation and rehabilitation programme to protect the scarce range resources. This will mainly be and extension and improvement of the present drift fences. In community fenced areas:

a) Community boundaries will be established by the Lands Boards.

b) A detailed land use plan, for each area, by the Ministry of Agriculture in consultation with local authorities and communities will be developed.

(Information taken directly from National Policy on Agricultural Development, 1991).

2.2.3 The Draft Botswana Land Policy

This Policy makes a number of important recommendations concerning rangeland management. They are as follows:-

2.1.9 Future growth of wildlife and tourism will require that linkages between wildlife systems are maintained, including connectivity and links between protected areas and wildlife management areas. Growth should focus on areas with comparative wildlife utilization advantage through conferring of legal status to currently un-gazetted WMAs, encouraging multiple resource uses compatible with wildlife utilization and protection of user access rights.

Commercial Land

2.1.10

v) Effective range management practices will be implemented to discourage the practice of dual grazing rights.

Game Farming

2.1.11 Game farming provides opportunities for growth in the tourism sector and is becoming a popular undertaking in the country. There is however an emerging conflict between game farming and livestock production because most game farms are developed from converting livestock farms into game farms. It is therefore necessary to address this conflict to ensure that either of these undertakings does not flourish at the expense of the other. The following will be undertaken:

i) Comprehensive assessment on applications to determine suitability of converting livestock areas into game farms.

Remote Area Dwellers

2.2.5 Some Batswana communities have from time immemorial believed in communal use or collective use and ownership of land. Overtime this has proven to be unsustainable due to economic changes. The absence of exclusive rights to land for these communities does not improve their economic well being and does not accord them secure land rights. The following will be undertaken:

i) Where appropriate, continue to establish formal settlements for these groups;
ii) Sensitize them of their rights; iii) Confer title to those allocated pieces of land; and iv) Put in place appropriate structures for management of their resources.

PART III: LAND MANAGEMENT AND ADMINISTRATION

3.1 Rapid population growth and the increase in the number of livestock and wildlife have resulted in land use conflicts. These conflicts manifest themselves in spiralling encroachment of land uses such as settlements into arable land, arable into grazing, and grazing into wildlife areas. The ultimate effect of this is land use conflicts leading to unsustainable resource management and environmental degradation. The policy needs to facilitate access, development and utilization of land to achieve the policy goal. Various sectors have to secure portions of land and the development and utilization of such land has to be environment friendly and protective of the land resources.

The above sections extracted from the Draft Land Use Policy emphasise the need for a holistic and multi sectoral approach to the proposed SLM study. CBNRM appears to be critical if the current high levels of land use conflict are to be reversed.

2.2.4 Game Ranching Policy for Botswana (2002)

The policy is aimed at developing a game ranching industry that will provide a commercially viable and sustainable alternative for livestock enterprises either on its own or in mixed livestock/game ranches. Game ranching is the managed, extensive production of free living wildlife on land fenced in accordance with the fence specification in respect of a given species. Game/livestock ranching means extensive production of livestock or small stock in combination with wildlife species in fenced, large, private or communal areas. It only deals with game ranching – game farming to be dealt with in a separate policy document. [Game farming = more intensive production like ostriches, crocodiles, snakes, rabbits, guinea fowl etc.].

Major constraints for game ranching are lack of freehold land, capital and know-how. The National Policy on Agricultural Development (1991) provides for a shift from communal to leasehold land tenure in tribal areas.

The game ranching industry is seen as an opportunity for economic diversification in rural areas.

Objectives:

- Increase economic returns from wildlife outside National Parks, Game Reserves and Wildlife Management Areas
- Promote development of a commercially viable and environmentally friendly industry
- Maximise private sector role in the development and value addition of the industry facilitated by government
- Facilitate development of markets for wildlife and products

- Provide up to date knowledge through research and extension
- Use game ranches for conservation of rare/endangered species
- Ensure well-being of game populations in the wild
- Facilitate and give preference to Batswana in Management and ownership and encourage foreign partnerships
- Increase impact of game ranching on national and rural economy, employment and diversification

Development of game ranches within the buffalo fence not supported – would interfere with wildlife migration.

Non-indigenous species not encouraged and would be subject to special conditions e.g. extra fencing.

Specific points that should be highlighted include:-

6.2 This policy promotes the formation of conservancies to increase the economic value of game ranches.

6.3 All Game Ranches will be approved by and registered with the Department of Wildlife and National Parks. Only ranching of species and/or subspecies that are indigenous to Botswana will be encouraged. Nationally protected and partially protected species will be allowed for game ranching purposes for the benefit of conservation and possible reintroduction into the wild.

6.5 Species that are not indigenous to Botswana, or to a particular region in Botswana, may be subjected to special fencing requirements as determined by the Director of Wildlife and National Parks in order to prevent their escape and possible competition with indigenous resources or contamination of the indigenous gene pool.

6.6 All ranches that keep species or subspecies listed in one of the CITES appendices will be registered with CITES Authorities.

6.7 While ranchers will in general determine their stocking rates and off take levels, CITES listed, protected and partially protected species will be subject to a quota. Stocking rates will be monitored and controlled in the same manner as the livestock industry, i.e. through the leases and existing legislation as the Agricultural Resources Act.

6.8 Capturing and cropping in ranches will be allowed throughout the year and can take place at night.

6.9 All ranchers will be required to keep a register of animal populations existing in their ranches as well as any off take, for the purpose of monitoring by the Department of Wildlife and National Parks.

6.10 Live capture from freehold or leasehold ranches will be allowed with the approval of the landowner or leaseholder.

6.11 Capture of game from the wild for stocking or restocking shall be based on the annual capture quotas set by the Department of Wildlife and National Parks for each Controlled Hunting Area (CHA).

6.12 Live capture of game animals from the wild will be encouraged to take place in community and commercial concessions, thus creating economic activities in the rural areas that generate benefits directly from wildlife resources within those areas. The lessees are free to utilise part of their hunting quota for capture purposes. Concessionaires are allowed to yell live animals at prices negotiated with buyers or through auction or tender, except for the normal licence fees paid to Government.

6.13 All ranchers will be responsible for engaging their own capture operators. Only capture operators that have been registered with Department of Wildlife and National Parks may be used.

6.14 The Department of Wildlife and National Parks may limit or prohibit the live export of game species if it believes that such limitation or prohibition will favour the development of game ranches and/or allied processing industries locally.

6.15 **Valuable species such as roan antelope, sable antelope, leopard, wild dog, lion and cheetah that otherwise have to be destroyed as problem animals shall, wherever feasible, be removed alive and offered for sale to game ranchers.**

6.16 Government may request ranchers to donate game animals for reintroduction into the wild. Ranching of partially protected and CITES listed species will be subject to specific agreements between DWNP and the ranchers and will make provision for possible reintroduction into the wild.

8.2 Responsibilities of the Department of Wildlife and National Parks:

a) The approval and registration of game ranches in accordance with the Wildlife Conservation and National Parks Act of 1992 and the regulations developed thereunder.

b) The monitoring of the operations of game ranches to ensure compliance with the Wildlife Conservation and National Parks Act of 1992 and any regulations developed thereunder.

c) The approval, monitoring and inspection of any wildlife holding and auction facilities.

d) To provide guidelines for the development of management plans for game ranches and, where required, provide specific assistance in the development of such plans. e) The provision of research, extension and training concerning game ranching.

f) The issuance of permits for live capture, export and import of wildlife.

g) The approval and licensing of any game capture outfit that operates, or wishes to operate, in Botswana.

h) The provision of a wildlife quarantine facility in accordance with the guidelines and requirements of the Department of Animal Health and Production at a location that will facilitate the movement of game in Botswana.

8.3 Responsibilities of the Department of Animal Health and Production:
To monitor and advise on animal health aspects in game ranches.
The provision of veterinary services on game ranches.
Collaborate with DWNP in the provision and operation of wildlife quarantine facilities, including the provision of veterinary services.
The issuance of veterinary permits for the movement, import and export of all wildlife species.
e) The approval and registration of wildlife veterinarians employed by the Department of Wildlife and National Parks, game ranchers and game capture companies/organisations.
Concerning investment incentives the Policy states:-

9.1 A major obstacle for the establishment of game ranches is the large capital costs required for the requisite infrastructure, such as game proof fencing, water and buildings.

………………… The private sector is expected to provide the necessary capital for the development of enterprises related to game ranching.

With regard to human resource development, training and extension, the Policy states:-
10.1 The Government, through the Department of Wildlife and National Parks, will develop a specific programme to promote game ranching in Botswana.

10.2 The Government, through the Department of Wildlife and National Parks, will develop the capacity and infrastructure required to provide expert knowledge, undertake research, disseminate its results, and demonstrate and teach techniques and management skills in the field of game ranching. To this end DWNP has established the Matlho-a-Phuduhudu Demonstration Game Ranch that will serve as a focal point for such training, extension and research in game ranching. Other wildlife educational institutions may be utilised as required.

10.3 To assist game ranchers in their operations, a series of extension materials will be produced that deal with specific wildlife management issues and disseminate the latest developments and research findings in game ranching.
10.4 Relevant training will be extended to extension officers that will provide extension services, conduct applied research, monitor operations and assist Batswana interested in setting up game ranching ventures. The present Wildlife Game Capture Unit within the Department of Wildlife and National Parks will be expanded and strengthened so that it can be used to provide capture services where possible or at least supervise the capture operation by the private sector.

10.5 Training modules for game ranching will be developed at the Botswana Wildlife Training Institute and the Demonstration Game Ranch to provide training in game ranching techniques and management. These modules, with some adaptation, will also be used to provide training to (prospective) game ranchers.

2.2.5 CBD and National Biodiversity Strategy and Action Plan

In order to protect global and National Biodiversity Botswana ratified the Convention on Biological Diversity (CBD) in October 1995. As partial fulfilment to the CBD Botswana has produced a National Biodiversity Strategy and Action Plan (NBSAP) which strives to achieve:-

- the long term health of the country‘s ecosystem and related species, and to encourage sustainable and wise use of resources through the provision of a framework of specific activities designed to improve the way biodiversity is perceived, utilised and conserved.
- A nation in balance with nature, with fair access to biological resources, where the benefits deriving from the use of these resources are shared equitably for the benefit and livelihoods of current and future generations, and where all citizens recognise and understand the importance of maintaining Botswana‘s biological heritage and related knowledge and their role in conservation and sustainable use of biodiversity.

The strategic objectives of the BSAP are:-

- Better understanding of biodiversity and ecological processes.
- Long-term conservation and management of Botswana‘s biodiversity and genetic resources.
- Efficient and sustainable utilisation of all components of biodiversity in Botswana through appropriate land and resource use and management. An institutional environment, including human capacity, conducive to effect biodiversity conservation, sustainable use and management.
- Coping with environmental change and threats to biodiversity.
- Fair access to biological resources and equitable sharing of benefits arising from the use of these resources.
- An institutional environment, including human capacity, conducive to effect biodiversity conservation, sustainable use and management.
- Coping with environmental change and threats to biodiversity.
- Appropriate valuation/appreciation of biodiversity and raised public awareness on the role of biodiversity in sustainable development and public participation in biodiversity related activities and decision making.
- Safe industrial and technological development and other services based on national biodiversity resources for future prosperity.
- Improved availability and access to biodiversity data and information, and promotion of information exchange.
- Recognition of Botswana‘s and the Southern Africa Region‘s roles with regards to biodiversity and the implementation of the BSAP.

As a signatory to the Convention on Biological Diversity (CBD), the Botswana Government is committed to actively ensure that its biodiversity resource is maintained for generations to come. The Biodiversity Strategy and Action Plan (BSAP) provide a framework for the achievement of this goal, with the specific strategic objectives that are potentially challenged by the proposed Project detailed in the table below.

Table 4 Strategic objectives related to BSAP

No	Strategic Objective	Mitigation
2.2	Comprehensive protected area network to conserve ecosystems and species	Strengthen protected area network – prevent attrition of conservation areas
3.8	Sustainable use of agricultural biodiversity	Promote best agro biodiversity practices
5	Coping with environmental change and threats to biodiversity	Strengthen protected area network – prevent attrition of conservation areas
5.4	Reduced levels of habitat destruction and degradation	Mitigation measures as identified in EIAs to be enforced
5.5	Sustainable water use and management with the objective to maintain biodiversity levels	Wise use of water
5.6	Effective management of invasive species	Promote best agro biodiversity practices
5.7	Water and air pollution levels reduced to reduce biodiversity loss	Monitoring and management
5.8	Improved understanding of threats to biodiversity	Research and review
9.1	National standards established and disseminated to relevant groups for biodiversity data collection, including for metadata	Focus upon rare and endangered species monitoring and management
10	Recognition of Botswana‘s and the Southern African region‘s roles with regards to biodiversity	Strengthen protected area network – prevent attrition of conservation areas
10.2	Compliance with and efficient implementation of relevant biodiversity related conventions, agreements and treaties	Regular review and monitoring
10.3	Regional and transboundary collaboration enhanced (expertise, markets, resources, legislation, enforcement) and active participation in regional biodiversity networking programmes	Strengthen regional cooperation
10.4	Establishment of Botswana at the forefront of biodiversity management and conservation in the region	Highest standards of biodiversity management adopted
11	Implementation of the Biodiversity Strategy and Action Plan	High level political support and effective implementation

2.2.6 Biodiversity Priority Areas

The original NBSAP (2004) provides an indication of areas where levels of threat to biodiversity and components of biodiversity are perceived as high. The analysis included population and livestock pressure from settlements, livestock and tourism activities, hydrological change through water abstraction, areas prone to high numbers of wild fires and unsustainable elephant populations. The map indicates that the highest pressure on existing biodiversity occurred in the eastern parts of the country and in and around the Okavango delta, with smaller pockets in other parts of the country. This was mainly a result of population pressure and the threats to biodiversity caused by hydrological changes.

Botswana‗s biodiversity ―hotspots‖ of relevance to this Project are located in the north, around the Okavango Delta and Lake Ngami (See Figure 3, below). Key current threats over Ngamiland District include that from elephants and fire, with pressures related to settlement, infrastructure and arable expansion dominating the Okavango Panhandle and fringes of the Okavango Delta.

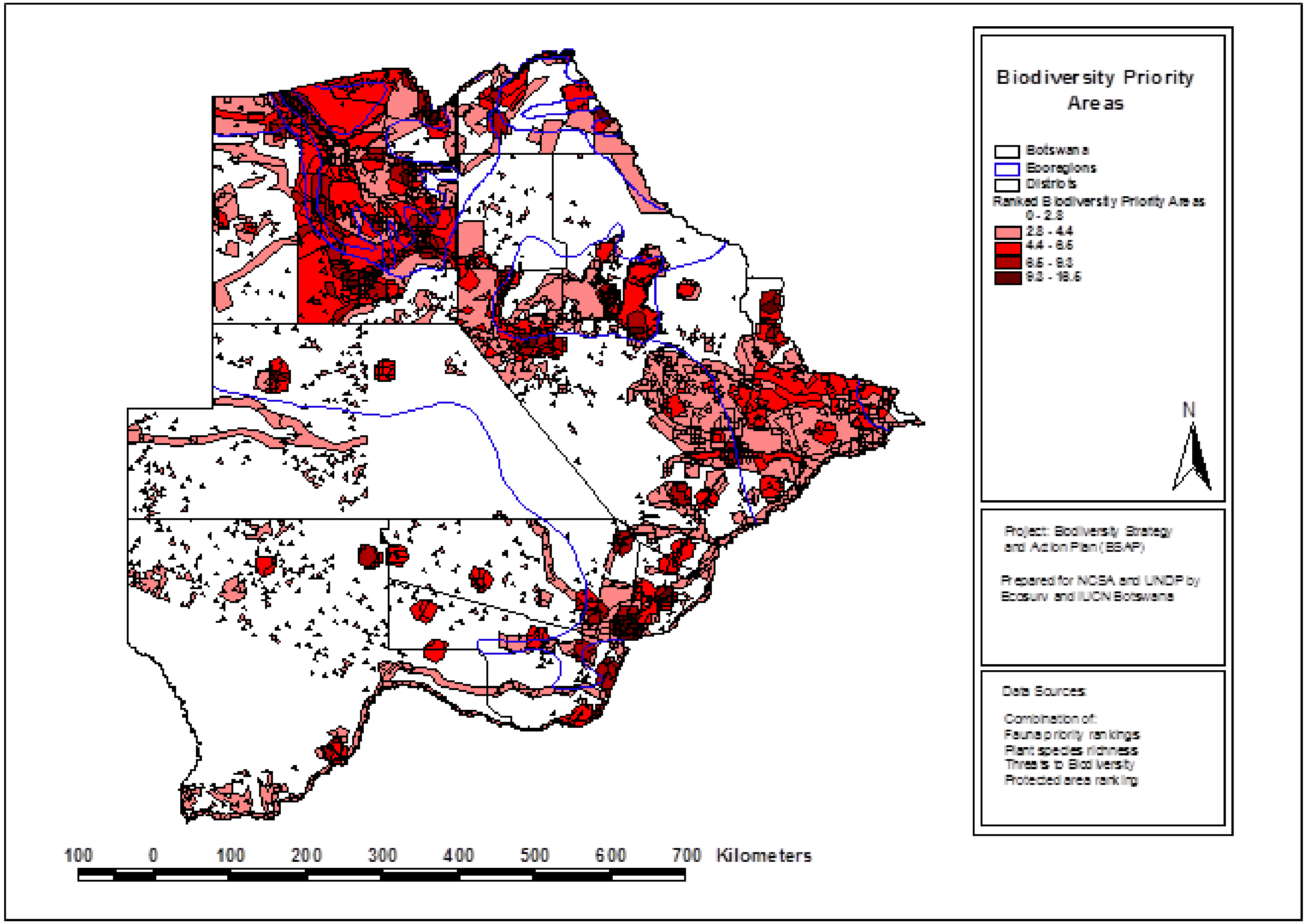


Figure 3 Biodiversity Priority Areas

(From NBSAP, 2007)

2.2.7 Rare or Endangered Species (Flora)

Under the SABONET programme a Red Data List (RDL), i.e. a list of rare and endangered species has been compiled for Southern African countries, and was published in 2002 (Golding, 2002). There are currently 43 species on Botswana's national Red Data List (NBSAP, 2003). Of these, 13 species are classed as threatened, 3 endangered and 10 vulnerable.

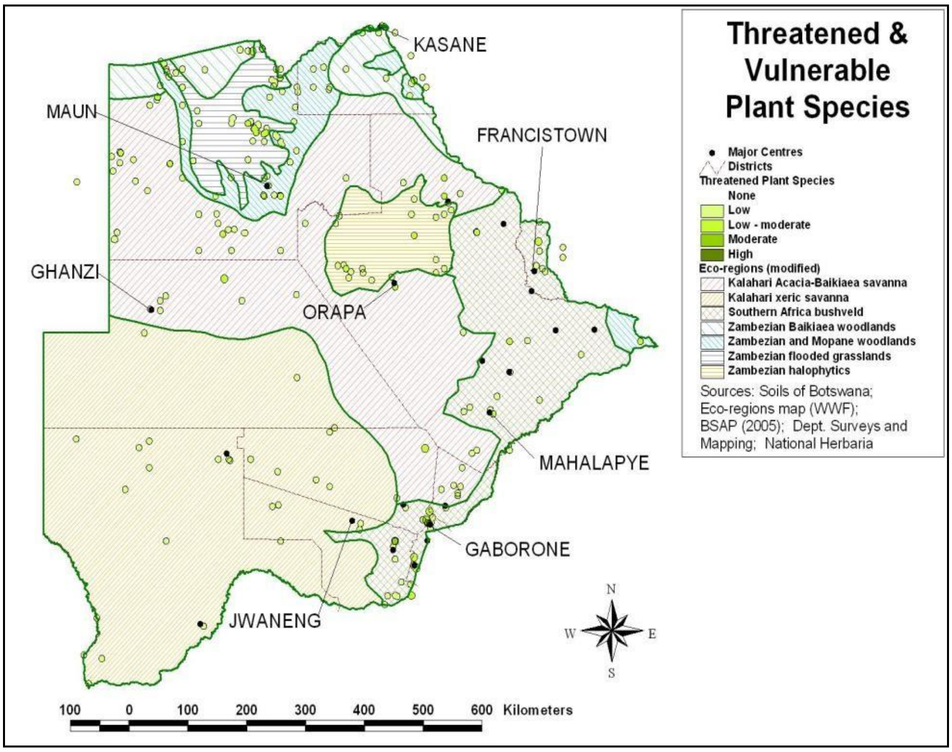


Figure 4 Distribution of threatened and vulnerable plant species in Botswana

(Figures 4 and 5 from NBSAP, 2007 - EcoSurv and Kew, 2006)

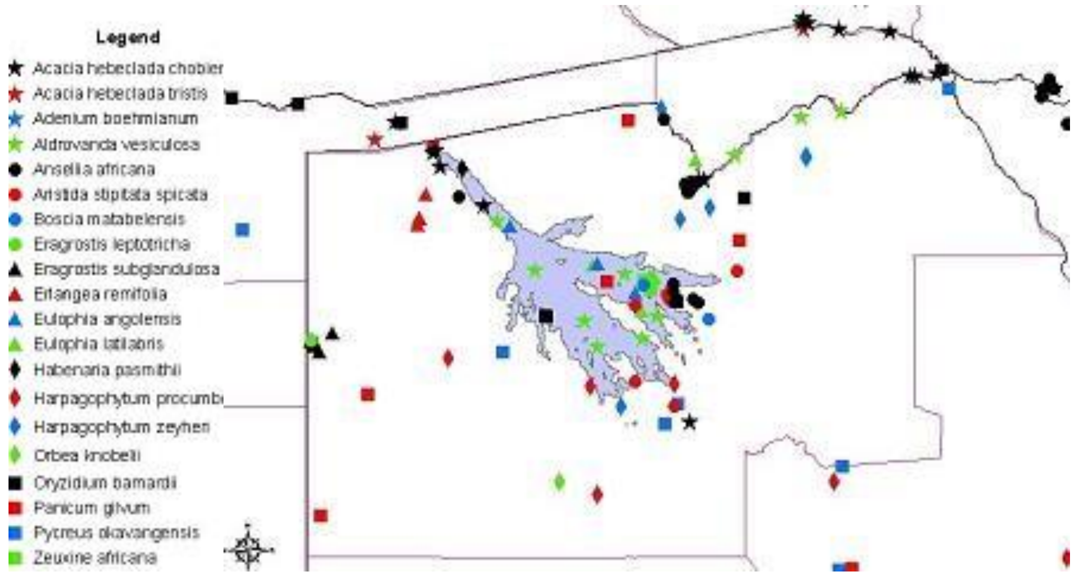


Figure 5 Important Plant Species in the Okavango/Linyanti Catchment

Most data exists for the Okavango Delta Ramsar Site (ODRS) within which twenty plant species were selected by Ecosurv and the Royal Botanical Gardens (KEW) for Red Data List status using recognised IUCN Red Data List criteria during the ODMP (NBSAP, 2007 - Ecosurv and Kew, 2006). Of these 20 species, 7 are listed as Threatened, i.e. at very to extremely high risk of going extinct in the wild (at local level):-

- *Zeuxine africana* is considered CE.
- *Eulophia angolensis* and *Habenaria pasmithii* are thought to be EN
- *Acacia hebeclada* subsp. *chobiensis*, *Aldrovanda vesiculosa*, *Eragrostis subglandulosa* and *Erlangea remifolia* qualify for VU status,
- *Ansellia Africana*, *Eulophia latilabris* and *Harpagophytum zeyheri* subsp. *sublobatum* are thought to be NT.
- *Aristida stipitata* subsp. *spicata*, *Boscia matabelensis*, *Harpagophytum procumbens* subsp. *procumbens*, *Harpagophytum zeyheri* subsp. *sublobatum*, *Orbea knobelii*, *Oryzidium barnardii* and *Panicum gilvum* are thought to be of LC.
- The grass *Eragrostis leptotricha* is still DD, but potentially and EN species.

The IUCN Red List of Threatened Species identifies three trees as threatened, with only *Dalbergia melanoxylon* (African Blackwood) not formally protected in Botswana.

Table 5 IUCN Red List of Threatened Tree Species

Class	Scientific Name	Common Name	Status
TREES	*Baikiaea plurijuga*	Zambezi Redwood	Lower Risk/near threatened
	Dalbergia melanoxylon	African Blackwood	Lower Risk/near threatened
	Pterocarpus angolensis	Kiaat or African Teak	Lower Risk/near threatened

(From IUCN, 2011)

2.2.8 Elephant Management Plan

The 1991 Conservation and Management of Elephants in Botswana Plan proposed the removal of about 3,000 elephant per year as a way of keeping the elephant population at 60,000. Since then no control measures have been taken with the 2006 Elephant Management Plan identifying four primary objectives have been identified for, but not limited to, managing elephants in Botswana. These are to:

- Reduce human-elephant conflicts to acceptable levels, or where feasible, total elimination;

- Prevent, reduce or reverse unacceptable elephant induced environmental changes;

- Maximise the socio-economic benefits from sustainable utilisation of elephants; and

- Protect elephants through legislation and law enforcement.

The 2006 Elephant Management Plan identified a number of management zones as shown below.

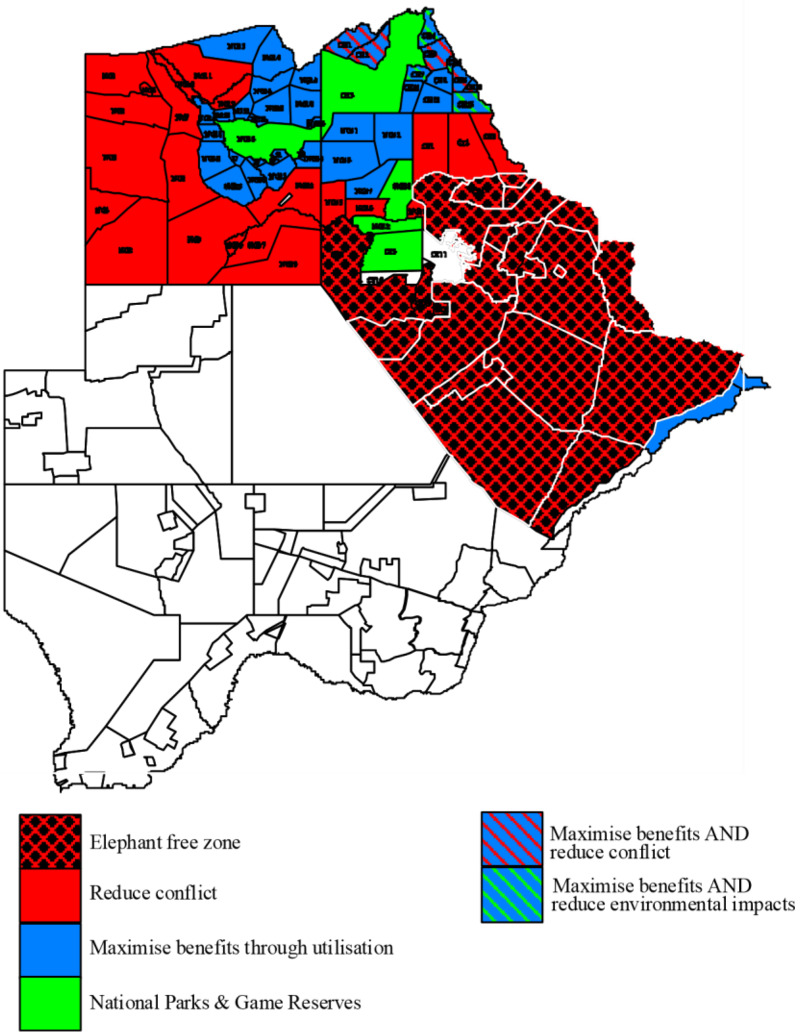


Figure 6 Elephant Management Zones

(From GoB, 2006; p.21)

The DWNP (2012) aerial survey estimated the elephant population to be 207,000. The majority of the elephants are found in an area measuring approximately 80,000 square kilometres in the north, while a small population is found in the central-eastern part of the country. As both human and elephant populations increase and expand there has been a corresponding increase in the level of conflicts between elephants and people. Crop damage by elephants is the major cause of conflict but people also have to contend with damage to other properties such as farm fences and water supplies. Although generally elephant damage is common throughout the elephant range, incidents and damage are mostly reported from the Central District, which has a maximum of 1% of the elephants (around Mmadinare, Nata and Gweta). The renewed flows along the Boteti River and to Lake Ngami have enabled elephants to extend their range along them, such that today they experience unprecedented levels of Human Elephant Conflict (HEC).

The broad definition of human-elephant conflict (HEC) adopted by the IUCN/ SSC African Elephant Specialist Group (AfESG) is ―*Any human elephant interaction which results in negative effects on human social, economic or cultural life, on elephant conservation or on the environment*‖ (Hoare, 2001). With some 80% of the potential elephant range in southern Africa being outside of protected areas (Cumming *et al*, 1997), HEC is likely to remain a serious concern for many years to come.

2.2.9 Botswana Threatened Species Management Policy, Implementation Strategy and Action Plan

The Draft Threatened Species Management Policy (KPMG, 2007) defines the general principles that will guide Threatened Species Management and recommends the creation of several administrative and governance bodies to provide interdepartmental support for Threatened Species Management.

The Threatened Species Management Strategy is based on four pillars:

- Appropriate and effective governance;
- Research, education and awareness programs;
- Effective resource allocation (i.e. financing and human capacity); Threatened Species specific administrative processes.

Several pieces of legislation and strategy address the management of natural resources. Chief amongst these is the Botswana Biodiversity Strategy and Action Plan (BSAP) and National Conservation Strategy (NCS).

2.2.10 Forest Policy

Approved by Parliament in 2011, the Forest Policy is a framework that provides guidance and facilitation in the management of forests and range resources of the country through conservation, development, and sustainable use. The Policy defines basic principles, objectives, strategies and action plans for management of forests and range resources through conservation, development, and sustainable utilisation to meet social, cultural, economic, environmental and ecological needs of present and future generations. It represents statements of intent that the government sets out as part of its overall vision for forestry.

2.2.11 Community-Based Natural Resource Management (CBNRM)

The 2007 CBNRM policy is closely associated with the Rural Development Strategy and Policy as it intends to lay a foundation for conservation-based development which balances the need to preserve biodiversity and ecosystems with the need to improve rural livelihoods and reduce poverty. The policy provides for 15 year communityleases from the relevant Land Authority for exclusive use of a wide range of natural resources (including wildlife, fish, wood and veldt products) subject to approval of a Land Use and Management Plan for the area.

2.2.12 Botswana Wetlands Policy and Strategy

This document notes the ―irreplaceable ecological and socio-economic value of wetlands‖, and has as its goal the conservation of Botswana‘s wetlands ―in order to sustain their ecological and socio-economic functions as well as providing benefits for the present and future well-being of the people‖. It explicitly identifies the importance of an ecosystem approach to use and management, which means that the system must be managed as a whole, not sector by sector, and that management must accommodate the inherent variability of the system, and not address only one state.

2.2.13 Wildlife Conservation Policy, 1968

This policy outlines the way forward for wildlife preservation through economic diversification. From a social perspective the policy emphasises both rural development and citizen participation, which supports the community-based management approach and wildlife conservation, through economic activities.

2.2.14 Revised National Policy for Rural Development (2002)

Relevant because it aims to reduce rural poverty, and promote sustainable livelihoods through (among others), natural resources use and increased agricultural productivity. Currently, households in the WMAs area are struggling due to low financial benefits from tourism and wildlife related activities, considerable inequity in terms of livestock ownership in and around the WMAs and increasing costs due to HWC, especially depredation. Reliance on the livestock sector is heavily subsidised by the Government and facing increasing arduous conditions such as reduced yields and lower quality (saline) groundwater, droughts, heat stress, range degradation and limited access to grazing resources.

2.2.15 Lake Ngami Management Plan (2013)

Lake Ngami Management Plan was funded through the USAID Southern African Regional Environmental Programme (SAREP) and developed by Ecosurv (2013). It covers the whole range of natural resource issues that surround the management of Lake Ngami, paying particular attention to its status as an Important Bird Area (IBA), and the sustainable management of tourism and fishing activities. It provides much essential material and information for the Lake Ngami focal area for the current SLM Project.

2.2.16 Okavango Development Management Plan (ODMP)

The ODMP was prepared as part of Botswana‘s obligations under the Ramsar Convention which the nation ratified in 1997. Key principles of the plan include: the use of the Ecosystem Approach, devolving responsibility to the lowest levels of society, and integrated planning process based on cross-sectoral collaboration, involvement of international stakeholders through fulfilment of multi-lateral agreements, and sensitivity to aspects of gender and HIV/AIDS. The plan was completed in 2008.

2.2.17 Strategic Environmental Assessment (SEA)

The 2012 SEA contains an analysis of the driving forces and resulting pressures on the current, and potential future, state of the ODRS. After the analysis, cumulative impacts of various development scenarios on the biophysical and socio-economic environments of the ODRS were assessed. These impacts are measured against sustainability thresholds to determine the degree of impact, and how close the system is to irreversible _tipping points‘. The management actions required to mitigate the cumulative impacts identified are set out in the Strategic Environmental Management Plan (SEMP).

Key findings of particular relevance to SLM were that there is need to integrate resilience thinking into the future management of the Okavango Delta and that an integrated approach to land use planning would assist in addressing land use conflicts.

2.2.18 ODMP Implementation Strategy

The Implementation Strategy (Plantec, 2012) outlines an institutional responsibility framework for implementing the revised ODMP. Specific implementation responsibilities, with regards to various recommendations of the mid-term review, lie with various stakeholder institutions and government departments. Key issues such as poaching, alien and invasive species, CBNRM and sustainable land use practices all feature prominently within the Implementation strategy for the revised ODMP.

2.2.19 SADC Protocol on Forestry, 2002

The SADC Protocol on Forestry of 2002 aims to promote the development, conservation, sustainable management and utilisation of all types of forest and trees; trade in forest products and achieve effective protection of the environment, and safeguard the interests of both the present and future generations.

The Protocol emphasises that Policies and mechanisms adopted in Member States should enable local people and women to effectively participate in forest management activities as well as respect the traditional knowledge related to forests. With the aim of poverty eradication in mind Member States should also strive to have substantial forest based industries within their territories.

Article 12 (Community-Based Forest Management) emphasises that the Parties shall:-

- Adopt national policies and mechanisms to enable local people and communities to benefit collectively from the use of forest resources and to ensure their effective participation in forest management activities, including affirmative steps to seek and encourage such participation;

- Develop regional guidelines and share information and expertise related to community-based forest management; and
- Encourage local people and communities to grow and conserve trees and to integrate them into existing farming systems.

The 2002 SADC Protocol on Forestry recognises the importance of forests in sustaining the livelihoods of a majority of the region‘s rural communities. Currently, the deforestation rate in the SADC region is the highest across Africa and annual fire storms are additional threats to these unique eco-systems (German Federal Ministry of Economic Cooperation and Development, 2012). Hence the SADC Sustainable Forestry Management programme that was implemented jointly with GIZ between 1996 and 2012, agreed on:-

- Implementation of the SADC Regional Programme for Transfrontier Conservation Areas;
- Support to the regional SADC programmes for cross-border fire-management and Reducing Emission from Deforestation and Degradation (REDD); and
- Integration of climate change and biodiversity conservation into regional and national programmes.

2.2.20 SADC Protocol on Wildlife Conservation and Law Enforcement

The primary objective of the protocol is to establish common approaches to the conservation and sustainable use of wildlife resources and to assist with the effective enforcement of laws governing those resources. Promotion of transfrontier conservation areas and CBNRM are part of the Protocol.

2.2.21 Convention on Biodiversity (CBD)

The objectives of the convention are to conserve biological diversity, to sustainably use its components and to fairly and equitably share the benefits arising out of the utilisation of genetic resources. Botswana has prepared a National Biodiversity Strategy and Action Plan, which articulates the measures that need to be taken to comply with the Convention.

2.2.22 CITES

The free movement of wild animal species internationally, and within the national borders of a country, is furthermore restricted by international conventions and agreements such as CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), and by restrictions imposed on the introduction or the movement of undesirable (e.g. exotic and/or carrier) species, into and from specific areas, by the Department of Wildlife and National Parks.

2.2.23 KAZA

The governments of Angola, Botswana, Namibia, Zambia and Zimbabwe are pursuing the establishment of a Transfrontier Conservation Area (TFCA) known as the Kavango-

Zambezi TFCA, abbreviated as the KAZA TFCA. The vision they share is *"to establish a world-class transfrontier conservation area and tourism destination in the Okavango and Zambezi river basin regions within the context of sustainable development"* (PPF, 2006; p.v).

The target beneficiaries of the KAZA TFCA are local communities, and public and private stakeholders in the wildlife and tourism sectors. From this joint venture the five partner countries want to achieve sustainable improvements in the livelihoods of local communities, better protection of the region's biological diversity, establishment of a premier African tourism destination, and the building of sufficient capacity for the on-going management of the region's wildlife and tourism resources.

The Pre-feasibility study recommended that the partner countries should approach the spatial development of the KAZA TFCA on an incremental basis. Their initial focus should be on securing functional ecological corridors between existing and potential protected areas that are situated in close proximity to the international borders. This network of protected areas and the ecological corridors linking them should form the initial core, or anchor, of the KAZA TFCA. As per the MoU which makes provision for incremental development of the TFCA, the partner countries should subsequently give attention to expanding the core area into the target areas they have identified. This expansion should be pursued as a series of sub-regional initiatives between the relevant partner countries.

The benefits include a significant enhancement of socio-economic development associated with nature-based or wildlife-based tourism, including safari hunting, promoting a culture of peace and regional cooperation (including encouraging community interactions across borders), and using the joining together of fragmented habitat patches to enhance the conservation of biological diversity.

The MoU was signed in 2006 and the treaty in 2011. The MoU:

- Describes the geographical extent of KAZA TFCA (in Botswana; the Okavango Delta, Moremi Game Reserve, Chobe Linyanti, MakgadikgadiNxai National Park and other land determined by migratory wildlife movement.
- Outlines the principles (e.g. protection of the ecosystem and tourism development) so that activities in one country will not affect areas in other countries;
- Describes objectives of the TFCA, including promotion of cross border tourism, harmonisation of national NRM approaches and community participation and benefits;
- Establishes an institutional framework including a Ministerial committee, technical committee, secretariat, working groups and task forces.
- Describes funding sources as member state contributions, donations and contributions from other stakeholders and donors.

2.2.24 UNCCD – United Nations Convention to Combat Desertification

Particularly in Africa (UNCCD) is a Convention to combat desertification and mitigate the effects of drought through national action programs that incorporate longterm strategies supported by international cooperation and partnership arrangements.

Botswana signed and ratified the United Nations Convention to Combat Desertification (UNCCD) in 1995 and 1996 respectively. As a result:-

- The country adopts the principle of bottom up approach in tackling desertification that is emphasized by the UNCCD, because people at grassroots level deal directly with impacts of land degradation on daily basis.
- The convention calls for the involvement of all stakeholders in decision making processes when policies, plans, programs and strategies are developed and implemented.
- As party to the convention, Botswana developed National Action Programme to Combat Desertification as required by the UNCCD. The NAP was completed in 2006

Significantly NAP Operational Objectives include facilitating the capacity building for stakeholders involved in combating desertification and mitigating effects of drought and in particular facilitating the establishment of alternative livelihoods projects so as to control and prevent land degradation.

Legislative and institutional frameworks in place to support UNCCD include a)

Forest Act of 1968

b) Agricultural Resources Conservation Act of 1974

c) Herbage preservation Act of 1977

d) Harvesting of veld products regulation of 2006

e) Draft National Forest Policy

f) Community Based Natural Resources Management Policy

g) The Fire Management Policy is currently in the formulation processes

National Action Programmes are developed in the framework of a participative approach involving the local communities and they spell out the practical steps and measures to be taken to combat desertification in specific ecosystems

2.2.25 UNFCCC – United Nations Framework Convention on Climate Change

Botswana signed the United Nations Framework Convention on Climate Change (UNFCCC) at the United Nations Conference on Environment and Development (UNCED), the ―Earth Summit‖ that was held in Rio de Janeiro, Brazil in June 1992. Botswana went on to ratify the Convention on 27th January, 1994 and it came into force on 27th April 1994. The Climate Change Convention was followed by the Kyoto Protocol. The Protocol legally binds industrialised Country parties to reduce their emissions. Botswana became a party to the Kyoto Protocol on 3rd August 2003. The Protocol came into effect in February 2005. Botswana‘s obligations under the Climate Change Convention was to report on the anthropogenic sources and sinks of greenhouse gases and identify measures to minimise the impacts of global warming and climate change.

Botswana‘s climate change adaptation priorities are guided and informed by the following documents:

i. The Second National Communication to the United Nations Framework Convention on Climate Change

ii. Sustainable Land Management
iii. National Water Master Plans

In order to ensure that climate change adaptation measures are mainstreamed into national development planning and sectoral planning, the current environmental programmes and projects strategically entail climate change adaptation. The ongoing SLM project in Ngamiland is a good example.

3 BIOPHYSICAL BACKGROUND

This chapter provides an overview of the key biophysical background data for the three Focal areas – NG2, Lake Ngami and the Hainavled Farms. For the sake of brevity information is provided at a general or District level, with each Focal Area described specifically in more detail, where appropriate. Of the three areas NG2 has not featured prominently in past reports or surveys, with only its easternmost portion falling within the Okavango Delta Ramsar Site (ODRS). Lake Ngami has been the subject of a recent Manament Plan (Ecosurv, 2013) that has compiled much vital information. The Hainaveld Farms comprise a diverse mix of owners and management strategies, making generalisations difficult. Many of the southernmost tier of Hainaveld Farms along the Kuke Fence have converted to Game Ranches. A complete survey of all Hainaveld Farms was beyond the scope of this Project but as far as is possible details about as many Farms as possible are included in this chapter.

3.1 Geology

The bedrock in Ngamiland District consists mainly of Karoo sedimentary rocks and basalts with metamorphic rocks of the Damara sequence and Gantsi and Kgwebe formations. There are relatively few areas where bedrock is exposed and loosely consolidated deposits, the Kalahari beds, obscure solid rock. The Hainaveld Farms form part of the Ghanzi-Chobe fold belt, which is a 140km-wide zone of deformation (SRK Consulting, 2010).

3.2 Climate

The climate of Ngamiland District is classified as semi-arid and tropical, with highly variable and unreliable rainfall. Rainfall is concentrated in the summer months from November to April and typically falls in high intensity convectional showers that are often very localised (Bhalotra, 1987). Winters are very dry, usually with no precipitation at all in July. Annual rainfall is normally less than 500mm per annum, as shown by the average annual rainfall recorded at the meteorological stations at Ghanzi (435.6mm) (n=47), Maun (446.8mm) (n=47), Toteng (296.2mm) (n=14) and Shakawe (462mm) (n=14). Drought is endemic due to the interior‘s peripheral and topographically isolated location in respect to the region‘s northern and eastern rain bearing air masses (Bhalotra, 1987).

3.3 Hydrology

The availability of water along the Panhandle and western margins of the Delta have made it a focus for livestock keeping for over a century. It has long tied domestic stock to the adjacent floodplains even though permanent grazing exposes them to intestinal parasites (liver fluke and roundworm) - that breed rapidly under moist soil conditions. Moreover, the concentration of livestock along the margins of the Panhandle and fringes of the Delta results in damage to dryland and flood recession melapo farming, resulting in conflicts with arable farmers. Water does inflow to the west just south of the Ikoga Fence as the flood works its way down from the Angolan highlands (See Below).

Plate 1 Inflow of water just south of the Ikoga Fence

Plate 2 Ephemeral pool along the road to Nxaunxau

West of the Okavango Delta there is no permanent surface water. Shallow depressions along the dry river valleys can hold water all the year round following ‗good' rainfall seasons, with livestock keeping dependent upon shallow wells or boreholes.

Since 2009 the floodwaters have once again reached Lake Ngami via the Kunyere and Nhabe rivers, which join at Toteng, and flow into the northeast extremity of the Lake by way of a well-defined channel (Shaw, 1983). The latter author points out that 80 per cent of Lake Ngami's water inflow is derived from the Cubango and Cuito Catchments in Angola, and so largely independent of local climatic conditions. In 1849 Livingstone remarks on a *"fine-looking sheet of water",* with maximum levels extending to the sand bar at Sehithwa itself and covering extensive areas of the flats, just west of Bodibeng. This occurred in 1898, 1899, 1904, 1925, 1926, 1968-69, 1978-79 and 1983, with high lake levels appearing to last for one or two years before receding (Shaw, 1983).

There are no perennial or ephemeral streams in the Hainaveld Farms. Access to the Nhabe River from the northernmost Hainaveld Farms has been removed by the 2014 construction of the _Northern Protection Zone' Fence. Tale Pan, and other smaller Pans and depressions dotted throughout the area can hold water for many months after it rains, and support a great diversity of birdlife.

3.4 Hydrogeology

Utilisation of sandveld pastures away from the Okavango Delta has been limited by the scarcity of suitable groundwater, with most boreholes being low yielding and/or saline. Boreholes and wells in NG2 are found along the Xaudum River Valley and isolated pans, which can hold water throughout the year. Water quality does vary but is generally salty, although there are exceptions which cattlepost owners rely on for their potable water needs. The Hainaveld Farms appear to be fairly uniform in the poor quality and low yielding nature of the aquifers that dominate the area. Perched aquifers occur around Kgwebe Hills and appear to offer better quality, and even potable water.

Although in other parts of the country, the Ecca formation constitutes a major potable groundwater resource (supplying Jwaneng, Molepolole, etc.), the water quality of the Ecca in Ngamiland District is poor. The TDS is around 30,000 mg/l and is therefore unsuitable in its raw state for most applications. Overall, however, groundwater is scarce and has greatly limited the development of the Farms, for both livestock and game. It is a reality that led to Boseto Mine placing its wellfield to the east of Lake Ngami and utilising highly saline water deep within the Ecca Formation so as not to impact upon the relatively sweeter water in the shallower Nthane Sandstone Formations that is used by cattleposts and ranches.

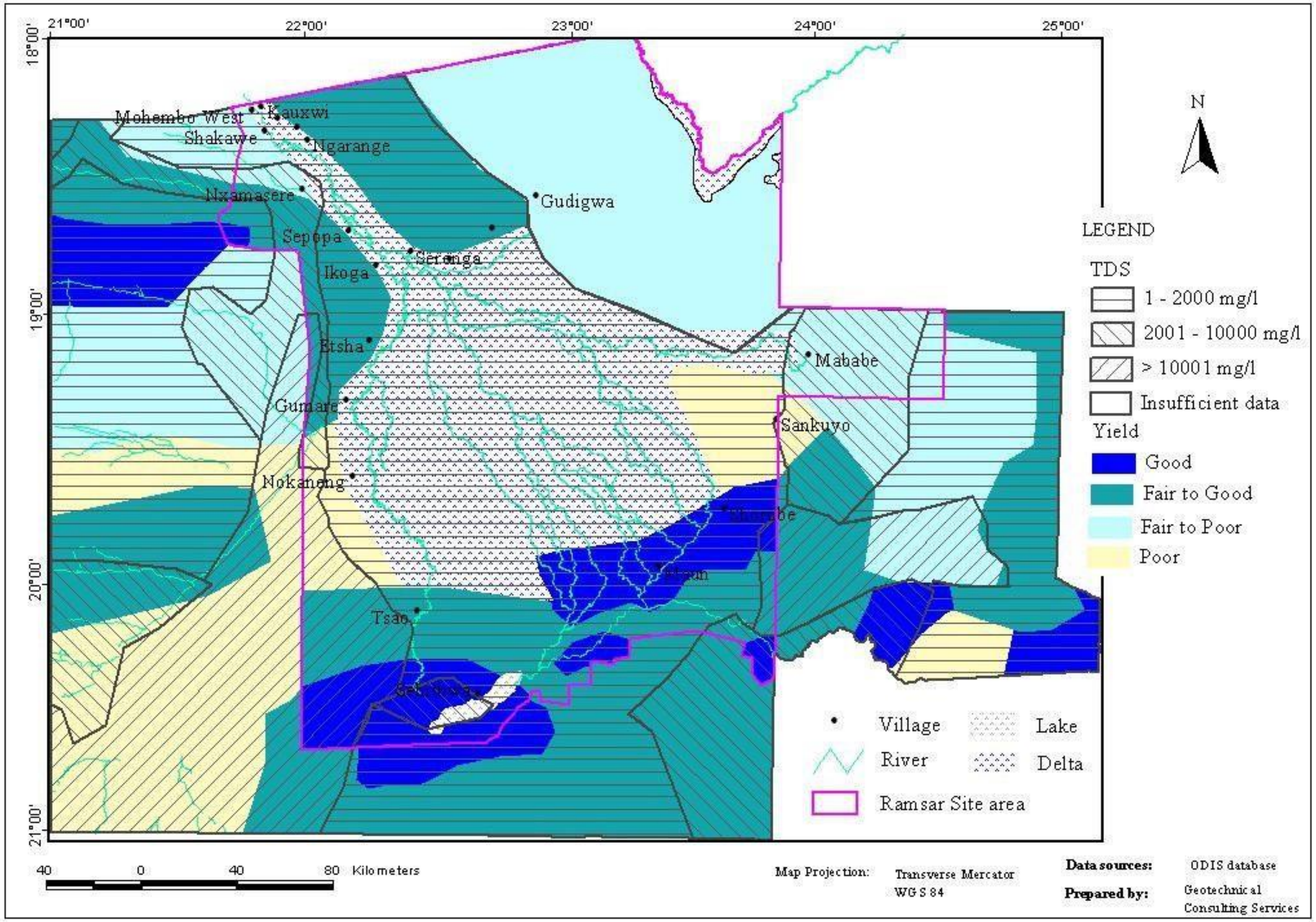


Figure 7 Groundwater Potential

3.5 Geomorphology

The dry river valleys or *mekgacha* of the Kalahari are considered to have formed during periods of former wetter climate in the Late Tertiary and Quaternary (Grove, 1969) and to have incised their courses into the relatively subdued Kalahari landscape. Within them duricrust exposures are found, which provide some of the most widespread surface outcrops of the terrestrial Jurassic to Holocene Kalahari Group sediments (Nash and Shaw, 1998), and also the possibility of potable perched water.

Wildlife populations, and domestic stock, are known to disperse along dry river valleys and utilise them disproportionately to the surrounding plains habitat. They are also common sites for baobabs that are unable to root in the deeper outlying Kalahari Sand. The dry river valleys together with the duricrust outcrops and landscape features they contain, therefore constitute significant biodiversity areas and contain valuable tree resources. Dry river valleys run throughout the savannahs with north western Botswana crossed for example by the Ncamsere and Xaudum fossil river valleys that, often due to their higher silt-clay fractions and relatively better groundwater resources, become access routes for vehicles and areas in which livestock-keeping is possible.

Dotted throughout the western Kalahari are a number of small closed basins or pans. Pans play an important role within the Kalahari ecosystem and are of vital significance to wildlife (Child *et al*, 1971) and domestic stock alike. Their relatively high silt-clay fractions, offer both important minerals, and hence otherwise unobtainable soluble salts, and also the possibility of water, either standing following rain, or attainable through the digging of shallow wells. Significant woodlands or forest areas can occur around the periphery of Pans, and also on ‗tree islands' that can occur within them. Water, although typically brackish, can occur at relatively shallow depths below the surface and before borehole technology arrived in the 1960s enabled livestock keeping to expand into the Kalahari Sandveld.

3.6 Soils

Arenosols dominate NG2, Lake Ngami and the Hainaveld Farms and while there may be some local variation along palaeo dry river valleys, these are often filled with Kalahari sand and hard to discern on the ground. Calcrete outcrops and ridges also run throughout all three areas with the distinctive *Catophractes alexandrii* vegetation they support appearing to mark the whereabouts of the Cu/Ag mineral deposits mined by Boseto Mine.

3.7 Phytochoria

NG2 is unusual in that its flora spans two biogeographic zones, the Zambezian domain to the north of the Ikoga Fence and the Kalahari Highveld domain to the south. The Kalahari-Highveld zone extends westwards into Namibia and contrasts with the area broadly east of the Okavango River northwards which is dominated by the floristically richer Zambezian zone (Hannah *et al*, 1988) (See Figure 8 below).

The transition between these different chorological zones is often marked by distinct ecotones that not only contain transitions in vegetation composition and structure, but also habitats of considerable value to wildlife. It is quite striking that the Ikoga Fence should have followed this floristic boundary, with the Kuke Fence following another phyochorological divide to the south west.

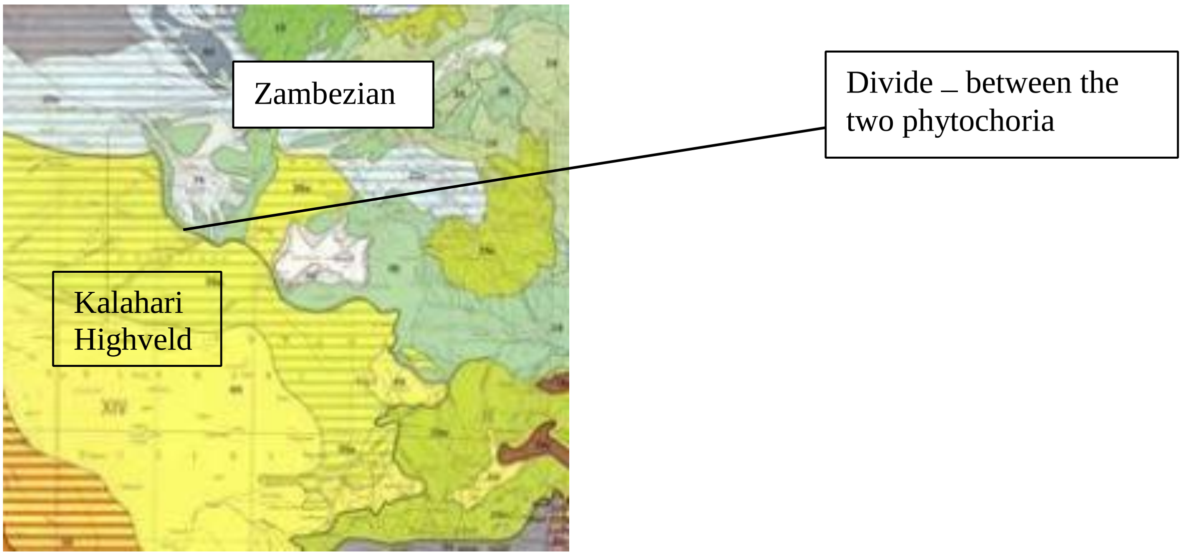


Figure 8 The Zambezian and Kalahari Highveld Zones

(From White, 1983)

Table 6 Biogeographic zones in Botswana

Centre of Endemism	Mammals species	Mammals Endemism	Birds species	Birds Endemism	Plants species	Plants Endemism
Zambezian	155	4%	650	15%	8,500	54%
Kalahari Highveld	32	0	172	5%	2,000	5%
Average for African Zones	37	5%	343	15%	3,700	34%

(Adapted from Hannah *et al*, 1988; p5.).

3.7.1 Vegetation

The northernmost part of Ngamiland is characterised by *Terminalia sericea, Burkea africana, Baikea plurijuga, Guibourtia coleosperma* and *Pterocarpus angolensis* in the tree layer. Groves of *Schinziophyton rautanenii* occur, for example along the Ikoga fence, south of Tsodilo Hills and are an important source of veld foods (mongongo). The Aha and Tsodilo Hills provide excellent examples of rocky hill woodland ecosystems that uniquely break up the sandveld dominated landscape in Ngamiland District.

On the sandy soils of the dune system and the fossil alluvium the *Terminalia sericea, Lonchocarpus nelsii* / *Acacia erioloba* association is found. Associated grass species include *Anthephora pubescens*, *Aristida meridionalis*, *Eragrostis* sp., and *Stipagrostis uniplumis*. The northern part of Ngamiland is predominated by the Miombo tree savannah on very deep sands, i.e. the *Pterocarpus angolensis* association found along the Tamacha to Tsodilo road. The mopane-line enters the region just north of Lake Ngami and runs around the Okavango Delta to the north in the direction of Nokaneng. From Nokaneng up to Shakawe *Colophospermum mopane* only occurs in a 5 - 15 km wide zone along the Okavango Delta and the Panhandle. Baobabs (*Adansonia digitata*) can occur in NG2.

The woody vegetation that became established in Lake Ngami‘s dry basin from the 1980s have since 2009 being swamped with water, with the die-back of Acacia trees (primarily *Acacia tortilis*) creating a unique and dramatic landscape (as below). The woody plants of the savannah surrounding the lake comprise mainly *Acacia*, *Combretum* and *Terminalia* species. In the immediate vicinity of the villages, the herbaceous layer comprises mainly forbs. In some places grazing has been so heavy that thickets of *Dichrostachys cinerea* and *Catophractes alexandrii* have formed. A generalised vegetation map was produced for the Lake Ngami Management Plan and is shown below.

Plate 3 Dead Acacia trees in Lake Ngami

Much of the savannah to the west of Lake Ngami, on the old Lake bed towards Kareng, comprises an open low density *Acacia erioloba* open woodland. Where there are boreholes, around Sehitwa and Toteng, the open woodland has become bush thickened with *Acacia mellifera* and *Acacia tortilis*.

Plate 4 *Acacia erioloba* open woodland

Plate 5 *Acacia mellifera* bush encroached savannah

The vegetation within the Hainaveld Farms varies greatly but a broad contrast can be made between a dominantly *Terminalia prunioides/Acacia* tree savannah in the north and a medium/high density bush savannah dominated by *Terminalia sericea* and *Lonchocarpus nelsii* as one moves towards the Kuke Fence and the northern boundary of the CKGR.

3.7.2 Protected Species

The majority of the ten protected species in Botswana, under the 1968 Forest Act, have a very specific distribution, with species more characteristic of the ‗miombo' vegetation type tending to be confined to northernmost Botswana. Those species that can be found in NG2 are detailed below.

Table 7 Protected Species in Botswana and their uses

Botanical Name and Key details
Adansonia digitata L. (Mowana) (Baobab)
A large, round canopied tree with a swollen trunk, about 10-25 m in height, often with a bole of 3-10 m (giant individuals attain a girth of up to 28 m); bark is soft, smooth, fibrous. *A. digitata* is resistant to fire, termite and drought, and prefers a high watertable. It occurs as isolated individuals or grouped in clumps irrespective of soil type. It is not found in areas of deep sand, presumably because it is unable to obtain sufficient anchorage and moisture. *A. digitata* is very sensitive to waterlogging and frost – and is not found in areas with more than 1 day frost/yr. Food: An edible white, powdery pulp found in the fruit is very rich in vitamin C and B2 and makes a refreshing drink. Having a high water content, the wood is chewed by humans and animals in case of extreme water scarcity. The wood can be used as a salt substitute. Young leaves, fruit, pods and seeds provide fodder for game and domestic animals. Livestock and game often destroy young trees. Apiculture: The tree is a source of fine quality honey. Wild bees manage to perforate the soft wood and lodge their honey in the holes. In many parts of Africa, the hollow trunks are used for beekeeping. Fuel: The long-fibred wood is suitable for firewood. The shell and seeds are also used for fuel. The wood is whitish, spongy and light (air-dried 320 kg/cubic m). It is used for making canoes, rafts, insulating boards, wooden platters and trays, boxes and floats for fishing nets. Medicine: Hyposensitive and antihistamine properties are present in the leaves, which are used to treat kidney and bladder diseases, asthma, general fatigue, diarrhoea, insect bites, and guinea worm. Leaf and flower infusions are valued for respiratory problems, digestive disorders and eye inflammation. A decoction of the roots is taken as a remedy for lassitude impotence and kwashiorkor.
Diospyros mespiliformis Hochst ex A.D.C. (Mokutshumo) (Jackalberry , African Ebony)
Large (4-6m high; occasionally 25mh) deciduous tree often grow on termite mounds, preferring deep alluvial soils. The leaves are dense and dark green and often eaten by buffalo and elephant, and the fruits by a diverse array of wild animals. The fruit is edible for humans; its flavour has been described as lemon-like, with a chalky consistency. They are sometimes preserved, can be dried and ground into a flour, and are often used for brewing beer and brandy. The leaves, bark and roots of the tree contain tannin, which can be used as a styptic to staunch bleeding. The heart wood is fine-grained and strong, and is often used for making wood floors and furniture. Trunks of the tree are used for canoes.
Baikiae plurijuga Harms. (Mokusi) (Mukusi, Rhodesian teak, Zambian teak or Zambesi redwood)

During the last century, most of the original Zambesi teak forests have been heavily exploited by logging, clearing of land for agriculture and frequent fires and the species is now mainly found in open, dry, deciduous woodland. The timber is used as a general timber for bridge construction, flooring, railway sleepers, furniture a.o. It is resistant to termites and borers and used in certain areas as fencing posts. It makes good fuel, producing very hot coals. Locally the bark is used in medicine and for tanning leather but not for its wood as it is too hard to cut.

Guibourtia coleosperma (Benth) J. Leon (Tsaudi) (African rosewood, large false mopane)
Medium to large, almost evergreen, tree, to 20 m. The seeds are edible and the seed oil can be used for cooking, as well as cosmetics. The wood can be used for dug-out canoes, construction timber and carved utensils. Various parts are used medicinally. It has horticultural potential in frost free areas, as it is a very attractive evergreen shade tree with striking fruits, and white, star-like flowered that show up against the dark, glossy foliage.
Berchemia discolor (Klotzsch) Mensley (Motsintsila) (mountain date, bird plum)
Shrub or a tree 3-20 m high; Humans find the sweet, datelike taste of the fruit quite pleasant. The sugar content of the pulp is as high as 30%, and seeds taste like walnuts. The vitamin C content of the fruit is 65 mg/100 g. The fruit may be eaten boiled with sorghum. A beverage similar to tea is made from the leaves. Large quantities of the fruit are collected, dried and stored and later used by people in the low veld areas of South Africa. Fodder: The fruit and leaves can be used as fodder. Apiculture: Bees are attracted to the small yellow-green flowers found in loose clusters on the tree. Timber: An important timber species of southern Africa. The wood is excellent for making furniture such as tables, chairs and benches and is also used in making poles, pestles and hair combs. Gum or resin: The heartwood produces a resin. Tannin or dyestuff: Black dye, popular with basket makers, is produced from powdered heartwood and roots. Alcohol: A strong alcoholic drink is distilled from the fruit. Medicine: The roots have various medicinal uses. Other products: The whitewash produced from the ash is used for painting houses.

edia.org/wiki/Diospyros_mespiliformis
http://en.wikipedia.org/wiki/Miombo#References
http://en.wikipedia.org/wiki/Guibourtia_coleosperma
http://www.worldagroforestry.org/treedb/AFTPDFS/Berchemia_discolor.pdf
http://treeatlas.biodiversity.org.na/viewspec.php?nr=302 All
Sites Accessed 25/5/15

3.8 Mogau

Mogau (*Dichapetalum cymosum*) is the most significant poisonous plant that adversely affects livestock in many parts of Northern Botswana, including Ngamiland. *Dichapetalum cymosum* is deep rooted and emerges before the rains commence or immediately after fires – when there is a distinct absence of green. shoots. After sufficient rainfall, Mogau leaves become old and leathery, and appear less appealing to cattle (GCS, 2007).

Plate 6 Mogau (*Dichapetalun cymosum*) plants seen in NG/2

The poisonous agent is monoflouroacetate, which affects the heart and the nervous system and is released once the affected animal drinks water (Bromilow, 2001). Its distribution is limited to parts of the Sandveld, especially the southern and northern parts (GCS, 2007). Local cattle might suffer up to 4% mortality by eating this plant (GCS, 2007) with it recommended in the integrated land use plan for Ngamiland that land infested with Mogau is developed as game ranches, as wildlife is not so susceptible to it (Landflow, 2009).

3.9 Invasive and Alien Species

The exotic invasive, the common cocklebur (*Xanthium strumarium*), forms densely packed thickets and can form a monoculture over the Lake bed. The plant is a host for a number of pathogens and the young leaves are poisonous to stock.

Plate 7 The alien *Xanthium strumarium* on the dry Lake Bed
(Photo: R Randall) (From Ecosurv, 2013; p.36)

Plate 8 The alien invasive *Xanthium strumarium*

- *Cenchrus biflorus*

Prior to the assessment we had received reports from farmers within the Hainaveld region of an increase in the presence of *Cenchrus biflorus*, a highly unpalatable invasive annual. However, this grass was not identified during the current survey in the Hainaveld region. The only record of the grass across the assessed area was near to Bodibeng village to the south-west of Lake Ngami.

Plate 9 *Cenchrus biflorus*

3.10 Livestock

Livestock numbers in Ngamiland District have fluctuated drastically over time, primarily in response to spatial and temporal variations in the occurrence of rainfall and disease outbreaks. In general livestock numbers tend to build up in wet years and crash catastrophically in drought periods. It is a _boom and bust‘ trend that has been further accentuated by disease outbreaks, such as that of Contagious Bovine Pleuro Pneumonia (CBPP) that resulted in the eradication of all cattle in Ngamiland in 1996. At that time the cattle population was 320,000 (12 % of the national herd) distributed as shown below.

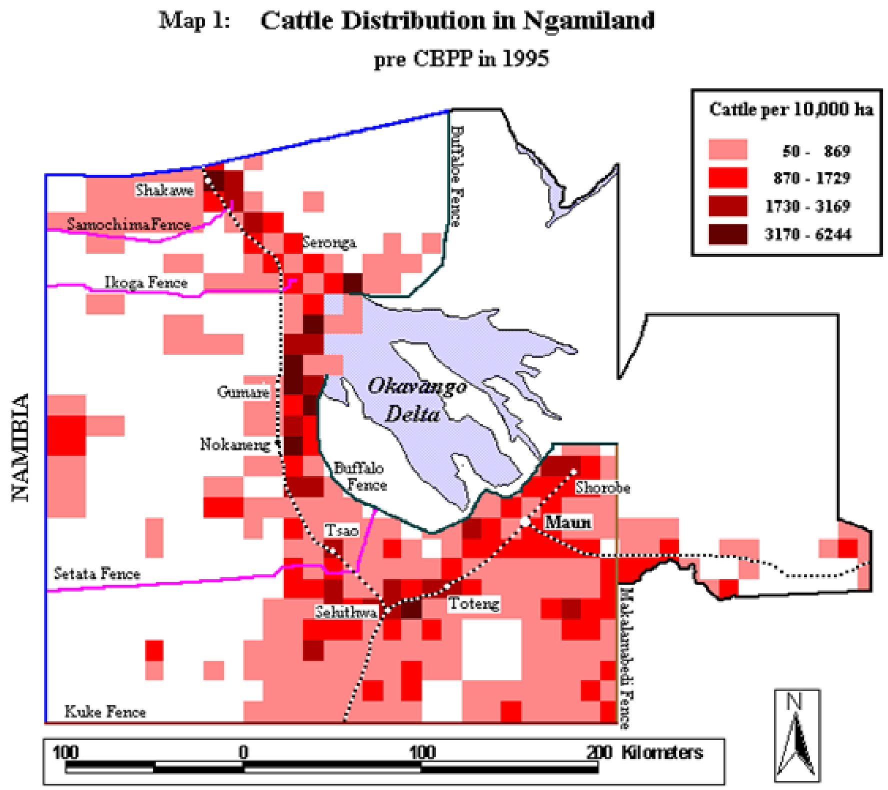


Figure 9 Cattle distribution in Ngamiland: Pre CBPP in 1995

(From Scott Wilson, 2000)

Cattle crush data from the Department of Veterinary Services (DVS) in Maun for 2012 puts Ngamiland District‘s livestock population at 370,639 individuals. The 2012 estimates for sheep and goats is 21,341 and 57,597, respectively, giving an overall smallstock population of 78,938 – a figure that is likely to grossly under-estimate the actual population, which was 217,000 goats alone in 1993 (Scudder *et al*, 1993). The 2012 dry season aerial census of animals in Ngamiland (DWNP, 2013) estimates Ngamiland‘s domestic stock as, cattle (422,365), donkeys (34,634), horses (12,952) sheep and goats (124,838). Aerial surveys tend to under-estimate the overall size of ungulate populations and in light of the fact that significant livestock mortality has occurred in the district over the last two years, it is evident that that the cattle population was probably over 450,000. The estimates for horses and donkeys is also likely to be inaccurate, as their populations from both DVS and DWNP data appears to be low – in light of the fact that they were not slaughtered during the CBPP outbreak, with donkeys in fact being brought in as part of a Scandinavian aid package – in order to provide draught power.

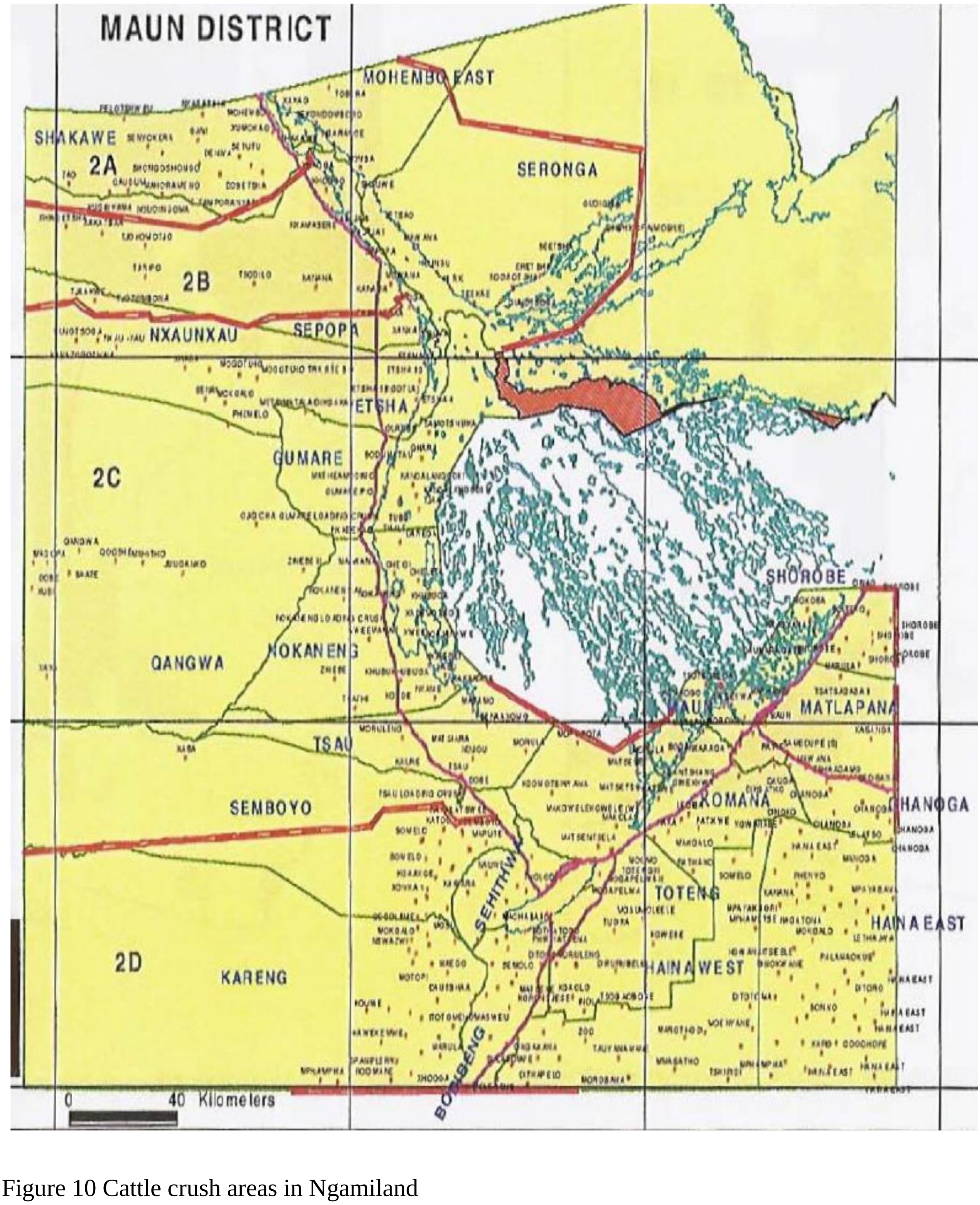


Figure 10 Cattle crush areas in Ngamiland

(From Scott Wilson, 2000)

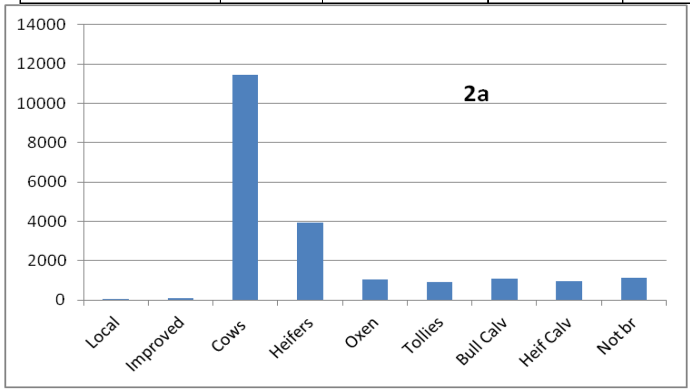
Table 8 Cattle crush statistics

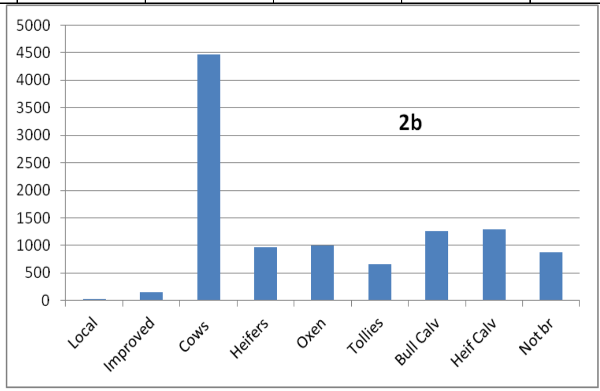
(Below - From DVS, Maun)

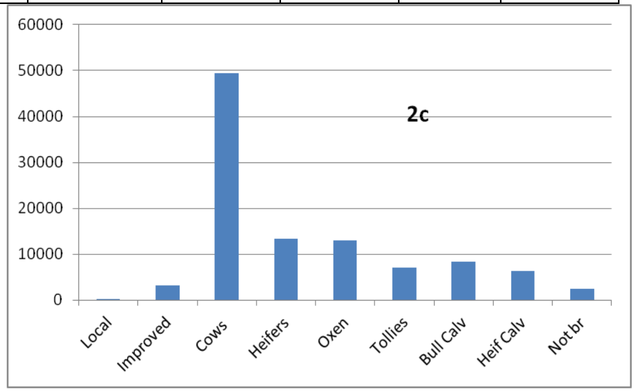
Extension Area	Local Bulls	Improved Bulls	Cows	Heifers	Oxen	Tollies	Bull Calves	Heifer Calves	Not brought	Total Cattle	Sheep	Goats	Horses	Donkeys
Zone 2a														
Seronga	6	28	2354	661	108	76	335	108	97	3773	231	356	107	98
Mogotho	3	15	1035	752	189	102	91	89	39	2315	198	445	126	143
Beetsha														
Xakao	6	14	2997	1265	256	305	156	233	96	5328	0	0	0	0
Shakawe	7	12	1160	128	277	76	92	131	96	1979	0	492	40	420
Gani	47	28	3896	1125	235	365	402	400	814	7312	98	375	299	399
Total	**69**	**97**	**11442**	**3931**	**1065**	**924**	**1076**	**961**	**1142**	**20707**	**527**	**1668**	**572**	**1060**
Zone 2b														
Nxamsere	5	23	1602	342	252	183	264	203	98	2972	102	452	225	385
Chukumuchu	23	104	1358	524	653	379	533	607	486	4667	30	765	170	494
Sepopoa	2	27	1501	98	100	102	458	476	293	3057	0	988	24	366
Total	**30**	**154**	**4461**	**964**	**1005**	**664**	**1255**	**1286**	**877**	**10696**	**132**	**2205**	**419**	**1245**
Zone 2c														
Nxaunxau														
Etsha	22	116	3517	829	891	658	342	409	446	7230	2	2719	135	917
Qangwa	5	107	2093	777	750	628	552	578	63	5553	0	993	134	371
Gumare	13	2356	7896	1632	765	902	986	725	364	15639	5400	574	994	556
Nokaneng	133	309	12568	4563	2314	2531	1901	1256	432	26007	357	3979	405	885
Habu	26	91	5241	1719	1558	667	967	684	286	11240	756	2568	138	303
Tsau	33	243	6586	1994	2501	1490	1527	1655	536	16565	1010	3680	331	936
Tubu	5	16	11456	1896	4231	122	2154	1023	280	21183	0	283	40	116
Total	**237**	**3238**	**49357**	**13410**	**13010**	**6998**	**8429**	**6330**	**2407**	**103417**	**7525**	**14796**	**2177**	**4084**
Zone 2d														

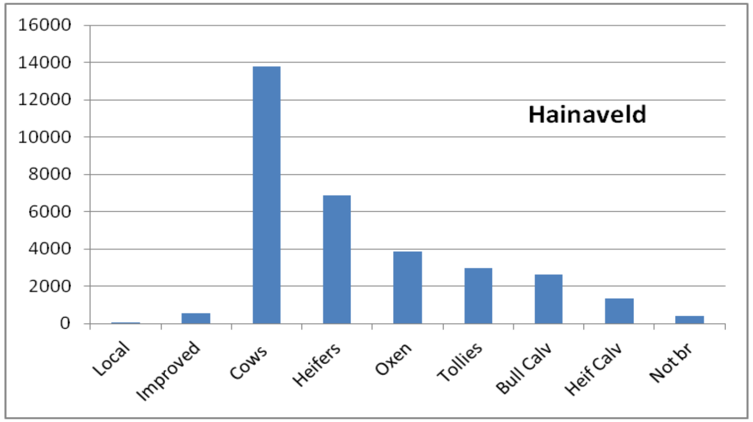
Semboyo	44	384	7231	2029	3755	1517	1144	1183	2699	19986	632	3484	498	801
Bodibeng	141	1737	9220	3857	5734	2222	1846	1701	384	26842	1313	4076	1050	766
Kareng E	72	496	15234	3217	7689	3168	3896	1828	2122	37722	707	4760	714	1136
Sehitwa	36	199	6457	1946	2978	1901	1127	1140	851	16635	471	1712	348	605
Toteng	135	389	10247	3187	4129	2093	1986	2072	590	24828	1015	5743	647	797
Komana	41	156	4586	2213	3125	2035	1002	1014	860	15032	1242	5452	516	863
Maun	180	3962	7467	3549	2513	1781	1690	1467	791	23400	4768	2325	1650	676

Extension Area	Local Bulls	Improved Bulls	Cows	Heifers	Oxen	Tollies	Bull Calves	Heifer Calves	Not brought	Total Cattle	Sheep	Goats	Horses	Donkeys
Shorobe	37	122	5003	2134	2013	496	695	851	1216	12567	352	2264	117	475
Chanoga	11	202	6586	2013	2354	2231	987	725	706	15815	510	3492	282	1027
Hainaveldt	65	579	13776	6884	3858	2983	2648	1334	423	32550	1976	4638	700	445
Makalambedi	2	306	4256	1986	1001	790	600	544	957	10442	171	982	149	116
Total	**764**	**8532**	**90063**	**33015**	**39149**	**21217**	**17621**	**13859**	**11599**	**235819**	**13157**	**38928**	**6671**	**7707**
Grand total	***1,100***	***12,021***	***155,323***	***51,320***	***54,229***	***29,803***	***28,381***	***22,436***	***16,025***	***370,639***	***21,341***	***57,597***	***9,839***	***14,096***








16000
14000
12000
10000
8000
6000
4000
2000
0
Hainaveld
Local
Improved
Cows
Heifers
Oxen
Tollies
Bull Calv
Heif Calv
Not br

The number of sheep and goats is likely to be an under-estimate, as probably is the case for donkeys, many of which are effectively feral.

Table 9 Sheep, goats, horses and donkeys census

Extension Area	Sheep	Goats	Horses	Donkeys
Zone 2a				
Seronga	231	356	107	98
Mogotho	198	445	126	143
Beetsha				
Xakao	0	0	0	0
Shakawe	0	492	40	420
Gani	98	375	299	399
Total	**527**	**1668**	**572**	**1060**
Zone 2b				
Nxamsere	102	452	225	385
Chukumuchu	30	765	170	494
Sepopoa	0	988	24	366
Total	**132**	**2205**	**419**	**1245**
Zone 2c				
Nxaunxau				
Etsha	2	2719	135	917
Qangwa	0	993	134	371
Gumare	5400	574	994	556
Nokaneng	357	3979	405	885
Habu	756	2568	138	303
Tsau	1010	3680	331	936
Tubu	0	283	40	116
Total	**7525**	**14796**	**2177**	**4084**
Zone 2d				
Semboyo	632	3484	498	801
Bodibeng	1313	4076	1050	766
Kareng E	707	4760	714	1136
Sehitwa	471	1712	348	605
Toteng	1015	5743	647	797
Komana	1242	5452	516	863
Maun	4768	2325	1650	676
Shorobe	352	2264	117	475
Chanoga	510	3492	282	1027
Hainaveldt	1976	4638	700	445
Makalambedi	171	982	149	116
Total	**13157**	**38928**	**6671**	**7707**
Grand total	***21,341***	***57,597***	***9,839***	***14,096***

Based on DVS (2013) cattle crush statistics

The extent to which livestock is dependent upon surface water is clearly shown below.

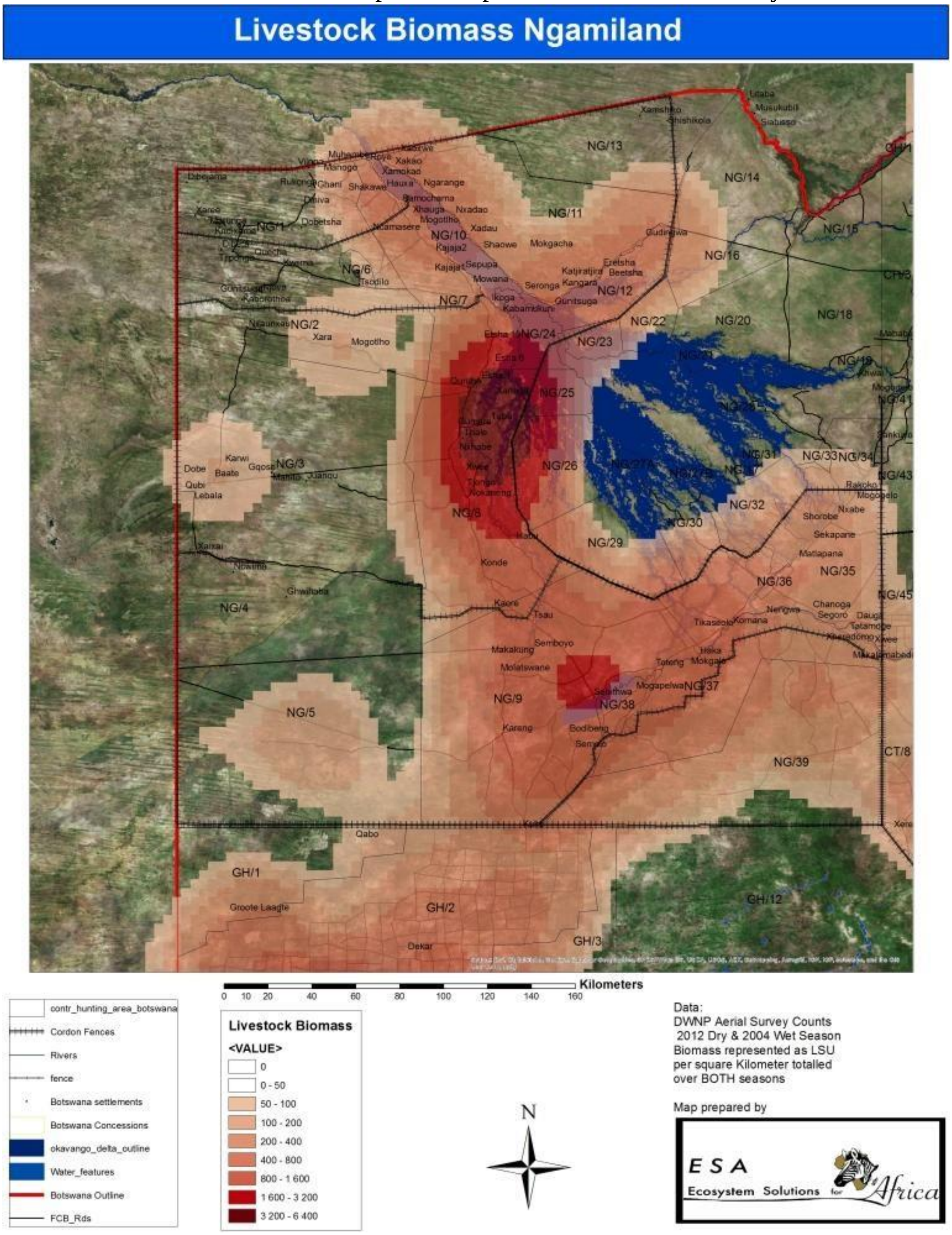


Figure 11 Livestock pressures around the Okavango Delta

3.11 Wildlife

The so-called _gap‘ between the northern and southern buffalo fences, refers to the area where the fence passes through perennial and seasonal swamps dominated by papyrus, together with intermittently inundated and dryland associations. The gap area occurs where the Kalahari Highveld zone meets the floristically richer Zambezian zone and is important to a number of species such as lechwe and the threatened sitatunga (Scott Wilson, 2000). The latter report showed that there are seasonal movements of water dependent species such as zebra and wildebeest out of Delta to better grazing in the west during the wet season, with the aerial survey by Chase (2010), also showing significant concentrations of wild ungulates in and around the gap area.

Wildlife populations of the main ungulate species are becoming limited by this reality as the opportunities to disperse into the dry sandveld pastures, of the Kalahari Highveld system, in the wet season are becoming foreclosed by fencing and ribbon development (human settlement expansion and arable farming) along the fringes of the Panhandle and western fringe of the Okavango Delta.

The connectivity between the Zambezian and Kalahari Highveld chorological zones appears to be critically important to wildlife populations, particularly during periods of resource scarcity such as droughts, and high flood pulse events that reduce the amount of floodplain grazing. This phytochorological boundary broadly follows the westernmost side of the Okavango and the Boteti River and due to land use planning decisions is becoming synonymous with the boundary between livestock and wildlife dominated systems. Many protected species are confined to the Zambezian domain, often showing an extremely peripheral location within it, along the shared borders with Zimbabwe and Namibia.

A similar loss of access to the Boteti River in the 1982-86 drought, and across the same Zambezian/Kalahari Highveld divide, resulted in the die-off of over ninety per cent of the Kalahari wildebeest and hartebeest populations (over half a million animals) (DHV, 1980) from which their populations have never recovered. Mobility is the key survival strategy of herds of wild ungulates, and while opportunistic movements in response to the spatially and temporally highly variable occurrence of green grass following fire and rainfall events is critical, so too are seasonal and strategic movements to resource areas during times of forage scarcity.

Without migratory corridors in place, large tracts of western Ngamiland will remain unutilised and large herbivore populations in the District will continue to be devastated by perturbations such as drought, fire and flooding that form such an integral part semi-arid ecosystem functioning.

Figure 12 Key wildlife movements in Ngamiland

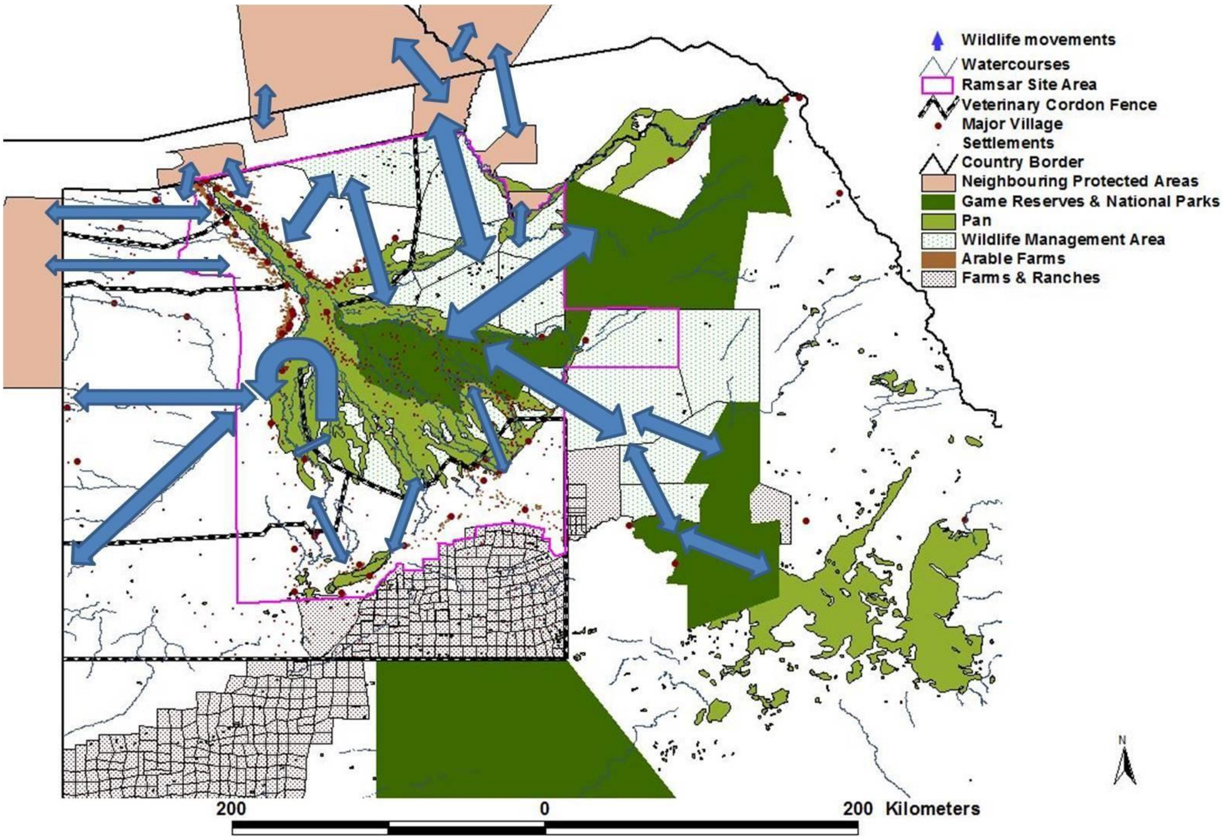
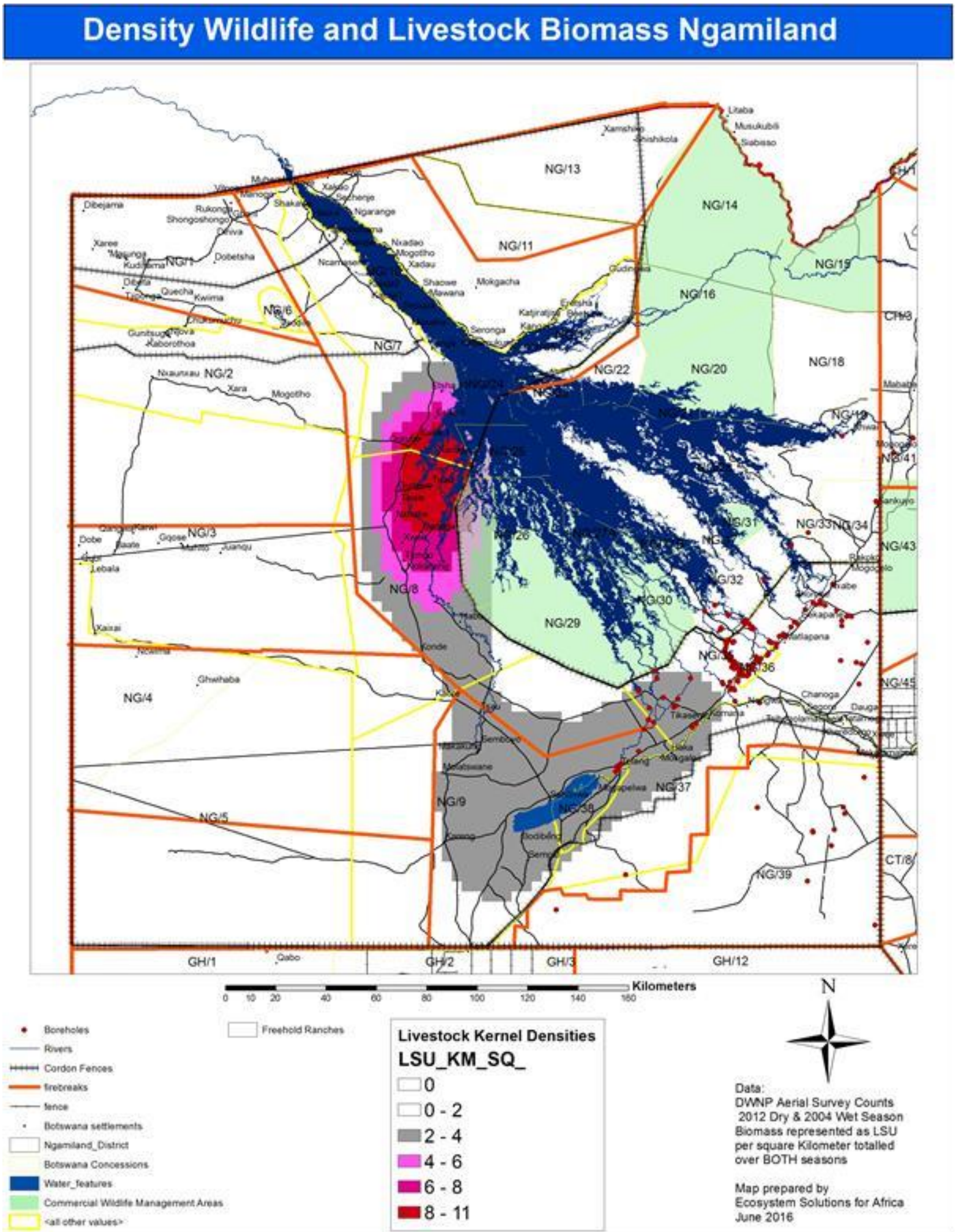

Wildlife movements
Watercourses
Ramsar Site Area
Veterinary Cordon Fence
Major Village
Settlements
Country Border
Neighbouring Protected Areas
Game Reserves & National Parks
Pan
Wildlife Management Area
Arable Farms
Farms & Ranches
N
200
0
200 Kilometers

Figure 13 Density of Wildlife and Livestock biomass in Ngamiland



3.11.1 Elephants

The elephant population in Northern Botswana is estimated to be approximately 207,000 (DWNP, 2012). The quadrupling of the size of the elephant population between 1990 and today, and the drastic increase in the spatial area they now cover (See Figure 14 below), is clearly an important factor in terms of its impact on land use planning and management in Ngamiland District. This is especially the case as movements out of Northern Botswana into the KAZA-TFCA and in Botswana (See Figures 15-16) are in fact limited and in the latter case leading to unprecedented levels of HEC.

It is a factor that is likely to become worse over the short term (5yrs) and was cited by some cattlepost owners in NG2 as one of the main reasons why they saw no point in fencing their grazing lands. Indeed, while the return of inflows to Lake Ngami and the Boteti River offers considerable livelihood related opportunities it has also enabled, predominantly bull elephants to move southwards from the Northern Conservation Zone into such areas as the CKGR and Rakops, and even further afield. The unprecedented levels of HEC and infrastructure damage that is resulting from this movement has profound implications for sustainable land management in the country as a whole and not just Ngamiland.

Plate 10 Elephant damage along the Kuke Fence


.

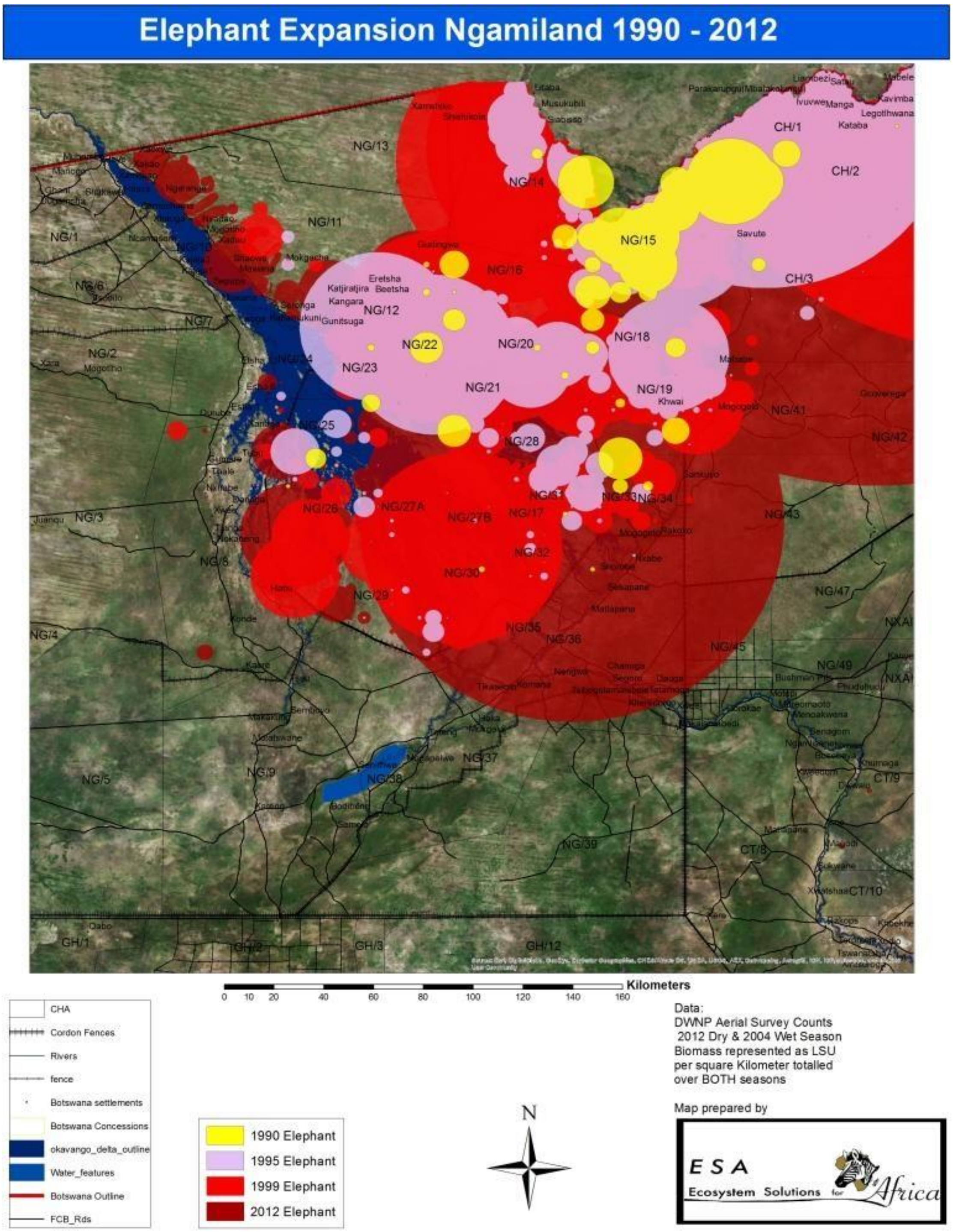


Figure 14 Elephant Threat Expansion (1990 – 2012)

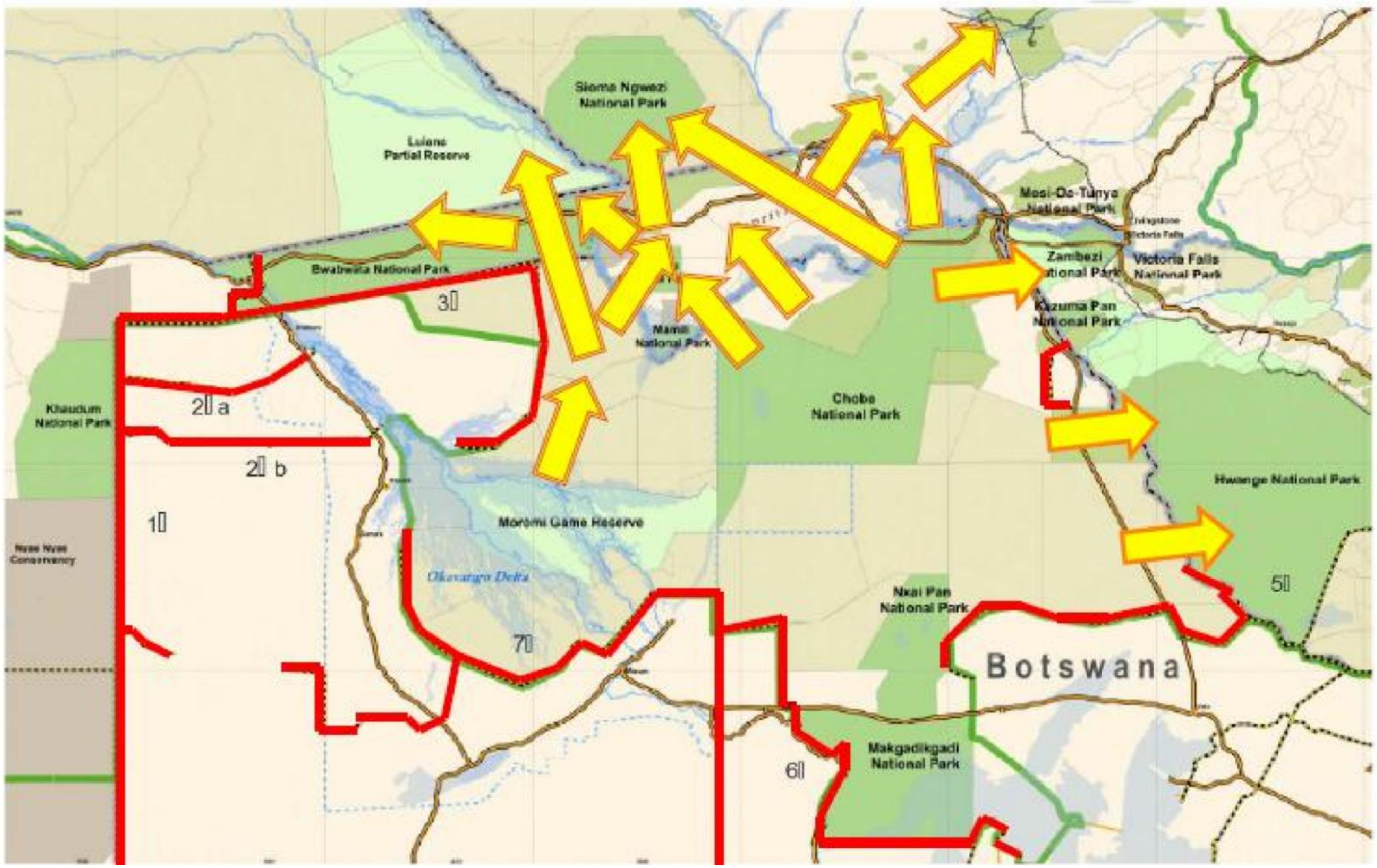


Figure 15 Key fences constraining elephant movements in the KAZA - TFCA

(From Brooks and Chase, 2014)

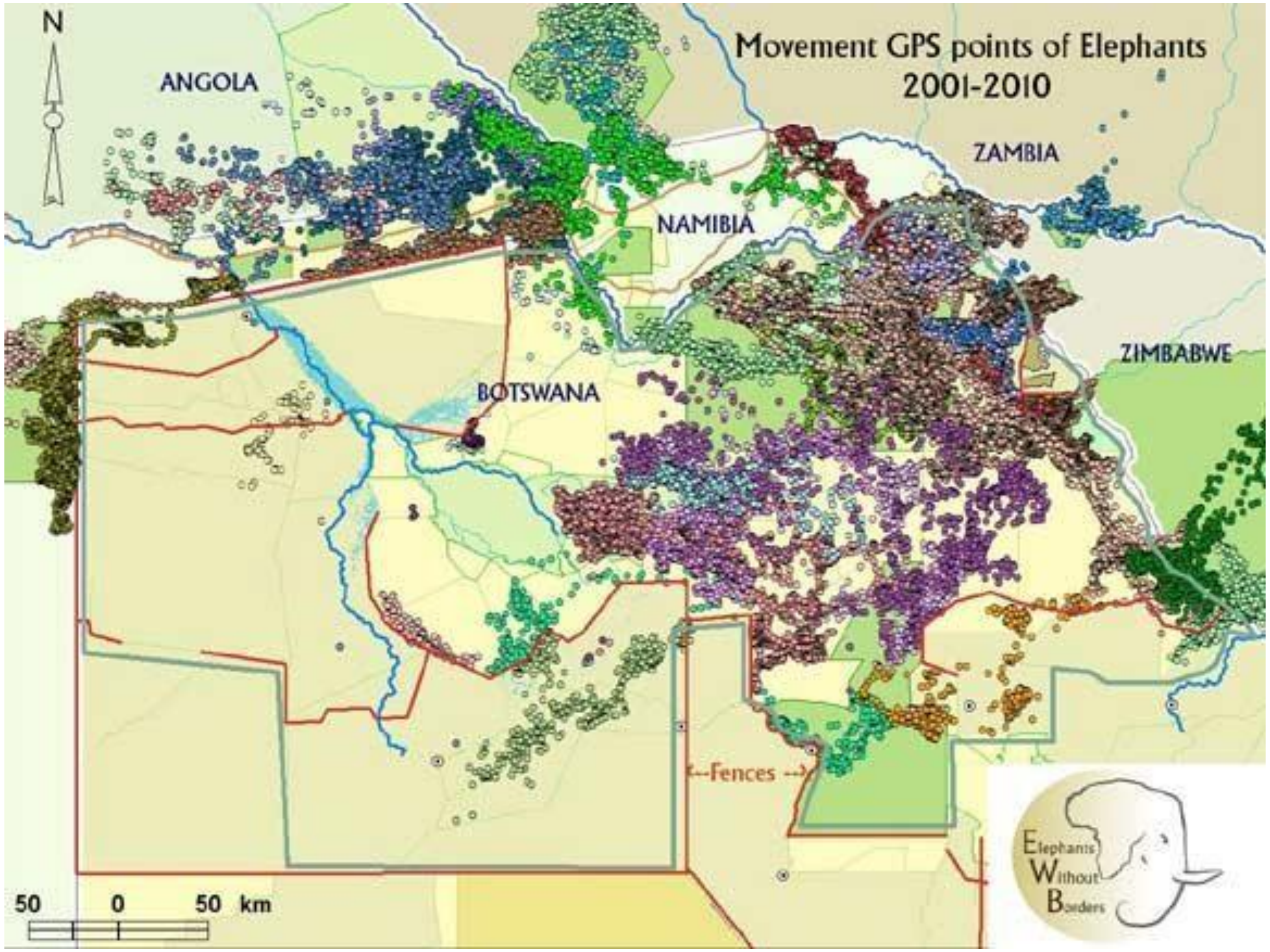


Figure 16 Map illustrating elephant movement within and across Botswana to neighbouring countries (From Brooks and Chase, 2014)

3.12 Fire

Most fires occur in the dry season with fire monitoring using NOAA AVHRR data occurring between April and October, when it is possible to detect fire effects due to the contrast they produce with the surrounding areas. Skies are also generally clear, which is important for the satellite's view not to be obscured by cloud cover. Monitoring commences on April 1st each season with fire affected pixels colour coded according to the day on which they occur. MODIS can routinely detect fires at an average size of 30 meters by 30 meters (900m^2) under a variety of conditions.

An analysis of MODIS data for the last 14 years was undertaken for the Project areas and is shown below (See Figure 17 below). The MODIS analysis reveals that extensive areas of NW Botswana burn every 1-2 years and that only small areas of Lake Ngami and the Hainaveld Farms burn. Game ranchers in the southern tier of game ranches along the Kuke Fence spoke of extensive fires over the past five years which also burnt extensive areas of the CKGR. It is also clear from the burn scars on the dead Acacia trees in the bed of Lake Ngami that the papyrus beds and woody biomass can burn – it seems likely that this occurrence is related to past presence of fishing camps throughout the Lake bed as water levels receded.

Table 10 Summary of fires in the three focal areas over the period 2000 - 2014

Area	Location	Context
NG2	Extensive areas of NW Botswana – fire extent greatest in westernmost areas	Low wild ungulate biomass, and limited piospheres resulting in high primary biomass
Lake Ngami	Areas west of Tsau	Low wild and domestic ungulate biomass resulting in high biomass
	Western Ngamiland	
	Lake bed	Papyrus reed beds, seasonal floodplains
Hainaveld	Smaller areas (10,000ha)	Low wild ungulate biomass on unoccupied Farms and several kilometres from waterpoints

Analysis of MODIS data reveals that the total seasonal burn areas of Ngamiland can exceed a million hectares, ranging from 10-20 per cent of the entire District. It is clearly a significant impact for over a million hectares of rangeland to burn at any one time, with the loss of timber, veld products and biodiversity this represents, undocumented, but likely to be substantial. Trollope *et al* (2006) make a number of recommendations for fire management in Ngamiland, such as _reduce fire frequency to a rate of one in 3-5 years and promote cool burns‘.

Plate 11 Fire affected savannah in western Botswana (2013)

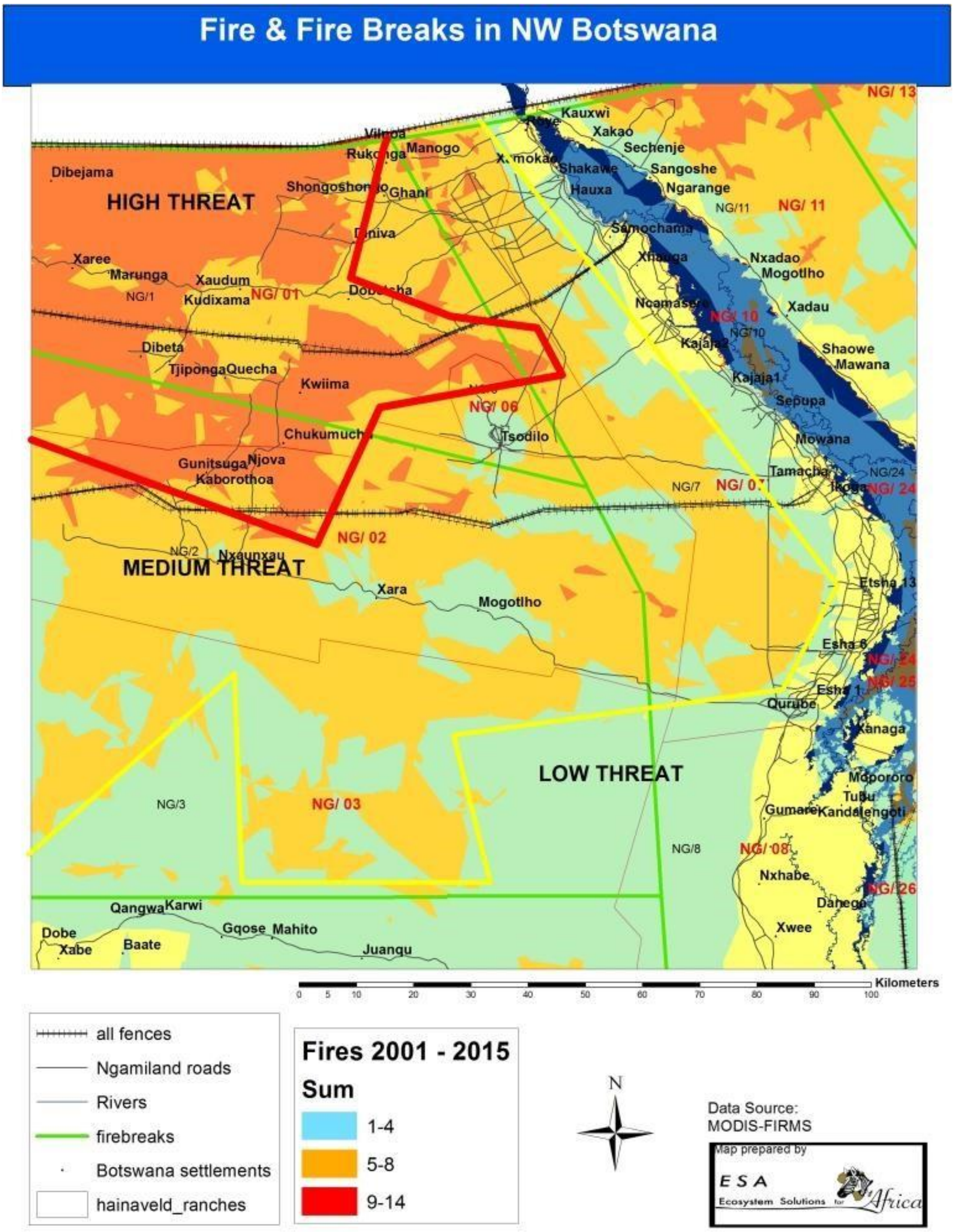


Figure 17 Fire threat in NW Botswana 2001 - 2014

4 SOCIO-ECONOMIC BACKGROUND

This chapter provides an overview of the key socio-economic background data for the three Focal areas – NG2, Lake Ngami and the Hainavled Farms.

4.1 Land Tenure, Access and Use

The land use zones in Ngamiland are shown below. The key settlements and infrastructure are concentrated along the Okavango Panhandle and fringes of the Okavango Delta, with much of western Ngamiland a wilderness area.

NG2 is a communal grazing area, the southern ‗boundary' of which is marked by the road which travels to the community of Nxaunxau on its southernmost border. To the north, the boundary is marked by the road to Chukumuchu. The Ikoga veterinary fence bisects the area from east to west. Apart from a small game farm (approximately 3200 ha) in the southeastern corner of the area, there are no other fences in the area.

The Nxaunxau community area was originally inhabited by the Basarwa (same people as the Qangwa). It is thought that in the 1930s /40s the Baherero, Bayei and Hambukushu (all livestock people from the river area) moved to the Nxaunxau area. They found the Basarwa people there already. They relocated from the area near the river (Gumare all the way up to Shakawe). They relocated due to the Tsetse fly problem. Other farmers moved to the area to avoid conflict with the arable farmers closer to the river.

Many of the water points and cattle posts were established before the land tenure system was put in place and therefore there we no restrictions on the spacing of the water points. New boreholes that are established have to be spaced at least 8km away from the nearest borehole to allow for grazing around that area.

The Lake and its surrounding land is Tribal land, also known as communal land. The major land use designation is tribal grazing (Ecosurv, 2013). The reflowing of the river and filling of the lake since 2009 has had a huge impact on the way people use and access the land. The lake bed itself used to be a dry grazing season area, however, now with the lake flooded the grazing areas have been ‗lost'. In addition, conflicts have arisen within and between communities in terms of land access and uses. In fishing for example, locals in and around Lake Ngami complain about fishermen from as far Zambia crowding in the Lake for commercial fishing and littering the area (Ecosurv, 2013). Movements and history of settlement in the Lake Ngami area has been driven by the demand for water and through avoiding disease (e.g. Tsetse flies).

The Hainaveld farming block is located in the south-eastern part of the district. This was originally zoned for commercial ranch development under the Tribal Grazing Land Policy of 1975. Some of the earliest ranch allocations were in the Hainaveld in August 1979 (23 ranches), with subsequent phases thereafter. By March 31, 1987 some 424 TGLP ranches had been demarcated by the MoA. Advertisements calling for applications had been placed for 279 ranches, 236 had been allocated and leases signed for 179 ranches (McGowan and Associates, 1987). Ngamiland at that time contained 81 of the allocated ranches, typically of 4,900 ha rather than the more usual 6,400ha. In 1990 the block was extended by a further 31 ranches. The size of the individual ranches varies from 4,050 ha to 7,600 ha (Bendsen and Meyer, 2002), with the latest phase of ranch expansion targeting Toteng/Maun and the area west of Kuke, in line with the new _Northern Protection Zone' veterinary cordon fence that runs from Makalamabedi to the Kuke Fence.

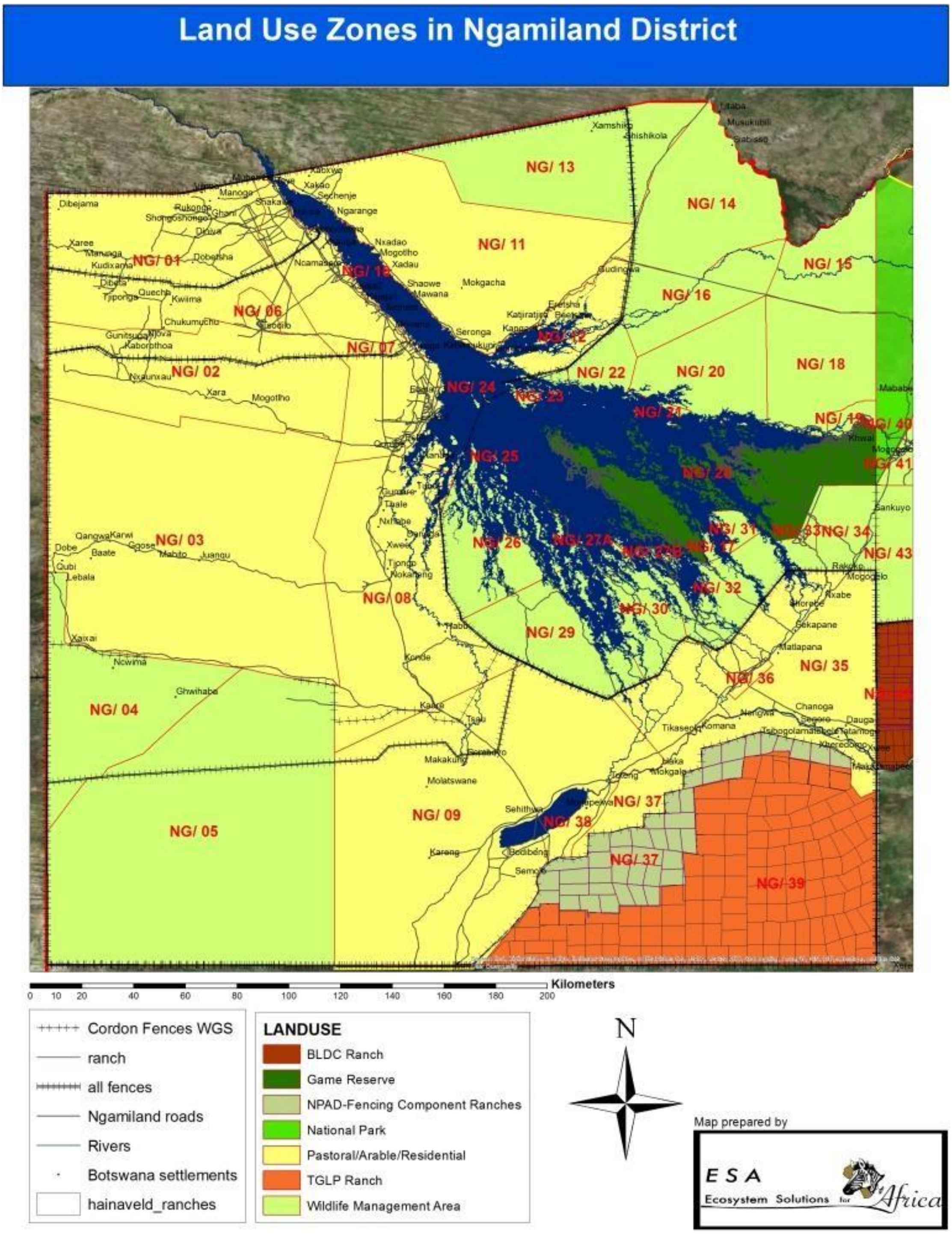


Figure 18 Land Use Zones in Ngamiland District

In 1991, Tsimako reported that out of the 120 ranches that were demarcated, 68 are allocated to individuals, 42 to ranching syndicates, 1 to an Agricultural Management Association, 5 were reserved for communal group ranching and 4 have been de-zoned and are used as communal service centres. Since that time, the number of farms have grown to something in the region of 190 farms. These have been allocated now within the Hainaveld TGLP ranches. The gazetted settlement of Somelo is located within the Hainaveld TGLP block, within the area of farm OM73. Through discussions with various stakeholders (including DAP and the mining personnel) and from the ecological field visits it is estimated that:

- 110 are still be utilised at cattle and livestock farms,
- 32 have been converted to game farms,
- 17 have been or are in the process of be acquired by the mines,
- 1 is being utilised by the Somelo village,
- 10 farms are not functioning at all, and
- 26 of the farms the status was unknown at the time of this study.
- In addition, 98 of the farms are currently being impacted by the mine exploration activities.

Before the erection of the new veterinary cordon fence between Makalamabedi and Kuke, Hainaveld farmers would herd their cattle to utilise the grazing (and water) around the Lake in the wet season, before retreating to their own farms in the dry season. This would provide some ‗rest' to their own grazing, but of course exacerbate the stocking density and overgrazing on the communal lands. The new fence has prevented this movement under ‗dual grazing rights' from occurring.

It is also appears that many farms have been sold on or have been left unoccupied because it is unclear who owns the leases on them. The trend for Farm occupation to be passing to non-Botswana Nationals also appears to be quite pronounced. Another, perhaps not unrelated trend, over the last decade in particular, has been a move towards game ranching. Indeed the joining of Farms, infrastructure provision and stocking of them with game has meant that quite a few are now worth more than five million US dollars. It is a trend that appears set to continue, driven perhaps by predator pressure, HEC and the dearth of opportunities for livestock offtake and sales.

4.2 Demography

NG2 is sparsely populated compared to the Okavango Panhandle and western margings of the Delta. In NG2 the population of Nxaunxau village in 2001 was 330 people, and in 2011 it was estimated to be 672 (of which 325 are male and 347 are female) - 54.5 percent of the population comprises of dependents from the ages of 014 years, while 40.9 percent are considered to be labour force age. The population in Nxaunxau makes up only 1.1 percentage of the Ngamiland West District population. The average household size in Nxaunxau is 7 people per household, which is significantly more than the Ngami West's average of 4.5 people per household (Ngami West Sub-District Census Data from 2011 Report, 2015). The population of Chukumuchu village in 2011 was recorded as 161 people (CSO, 2011).

The Lake Ngami area is situated in NG/38 and a portion of NG/9 south of the main Maun to Ghanzi road. This includes the villages around the lake of Toteng, Legothwana, Mogapelwa, Bothothogo, Bodibeng, Kareng and Sehithwa, and the village's further north-west of Tsau, Semboyo, Makakung / Kgakgae and their grazing areas. The populations of the villages in the Lake Ngami area for the last two censuses in 2001 and 2011 is shown below.

	Toteng	Sehithwa	Bothothogo	Bodibeng	Kareng	Semboyo	Makakung /Gage	Tsau
Male	1377	2671	340	335	993	208	136	1528
Female	1183	2471	366	443	960	204	143	1521

Population growth in the villages of Toteng in particular, and also Sehitwa, undoubtedly increased as a result of the development of the Copper/Silver Mine approximately 45kms south east of Toteng in 2010. The influx of people related to the Mine would have affected the 2011 Population and Housing Census. Boseto Mine ceased operation in 2014 and has now been taken over by Khoemacau Mine that is planning to re-open the mine as well as mine the adjacent mineral concession. The timing of the re-opening of the mine that is currently under care and maintenance is undecided currently due to the low commodity prices.

The size of the settlements around Lake Ngami is shown below for 2001 and 2011. The majority 277 (54.6%) of households in Sehitwa are female headed with 189 (45.4%) headed by males. In Kareng, majority of about 95 (61.3%) are female headed and 60 (38.7%) are male headed households. Toteng has majority of about 64 (54.7%) female headed and 53 (45.3%) male headed households. Female headed households are usually disadvantaged with regard to ownership of productive resources (Ecosurv, 2013).

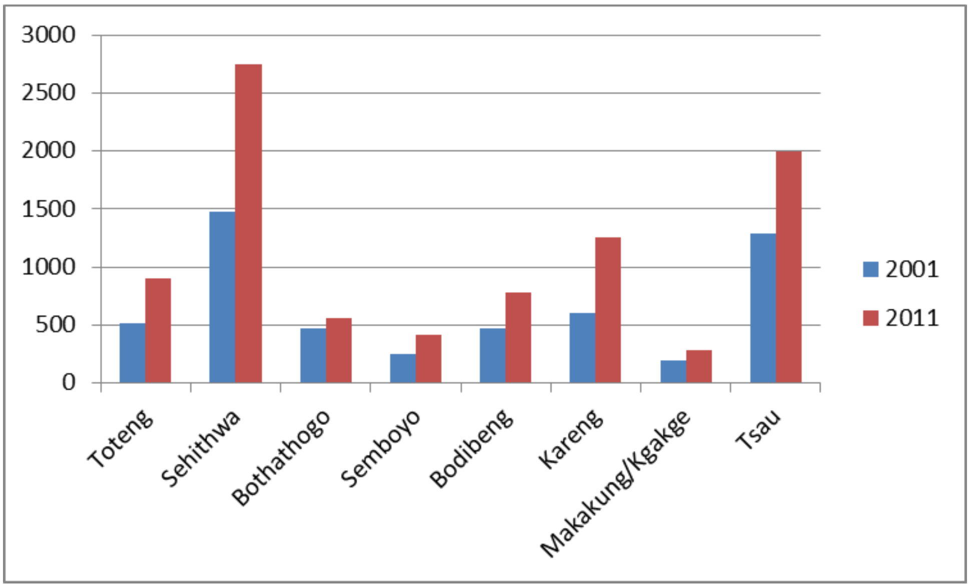


Figure 19 Population Figures for the Lake Ngami settlements 2001 and 2011

Kareng, Makakung, Komana, Semboyo, and Tsau had average household sizes of more than 5 persons in 2011.

Many of the Hainaveld farms are owned by absentee landlords who reside in Maun, and surrounding villages, or other areas of Botswana as well as from further afield such as the USA. From the 2013 agricultural survey, 67 of the 120 farms (recorded) were surveyed and a total of 114 workers were reported to be residing on those farms. Of which 106 were male and only 8 were females. Of the 114, 58 were never married and 52 were either married or living with their partner. This indicates that approximately 45.6 percent could be residing on the farms with their families.

4.3 Education

The table below demonstrates the school attendance record for Nxaunxau village within the NG2 area during the 2011 Census. This is a good rate of attendance considering the village has a total of 227 children that are school going age. This is an 82.82 percent attendance by the children in the village. The literacy level for Ngamiland West, of which Nxaunxau is part, is 80.2 percent (of which 80.6 males are literate and 79.9 percent of females are literate). This is less than the national average of 86.5 percent (85.7 and 87.3 percent for male and females respectfully) (CSO, literacy survey, 2014).

Table 11 School attendance in the NG2 area

	Nxaunxau	
	M	F
At school	77	105
Left school	1	1
Never attended	3	1
Total	81	107

The table below demonstrates the school attendance record for the villages within the Lake Ngami Area. The literacy levels for 2014 show that Ngamiland East SubDistrict (of which the Lake Ngami area is part of) has higher literacy levels than Ngamiland West Sub-District. This is an overall literacy rate of 87.1 percent (83.9 percent for males and 90.1 percent for females). The table below shows a high number that have never attended school throughout all the Lake Ngami villages.

Table 12 School attendance in the Lake Ngami Area

	Toteng		**Sehithwa**		**Bothathogo**		**Semboyo**		**Bodibeng**		**Kareng**		**Makakung/ Kgakge**		**Tsau**	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
At school	148	142	591	624	103	94	98	62	97	117	348	305	42	46	376	418

Left school	177	183	421	571	87	111	59	79	126	185	131	197	48	50	343	389
Never attended	89	108	212	199	69	56	43	55	85	108	107	113	39	37	151	216

Of the 114 farm workers within the Hainaveld TGLP, 39 workers had completed primary school and 33 had completed secondary school, but 42 had never been to school, which equate to 36.8 percent of the farmer workers (Annual Agricultural Survey Report, 2013).

Within Somelo, 37.5 percent of the population have not attended school, with only 29 percent reaching primary school and 25.6 percent reaching lower secondary school. Only 6.5 percent have reached upper secondary and a very low 1.1 percent has gone further than secondary school. However, it is encouraging that 94.8 percent of children from Somelo (6 -17 years) are currently attending school (KCM, 2015).

4.4 Dominant Languages and Ethnicity

The table below shows the language distribution within Nxaunxau from the 2011 Census. The dominant language is Setswana but is closely followed by Sesarwa and Sembukushu speakers who make up 31.36% and 29.31% respectively. Only 5.66% of the community speak Seherero and there is approximately 1.02% of the population speaking other languages. This shows that the community is quite mixed with no one particular dominant language. This was evident in the FGD as multiple languages were being spoken and interchanged. It is common in Nxaunxau for people to speak multiple languages which helps with the community cohesion and integration, which was shown to be strong during the FGD.

Table 13 Language distribution within Nxaunxau

Language	Percentage using as a first language
Setswana	32.65 %
Sesarwa	31.36 %
Sembukushu	29.31 %
Seherero	5.66 %
Other languages	1.02 %

Source: CSO, 2011

A wide range of languages are used in the Lake Ngami area. The dominant languages however are Setswana and Seherero. Within the Lake Ngami Villages, Bothothogo has the most mixed group of languages with little difference between the dominant language of Seherero (34.81%) and the other key languages of Setswana and Sekgalagadi (27.12% and 25.77% respectively). Semboyo and Tsau (the furthest away from the lake area) are the least diverse in regards to language and ethnicity. The languages directly link to the ethnicities that are found in the Lake Ngami area. These include the Herero, Kgalagadi, Basarwa, Humbukushu, Kalanga, Bayei and the Batswana.

The languages within the Hainaveld TLGP areas that are thought to be present include Setswana, Seherero, Sekgalakgadi, Afrikaans and English. It is unknown the percentage breakdown of each language but it is expected that the majority will understand and speak Setswana as a minimum.

4.5 Infrastructure and Services

Infrastructure and services are limited in NG2 due to its relatively remote location, an example of this is that Chukumuchu and Nxaunxau villages are 121 and 102 kilometres away, respectively, from a major hospital (in Gumare). This poses serious health concerns and presents a major challenge to the very sick people who need immediate medical attention in times of emergency. Both villages are yet to be connected to the main grid yet. In addition, in terms of services related to livestock management and sales, these are only found in Gumare, over 100 kilometres from Nxaunxau village. This restricts the day to day activities of livestock farmers in the NG2 area, especially when it comes to treating and vaccinating, and selling livestock.

The table below presents the infrastructure and services that are available in Nxaunxau village.

Table 14 Infrastructure and Services in NG2

Facility	**Nxaunxau Village**
Schools	One Primary school with boarding facilities
Health Services	One Health post
Roads	120km gravel road to the main road to Gumare.
Water supply	Most water is accessed from communal taps and then boreholes. A few households access water from piped indoor and outside water. A few are depending on wells for drinking water too.
Source of fuel for cooking	The major source of fuel for cooking is firewood. There are very few people who use gas and electricity for cooking.
Source of fuel for heating	The predominant source of fuel for heating is firewood.
Source of fuel for lighting	The main source of fuel for lighting is paraffin, with a few people using wood and candles for lighting. Very few have access to electricity for lighting. Not connected to the main grid.
Communications	There is cell phone reception in the village (Be Mobile and Orange). There are no landline phones and therefore no fax machine available. Faxes are sent to Gumare and delivered to Nxaunxau when possible.
Veterinary Services	None – nearest is in Gumare
Police Services	Police post at the Kgotla but the nearest Police Station is at Gumare.
Livestock Advisory Centre (LAC) / Botswana Agricultural Marketing Board (BAMB)	The nearest centre is in Gumare.

Infrastructure in the Lake Ngami area is increasingly well developed with the villages of Sehithwa and Toteng providing services to the surrounding villages. Although Bodibeng is accessible along the tarred Maun – Ghanzi road and Bothothogo is accessible via a well maintained gravel road that links Toteng with Bodibeng on the eastern side of the lake, the flooding of Lake Ngami has cut the direct access routes to Sehithwa from these villages and resulted in a long detour around the Lake. With the relative proximity to Maun access to health facilities is within reach, although this is hindered by poor public transport networks. Some villages are connected to the main electric grid where as some just have limited connectivity. Others are not connected at all.

Plate 12 Flooded road across Lake Ngami

The main Veterinary Services and BAMB are accessed in Sehithwa and now due to the limited access this will impact on access to these services.

Following the bankruptcy of DML Boseto Mine and all related infrastructure was bought by Khoemacau Copper Mine. This includes Toteng Housing Estate that was developed by DML on the eastern edge of Toteng Village and is accessed off the main Maun-Toteng road by means of a short calcrete road. The facility is fenced and covers 850ha. Roads are well maintained and services continue to be upgraded.

Table 15 Boseto Mine‘s Housing Estate at Toteng

Details	**2011 EMP**	**Actual**	**Proposed (1-5 years)**	**Proposed (10 years)**

Single family residential plots	370	53 (2 per house) = 106 people	Approx. 150 (3 per house) = 450 people	Approx. 250 (3 per house) = 750 people
Multi residential plots (single quarters)	20	6 main single (300 people) Parkhome incl.	100 people	100 people
Civic/community plots	4	4	4	4
Commercial plots	3	3	3	3
Open spaces	Various	Various	Various	Various
Estimated population	1,672	Approx. 390	Approx. 550	Approx. 850
Water consumption (l/day)	220,500**	100,000***	130,000***	190,000***
Electricity demand	BPC supply*+ generator	BPC supply* + generator	BPC supply* + generator	BPC supply* + generator
Sewerage treatment capacity (l/day)	176,400	90,000 (450 people)	2 units of 90,000	2 units of 90,000

* The existing supply is backed up by generators, as BPC supplies 375kVA at the moment which could increase in the future
** Assumed water demand of 138litres per person per day
*** Assumed water demand of 220litres per person per day

(From Biotrack Botswana, 2013)

The Villages around Lake Ngami are well serviced as Table 16 below shows.

There are no tar roads within the Hainaveld farming block due to the land being primarily farm land without villages or large settlements residing in the area. Therefore, the roads are sand roads that follow fence lines or lead to relevant infrastructure (kraals, handling facilities, boreholes etc.). Farmers are required in some cases to travel through neighbouring farms to reach their own farm, although the main routes through the Hainaveld tend to follow corridors between Farms that also serve as firebreaks.

Prospecting and mining activities while potentially impacting upon the Farm_s overall grazing area and groundwater quality and quantity on the one hand, have led to an improvement of the road infrastructure on the other. Access to the Remote Area Development Village (RADV) at Somelo was for example improved by DML‘s mining operations. Some Farms are still relatively inaccessible, particularly those along the Kuke fence, which impacts heavily upon the sale and marketing of domestic or wild stock and the costs of running livestock or game ranches. Those running the latter have often developed airstrips and fly tourists in rather than drive.

	Sehitwa	**Toteng**	**Kareng**	**Bodibeng**	**Legothwana**	**Bothatogo**	**Semboyo**	**Kgakge/Makakung**	**Tsau**
Access	Located at junction of the Maun – Ghanzi (A3) and Maun-Shakawe roads	90kms from Maun and 30km from Sehitwa	Gravel road from the A3, about 45kms SW of Sehitwa	Tarred road from the A3, 20kms from Sehitwa.	Gravel road 10kms SW of Toteng, 20kms NE of Sehitwa on A3	Gravel road 10kms from Sehitwa (currently flooded)	Gravel roads	Gravel roads	Tar road (Along Sehitwa – Shakawe road)
Roads	Network of gravel roads	Poorly developed roads	Gravel roads	Road to Sehitwa currently flooded by Lake	Network of undeveloped roads	No developed roads	Gravel roads	Gravel roads	Network of gravel roads
Water supply	Supplied by Maun Council through the water unit. Standpipes located throughout the village	Supplied by Maun Council through the water unit. Standpipes located throughout the village	Supplied by Maun Council through the water unit through communal taps.	Maun Council (Water Unit)	Maun Council (Water Unit)	Maun Council (Water Unit) – standpipes throughout Village	Maun Council (Water Unit) – standpipes throughout Village	Maun Council (Water Unit) – standpipes throughout Village	Maun Council (Water Unit) – standpipes throughout Village
Electricity	Electrified but few connections	Electrified but few connections	Electrified but few connections	No	No	No. Some solar powered street lights	No – some solar powered lights	Government offices are connected to the grid – some solar powered lights	Government offices are connected to the grid – some solar powered lights

Schools	Pre-school, primary school and junior secondary	Primary School	Primary School with boarding facilities which also provides nonformal education	Primary School and non-formal education	Primary School	Primary School	Primary School	Primary school	Primary school

	Sehitwa	**Toteng**	**Kareng**	**Bodibeng**	**Legothwana**	**Bothatogo**	**Semboyo**	**Kgakge/Makakung**	**Tsau**
Police	Station	Police Office	Police Office	No (Relies on Sehitwa)	No (relies on Toteng)	No	No	No	Police Office
Health	Clinic	Health Post	Clinic	Mobile Clinic	Mobile Clinic	Clinic	Clinic	Clinic	Clinic
Other	Post Office, station, One operating guest house, three general dealers	Three general dealers and a guest house (self-catering chalets)	Post Office , Five street vendors and a tuck shop	Relies on Sehitwa for many services	Number of street vendors	Number of street vendors	Street vendors	Street vendors	Street vendors

Table 16 Infrastructure provision in the area

(Adapted from Ecosurv, 2013)

4.6 Household Sanitation and Potable Water

In NG2, only 21 percent of the Nxaunxau community have access to sanitation facilities. Most the Nxanxau community rely on communal taps (53%) and boreholes (21.6%) for access to potable water. Water quality in Nxaunxau was reported to not be good for human consumption although they have limited other options. A few members of the community try and harvest water from roofs but this is not common due to most of the roofs being thatched with grass.

Many people rely upon water from the Lake itself for drinking water while some have drilled boreholes on their homesteads (and kraals) that surround the Lake. Within the Sehithwa area people draw water from stand pipes for their own drinking purposes. At the cattle posts further away from Sehithwa, they collect water from the village due to the water quality being too salty.

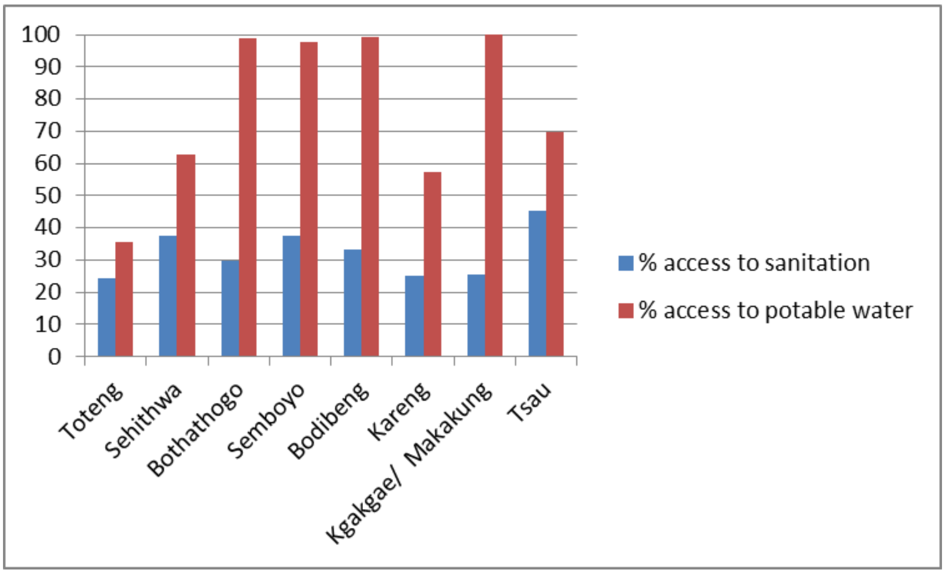


Figure 20 Access to Potable water and Sanitary toilets for Lake Ngami area Villages

The Hainaveld Farms typically have pit latrines. Some Farms have very modern housing and facilities, although all water is from boreholes and rainwater harvesting systems.

4.7 Energy Sources

Ninety per cent of the population in NG2 use firewood for cooking purposes. Everyone in Nxaunxau uses firewood for heating. 51 percent use paraffin for lighting, 21.5 percent use candle and another 21.5 percent use wood for lighting. There is certainly an interest in solar power to be used at cattle posts for pumping water but there is a lack of knowhow and finance to cover the investment costs, therefore it is not common in the area to use solar energy for pumping water or lighting.

The main energy sources for cooking in the Lake Ngami area is primarily wood followed by Gas (LPG) with approximately 75% of the population relying on wood as a source of energy for cooking. In addition, wood is the main source of energy for heating. A range of electricity, candles, solar, petrol / diesel and paraffin are used for lighting in the Lake Ngami villages. Electrification of the district is ongoing, with new powerlines planned between Ghanzi to Sehitwa and on up to Shakawe, adjacent to the existing roads.

On the Hainaveld Farms the main energy sources are unknown but from previous studies it is shown that diesel engines are the most popular source of energy for pumping water. It is anticipated that most farms will use firewood for cooking. Game farmers and wealthier farmers have invested in solar panels for pumping water, and supplying light in houses and lodges.

4.8 Main Livelihoods

The main livelihoods in the area are subsistence pastoral farming, arable farming, gathering of veld products and other employment in the area.

4.8.1 Pastoral farming

The main livelihood in NG2, Lake Ngami and the Hainaveld Farms is pastoral farming. The main livestock that are kept include cattle, goats, sheep and poultry. Cattle are kept for milk and for selling for to the abattoirs and local butcheries to obtain a source of income to purchase household items, school fees, herder salaries and inputs to the animal husbandry (such as lick, vaccines etc.) and other emergencies that may arise. The cattle are also valued for the milk that they produce as a source of protein while at the cattle posts. Cattle are socially and culturally entwined in the people‘s lives.

In a good rainfall year in NG2 seasonal pans can hold water all the year round, with wells and boreholes also used. The use of handwells in NG2 was quite common and this limited the amount of water cattle are able to access per day and also put the animals under a lot of stress, especially in the dry season – when they were more susceptible to mogau.

Since Lake Ngami has held water there has clearly been a proliferation of kraals that now encircle the Lake. The density is such that tracks connect one homestead/kraal to another with nothing but bare ground and thorn bushes in between. It is a complex mosaic in terms of the distribution and make-up of livestock owning families and one that will not be easy to galvanise some king of community cohesion or agreement over a controlled grazing/stocking regime.

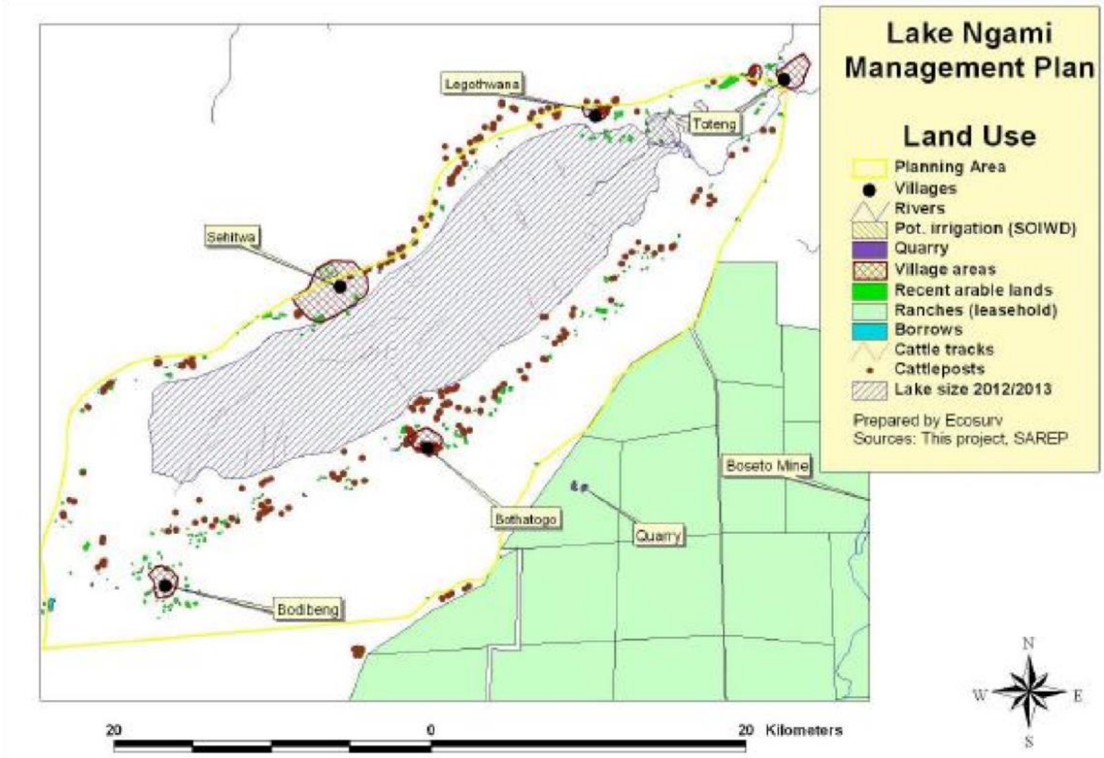


Figure 21 Kraals encircling Lake Ngami
(From Ecosurv, 2013)

4.8.2 Arable farming

In NG2, Lake Ngami and the Hainaveld Farms arable farming if practiced at all is carried out on a small subsistence scale. In the Lake Ngami area some families practice only arable farming (Ecosurv, 2013). Ecosurv (2013) point out that arable lands appear to be expanding along the south eastern margin in response to improved soil moisture conditions. However, in Legotwana and Sehitwa, fields have been flooded and are threatened by further flooding should the lake level continue to rise.

Arable farming is an important subsistence activity throughout Ngamiland District with the Integrated Support Programme for Arable Agriculture Development (ISPAAD) providing a number of incentives for farmers to engage in cropping. The components of ISPAAD include: Provision of Draught Power, Potable Water, Seeds, Fertilizers and Herbicides, Facilitation of access to Credit and Fencing and Establishment of Agricultural Service Centres. Subsistence farmers are able to cultivate up to a maximum of 16ha, emerging farmers more than 16ha up to 150ha and commercial farmers over 150ha. Private contractors are made available at the following rates:-

The rates for ploughing row planting operations are as follows:- Ploughing
and row planting P800.00/ha
Minimum tillage P500.00/ha
Harrowing (where applicable) P360.00/ha

Cluster fencing up to P200,000 and individual fencing up to P70,000 is catered for.

The number of ISPAAD beneficiaries was 96,000 in 2008/09 when ISPAAD started and increased to 118,000 in 2010/11 (BCA, 2012). The area planted was 298,000 ha in 2008/09 when ISPAAD started and rose to 377,000 ha in 2010/11 (BCA, 2012).

The primary objectives of ISPAAD are to increase grain production; promote food security at household and national level; commercialise agriculture through mechanisation; facilitate access to farm inputs and credit; and improve extension outreach. However, it is also important to see how these subsidies may be interpreted by some as one of the few ways to generate significant cash income in rural areas. It is clearly critical that areas allocated for subsistence and commercial fields do not encompass areas of high biodiversity or NTFPs with ISPAAD triggering a new cycle of land clearance, potentially of valuable habitats such as riparian woodlands.

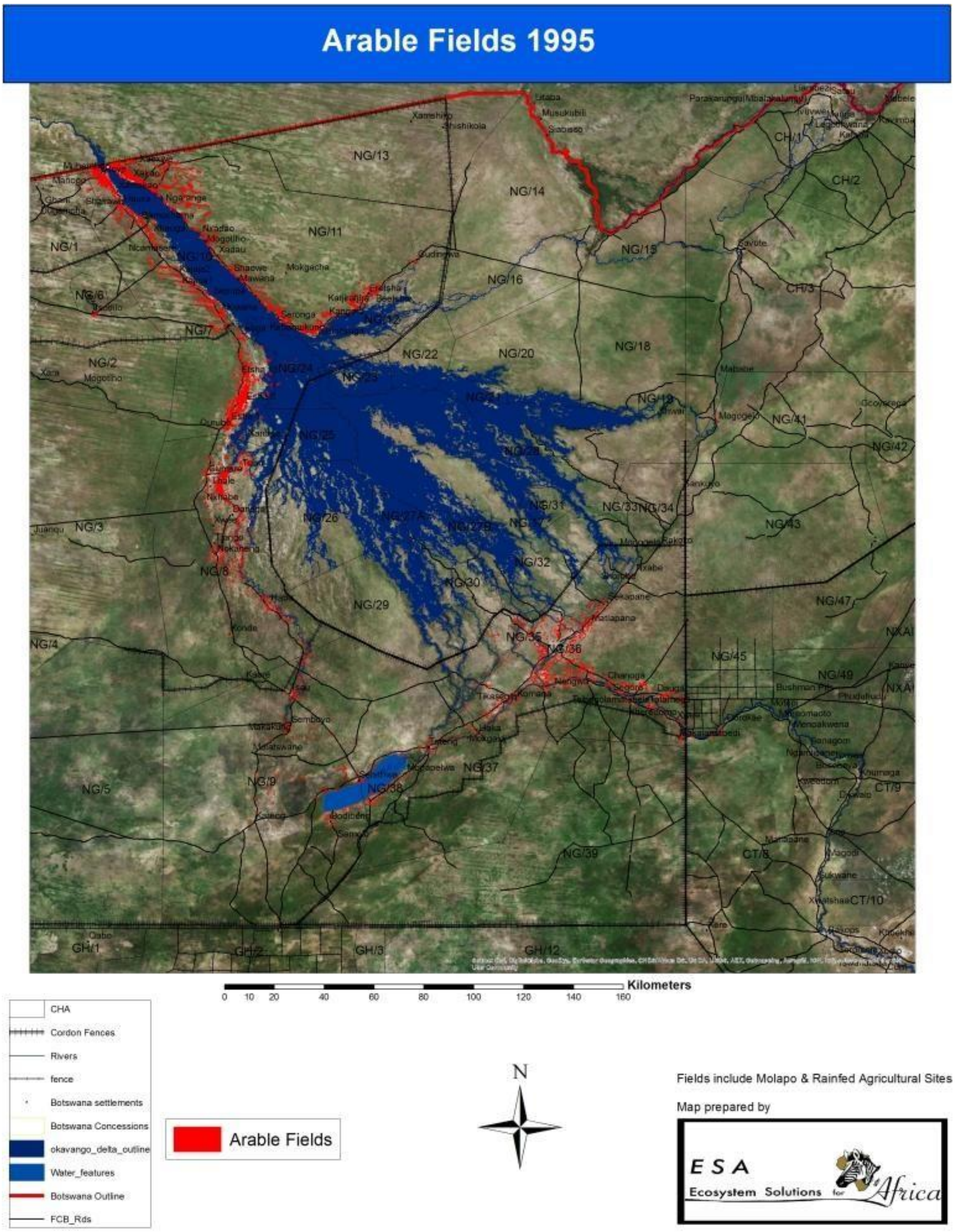


Figure 22 Extent of molapo and rainfed agriculture in ODRS

Arable fields are clearly evident as a ribbon type development along the Panhandle and often involve the highly damaging clearance of riparian woodland. Major problems with all field crops in the ODRS include raiding by elephants, hippos and cattle especially during the dry season with evidence that the incidence of crop raiding increasing especially during the dry season (SAIEA, 2012). The location of arable farming all along the edge of the Panhandle and western side of the Okavango Delta poses a major challenge to efforts to connect wildlife populations in the Delta with western Ngamiland.

4.8.3 Veld food and resources

Veld products are especially berries are gathered in most parts of the year and the most common are wild morogo (wild vegetable), morama, moretlwa, motsotsojane, mmupudu, mogorogorwana, mokgompata, mahupu, mokokose, mhamang (Botswana Vulnerability Assessment Committee, 2010).

4.8.4 Fishing

Subsistence fishing is practices by some of Bayei and Hambakushu in the communities close to Lake Ngami (Ecosurv, 2013). The latter report details how the uncontrolled nature of commercial fishing, typically undertaken by people from outside of the area, led to a great variety of negative environmental impacts and ultimately a fishing ban. The latter remains in place and has proven controversial, but the rubbish and discarded fishing nets that were associated with the temporary fishing camps are still visible in the Lake bed, as the burn scars from uncontrolled fires. While fishing is clearly an opportunity and an important source of protein the impacts associated with it and detailed in the Lake Ngami Management Plan (Ecosurv, 2013) must be controlled – the latter report points out that locals around Lake Ngami face a significant challenge posed by refugees from Dukwi camp and from residents of other villages in the district, who come in and camp, and practice commercial fishing in the lake.

4.8.5 Game Ranching

Game ranching is becoming increasingly important in the Hainaveld Ranch block with many of the southernmost tier of ranches, those just above the Kuke Fence, converting from livestock to game (See Figure 23). Some game ranches have also assimilated other ranches into bigger 10,000 – 15,000 hectare operations. A few ranches run both game and cattle although there are reports from game ranchers that the DWNP has requested that they choose one or the other resource.

Rare antelope species such as roan, sable and tsessebe are not found on the Hainaveld Farms, due to disease control movement restrictions, even though they could survive there. BWPA (2005) point out that insufficient bulk grazers is a common problem on game ranches, due primarily to the exclusion of buffalo due to FMD restrictions. Game ranches are usually stocked with a variety of game. Bulk feeders feed on coarse and tall grasses, which are mostly ignored by the selective grazers. When these coarse grasses are not regularly removed, they will become moribund and form dense stands, which are not utilised and become a fire-hazard. A widely accepted recommendation in southern Africa is to stock an equal amount (LSU) of bulk grazers and selective grazers. BWPA (2005) recommends that in such cases, zebra, or even cattle, can be substituted as bulk grazers.

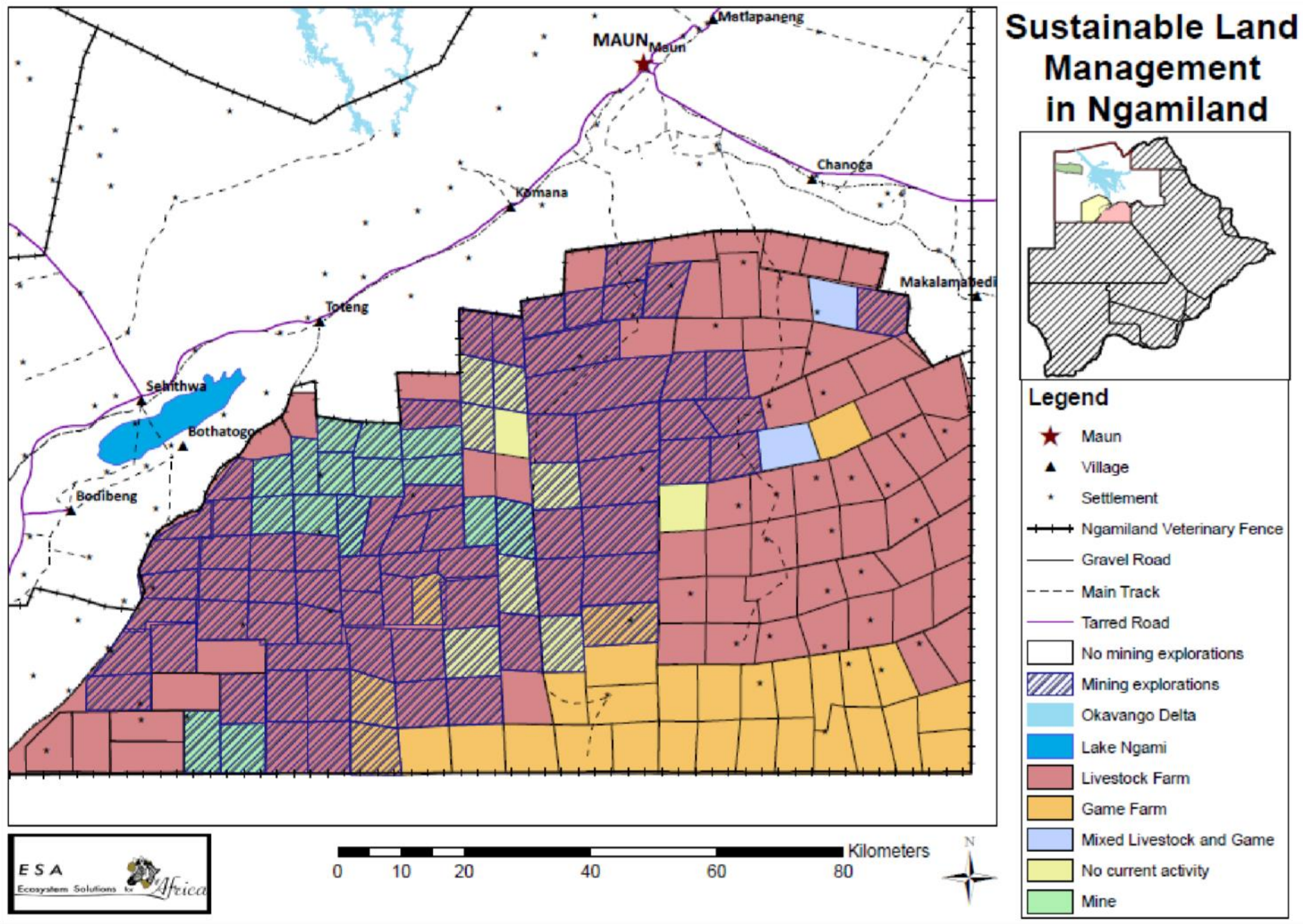


Figure 23 Use of some of the Hainaveld Farms

4.8.6 Mining

As emphasised under the legislation chapter the subsurface is the dominant estate in Botswana and the concerns and wishes of the surface operators tend to be of secondary in importance to the ‗reasonable' production needs of the subsurface lessee. Large areas of Ngamiland are currently held as Prospecting Licences by various Mining Companies, who in many respects are waiting for commodity prices to rise before developing Mines. Extensive areas of NG2 would be potentially affected by the mining of iron ore at Shakawe – under prospecting licences currently held by Tsodilo Resources (Pty) Ltd.

The Copper/Silver mine at Boseto, 45kms from Lake Ngami, operated from 2010 – 2014 and employed a number of people from the local villages. The closure of the Mine in 2014 due to financial troubles has undoubtedly caused much hardship in the area. Khoemacau Mine has acquired Boseto Mine and is developing a Mining Plan with the intention of re-opening Boseto Mine and extending mining activities to its adjacent concessions. It is clear that many people are now wary and even disillusioned with the mining sector with many Farmers uneasy as to whether or not they will lose some or all of their Farms to mining in the future.

4.8.7 Other Employment

Many cattlepost and ranch owners are absentee managers and visit at weekends or the end of the month. It is difficult to generalise but many Ranchers run other businesses in Maun or other settlements or may work for Government or the BDF.

4.9 Grazing patterns and herding

The ‗cattlepost system' which dominates NG2, Lake Ngami and many Hainaveld Farms comprises a borehole (linked to a pump, storage tank and water trough), kraalsfenced or thorn bush enclosures where the cattle are kept at night, and often adjoining, the huts of herders and cattlepost residents. The cattlepost system displays a uniform rhythm of night kraaling, and release in the morning following milking, with the herd returning to the borehole in the late afternoon. It is a remarkably simple system, with routine herding confined to the collection and kraaling of animals around the waterpoint at dusk, and their subsequent release in the morning, in a daily cycle that is clearly adapted to avoid working in the extreme heat of the Kalahari days, and is more generally based upon the minimum expenditure of energy (Abel et al, 1987). Importantly, there is no perimeter or internal fencing.

There are no rules of grazing in the NG2 area around Nxaunxau. Cattle roam freely and come and go from the kraals at their own will. Livestock are not herded but ‗herd boys' are responsible for collecting cattle should they not come back to the kraal. However, due to financial constraints some people are struggling to pay salaries and therefore they do not have anyone to look after cattle anymore.

The grazing land is thought to be in good condition although the grazing towards Tsodilo is not good and there is thought to be more disease that side. It was said that the cattle do not ‗know drought'. However, the whole of the area has the plant ‗Mogau' which is poisonous to cattle if they drink water after eating it.

Livestock are drawn to Lake Ngami and can become entrapped in the soft sediments around the Lake. Before the Lake filled the boreholes and kraals were located in the dry Lake bed, but today they form a ring around the entire Lake at a distance of 1km or more from it. In June 2016 it was evident that heavy stocking rates had removed all the available forage.

The way the livestock farmers manage their grazing on the Hainaveld Farms varies significantly. Where there are no perimeter fences the cattle roam freely and only return for water (similar to the systems in the communal areas). However, during the rainy period, seasonal pans are used for livestock watering and therefore grazing around these pans will be more common during the wet season. The areas around the boreholes will be used for the dry season grazing.

Herding again does not exist in the conventional sense of the word, but herders are used for ensure cattle are watered and they are responsible for gathering cattle when required (e.g. vaccinations, selling, branding, castrating etc.). Herders also keep track of the cattle to ensure cattle are not lost. If any are missing, it is the herder's responsibility to go and find them.

4.9.1 Fences

All the CBPP fences, the Kuke fence and the Northern Protection Zone fence had been damaged by elephants. The Kuke fence was effectively down from Tsau Gate to 15kms eastwards, with damage patchy thereafter.

4.10 Markets

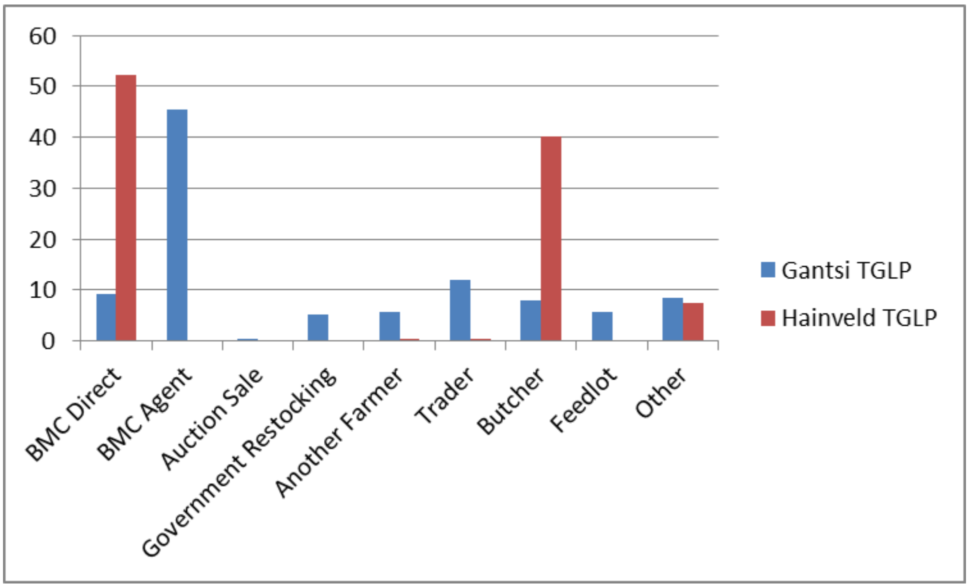
Farmers sell to the following outlets:

Botswana Meat Commission: This is the point of choice for most farmers. The Botswana Meat Commission has an abattoir in Maun. Cattle are sold here through various means. BMC is currently selling locally throughout Botswana. Meat is deboned and transported into the green zone like Lobatse and Gaborone. Farmers are responsible for finding their own means of transport. BMC to not take bookings from communal areas or farmers in the communal areas. Instead, BMC set quotas per area and have a schedule of where they are buying each month / week. The quotas are communicated to the villages in advance and through a Kgotla meeting the quota is divided up between the various families that would like to sell. Due to the very large rotation, buying is estimated to be on an annual basis from any one village / area. BMC does however allow farmers in the Hainaveld to apply for a quota. BMC had been buying from the Hainaveld and selling cattle to Zimbabwe but now since the FMD outbreak the market has been lost. BMC is working on finding alternative export markets to reinstate the kind of arrangement.

Ngamiland Abattoir: This is located between Komana village and Sitatunga area outside Maun. This is a private abattoir that has previously obtained an export permit and sold to DRC. At the time of the last interview with the abattoir they were waiting for the renewal of their export permit to be approved. They had been exporting to the DRC. They pay Farmers immediately, so they do not have to wait the 4-5 months for payment as they do for BMC. The abattoir has an open booking system, where by farmers come and _book‘ through completing a form which specifies their name contact details and numbers wanting to sell. They are then added to a systematic waiting list that they work through daily. They sometimes make allowances for emergencies. Trekking the animals to the abattoir is not allowed. The Farmers must find their own means of transport. Ngamiland abattoir has a capacity of 150/day. Ngamiland abattoir buys meat mainly from the communal areas rather than the Hainaveld Farms, who tend to sell to BMC.

Butcheries are located in some of the bigger villages, as well as Maun. Prices paid in the butchers are often low but are used when there is an emergency and the farmers need cash quickly. The challenge for the farmers is paying the transport, slaughter fee and receiving a low payment from the butcheries. It is not a preferred market to sell to.

Figure 24 Sales Avenues for Hainaveld Farmers



The cumulative effect of arable agriculture, settlements and infrastructure is to effectively disconnect the Okavango Delta wildlife system, from that of western Ngamiland.

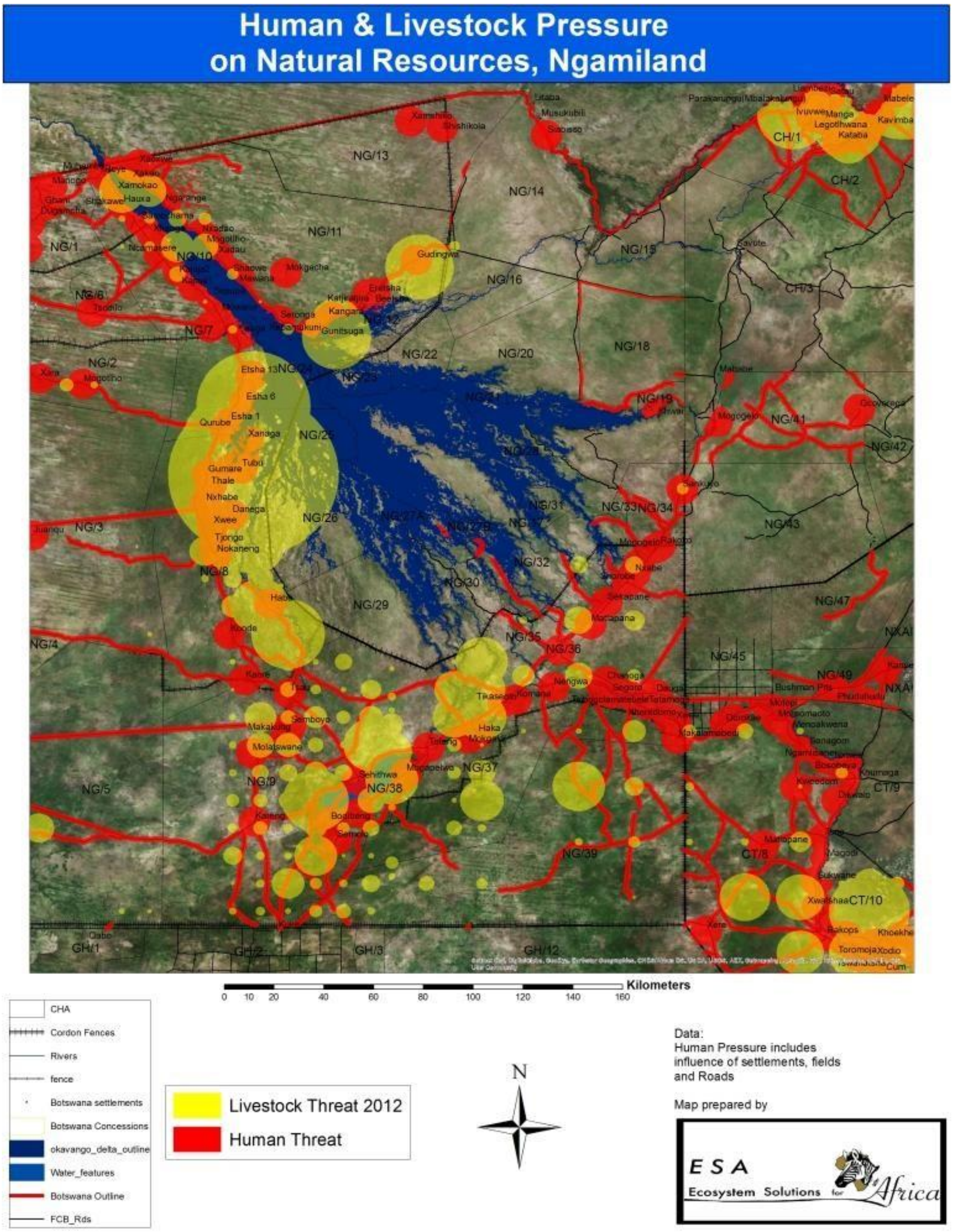


Figure 25 Human and Livestock Pressure

5 REMOTE SENSING ANALYSIS

This chapter utilises remotely sensed techniques, namely an analysis of NDVI at the broad District level. This analysis enables some link to be made between the range degradation processes and their spatial extent in Ngamiland.

5.1 Range degradation

The idea of land degradation cannot be separated from that of sustainability. A form of land use is sustainable if it can continue indefinitely, and sustainability therefore depends on properties both of the resource and the way it is managed. The quality in a resource that renders its use sustainable is its resilience, which may be defined as the ability of the ecosystem to recover from perturbation (e.g. extreme seasonal and cyclic variation in rainfall) or a change in land use. The bigger the shock absorbed, the greater the resilience. A recurrent shock in dry lands is drought, and it is usually drought that brings land degradation or desertification to notice. The anxiety behind rangeland ecology is that the resilience of semi-arid areas is being damaged, to the extent that land use systems may be unsustainable, and if stressed may collapse.

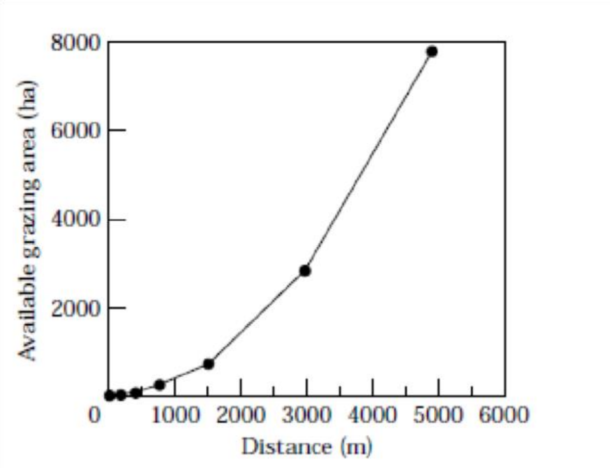
Criteria which are commonly taken to be indicative of rangeland degradation are:-
(i) increases in the amount of bare ground and weeds,
(ii) loss of palatable perennial grasses such as *Anthephora pubescens* and *Brachiaria nigropedata*, and increases in weeds and unpalatable species,
(iii) increase in invasive and problem species (e.g. *Dichapetalum cymosum, Pavetta harborii, Urginea sanguine* and *Cenchrus biflorus*),
(iv) bush encroachment or thickening – involving a range of species, but in particular *Dichrostachys cinerea* and *Acacia mellifera*.

5.1.1 Piosphere Effect

Livestock grazing in semi-arid savannas is dependent upon access to surface water, the so-called _piosphere effect' (Lange, 1969), which dictates that impacts are greatest at the waterpoint itself and decrease rapidly with increasing distance into the surrounding rangeland (Andrew, 1988) (Figure 26 and 27). Regular patterns of impact therefore emerge over time, and are spatially manifested as distinct zones which surround each borehole and differ significantly in both vegetation composition and structure (Perkins and Thomas, 1993ab).

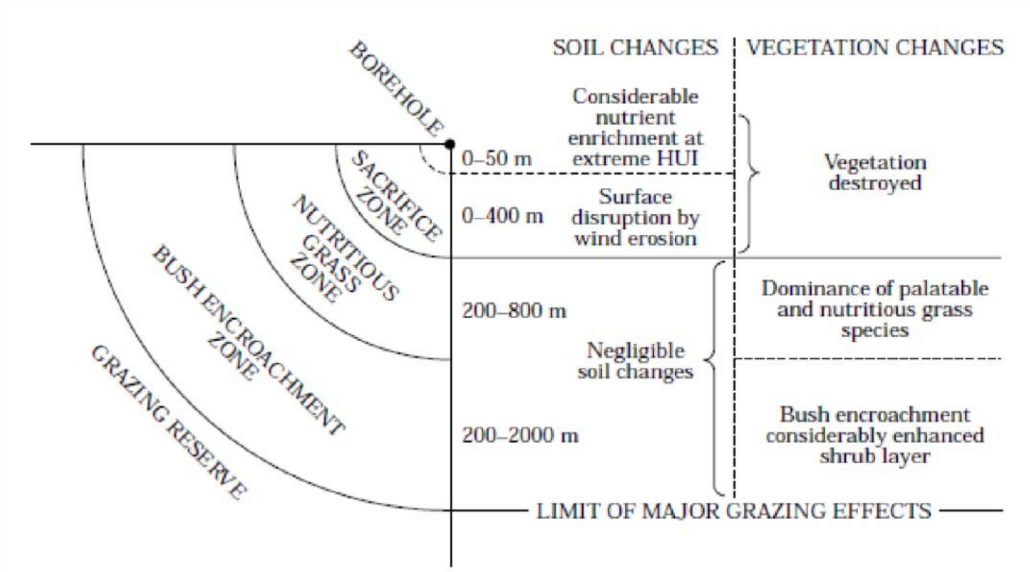
The piosphere or grazing gradient approach has formed the basis for all ground based rangeland monitoring in Botswana (GRM, 1986). Without exception the area immediately around the waterpoint experiences heavy trampling and grazing pressure and appears as open expanse of bare ground. Wind-blown sand creates the impression of a devastated area, with Stoddart et al's (1975) concept of a _sacrifice zone' appearing particularly relevant, as recovery of the vegetation seems unlikely. Beyond this zone, the dominant process is that of bush encroachment, which quite simply results in an increase in shrub cover and/or density at the expense of the grass layer. If borehole density increases, or the boreholes are heavily stocked for several decades, the grazing reserve can become entirely encroached with thick bush.

Figure 26 Relationship between distance and available grazing



(From Perkins, 1996; p.508).

Figure 27 Piosphere zones



(From Perkins, 1996; p.507)

The establishment of piospheres in the Kalahari has been modelled in the eastern (Duraiappah and Perkins, 1999) and southern (Jeltsch *et al*, 1997) Kalahari, the latter showing similar results to Perkins and Thomas (1993ab), despite the fact that the observed pattern formation was not an initial input into the simulation model. The piosphere or grazing gradient approach forms the basis of attempts to establish trends in the state of arid and semi-arid rangelands in Australia, particularly through its utility in enabling short-term rainfall variability led or natural changes to be separated from domestic grazing effects (Pickup et al, 1998; Pickup and Chewings, 1988).

An assessment of the spatial extent of these areas follows using remotely sensed and field based data.

5.2 Remote Sensing Analysis

In more homogeneously vegetated ecosystems such as forests and prairies, remote sensing techniques such as the normalised difference vegetation index (NDVI) provide useful broad-scale information on vegetation quality and quantity (Kastens and Legates 2002, Hansen & DeFries 2004). However, savanna rangelands are highly variable landscapes that can range from open grassland through dense scrub to woodlands. As gradient landscapes, savannas present a challenge to identifying what proportion of the landscape‘s primary productivity is from the herbaceous layer, and what from wood plants (Gibbes et al, 2013). Savannas combine grasslands, shrublands and woodlands, and each of these structural types has a unique NDVI signature, that not only varies seasonally, but also varies depending on the proportional combination of each of these structural elements in the landscape. In the wet season it is not possible to tell if the NDVI is measuring the productivity of grasses or of dry species, and indeed, a dense, encroached thicket of shrub species may have as high an NDVI signal as grasses, yet clearly these species are of very different utility in rangelands. Similarly, in the dry season both grasses and (later) most savanna trees stop photosynthesising altogether, and the amount of grassland can still not be captured.

In order to understand exactly what NDVI is measuring in rangelands, it is important to identify the relationship between primary productivity (especially as measured by NDVI) and vegetation structure in savannas, since this relationship is not likely to be linear. Knowing what proportion of a savanna rangeland is grassland is important for planning stocking rates, and especially where applied over larger areas, can help collective decision-making in collaborative grazing (Fynn and O‘Connor 2000) in any given year. In addition, managing rangeland involves in large part the challenge of controlling bush encroachment, and the ability to monitor and track changes in the ratio of grass to woody biomass composition over large areas in the long term is critical to sustainable rangeland practices.

5.2.1 Land Cover Categories in the Focal Areas

Categorical land cover information was derived from a Botswana national land cover classification carried out by the University of Botswana‘s Okavango Research Institute (ORI). This classification was based on 2006 Landsat TM5 imagery, with 9 generalised classes.

Although the land cover classification maps are based on 2006 imagery, they provide a useful template to begin the analysis of the kinds and distribution of different land cover types across the three focal areas. In Hainaveld, for example, dense and moderate woodland covers only about 40% of the area, as compared to the Lake Ngami and NG2 focal areas. When looking at degraded areas, the classification suggests that already in 2006, some 32.5 % of the Hainaveld could already be considered degraded. For the broader Lake Ngami area a corresponding extent of about 26.8 % of the focal area was mapped as degraded at 2006. NG2 had the lowest proportion of its landscape mapped as degraded at 21.9 %. These differences can in part be attributed to underlying ecological conditions such as rainfall, but variation in stocking rates will also likely have had an effect.

Table 17 Association of the ORI Botswana land classification map categories to the three broad vegetation associations relating to rangeland quality used in this study

1 7 8	Dark soils including pan grasslands Very sparsely vegetated and bare soil areas, incl burn scars Fields (lands areas)	Mainly grassland
2 6	Dense mainly broadleaved savanna woodland Dense mixed savanna including bush encroachment	Mainly shrub or woody species
3 4	Moderate mainly broadleaved savanna woodland Sparse mixed savanna woodland and grassland	Mixed grassland / woodland
5 9	Floodplains and bare soils, including degraded areas Flooded areas, hills and dark soils	Not rangeland

Although the classification approach recorded higher proportions of mainly shrub woodland than did the seasonal difference approach, there is general accordance between the land cover classification (as grouped in Table 17 above) and the amount of ‗mainly grassland' identified by calculating seasonal difference in NDVI for 2006 (see Table 18 below). At that time, Hainaveld had the highest proportion of its landscape as mainly grassland, while NG2 had the smallest proportion.

Table 18 Comparison of ORI 2006 classes and calculated proportions for different vegetation groups based on 2006 seasonal NDVI differences

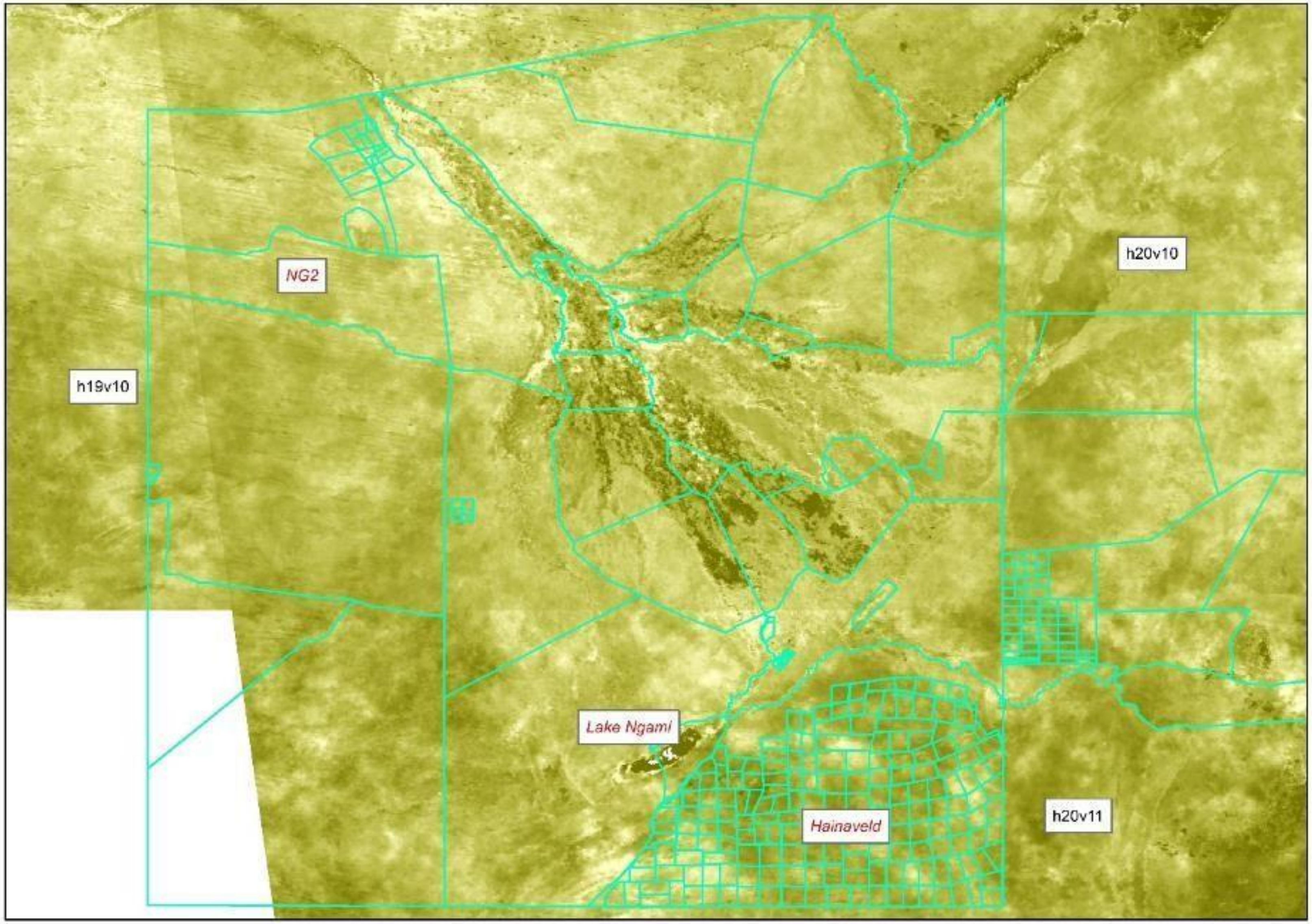
% of rangeland in 2006 in different vegetation groups	**Hainaveld**	**Lake Ngami Area**	**NG2**
% of rangeland mainly open grassland – from NDVI seasonal difference	22.23	20.06	17.91
% of rangeland mainly open grassland - from ORI land cover classification	26.27	21.69	19.57
% of rangeland grassland / woodland mix –from NDVI seasonal difference	51.94	53.86	53.15
% of rangeland grassland / woodland mix - from ORI land cover classification	42.11	42.57	51.61
% of rangeland mainly shrub / woodland –from NDVI seasonal difference	25.83	26.08	28.94
% of rangeland mainly shrub / woodland – from ORI land cover classification	31.62	35.74	28.82

5.2.2 Changes in Vegetation over time

MODIS imagery is acquired at daily intervals, and has a broader spatial resolution, making it suitable for assessing landscape level, ecological processes such as response to precipitation and fire, without too much ‗noise interference' from finer scale processes related to daily land use practices. In order to understand change in vegetation in recent history in the three focal areas, a standardised MODIS product, the Enhanced Vegetation Index (EVI) was downloaded. These images are composites of the previous 16 days of satellite acquisition, and have a pixel resolution of 500 m x 500 m. The composite date is based on early May, to correspond with the end of the growing season. Imagery for the past 6 years was downloaded for comparison of change over time. In order to cover all three focal areas, 3 of the large southern African tiles were needed: h19v10, h20v10 and h20v11 (Figure 28).

Figure 28 Schematic map showing footprints of MODIS EVI images relative to Ngamiland land use (layer source: DSM) and the study areas.

(Below)


h20v10
NG2
h19v10
Lake Ngami
Hainaveld
h20v11

These images were compared over time in order to evaluate spatial distribution of intensity of primary production, which is the basis for the EVI reflectance values. The six years were also assessed by calculating variance in EVI value over time. The output variance map highlights the locations which have experience the greatest extremes in EVI values over the time period, as well as those that show little or no variance. Interpretation of this variance should be supported with other analyses in order to understand the nature or direction of change in the EVI values.

it is important to bear in mind that vegetation indices derived from electromagnetic reflectance values capture a measurement of the amount of primary production taking place at the Earth‘s surface at a single point in time, and that in savannas this does not correlate well with total biomass, since in the late growing season, the herbaceous layer may dominate the photosynthetic signal, whereas in the dry season, only woody species are photosynthesising. However, it is useful to evaluate total vegetation cover, as this reflects general conditions on the landscape, and captures response to rainfall.

This variability is summarised in Figure 29, a map showing the range of variance for each pixel - and highlighting those areas that have experienced the greatest range in fluctuation of photosynthetic activity.

In the Lake Ngami focal area, considerable spatial variation between each of the years in terms of high EVI values was also observed in the analysis of individual images. Changes in the north-east of the focal area are associated with floodplains of the Xudum/Kunyere system, where floodwaters can temporarily mask vegetation, or with lower floods, grassy vegetation does well. These two areas show up as hotspots of variance in Figure 30, but what stands out most strongly is the variance associated with change in vegetation within the Lake Ngami lake-bed itself. Highlighting this change is important, because although much of the lake-bed was encroached by thornbushes, it was still very important grazing for livestock, and represents a substantial reduction in available grazing to the farmers in this area.

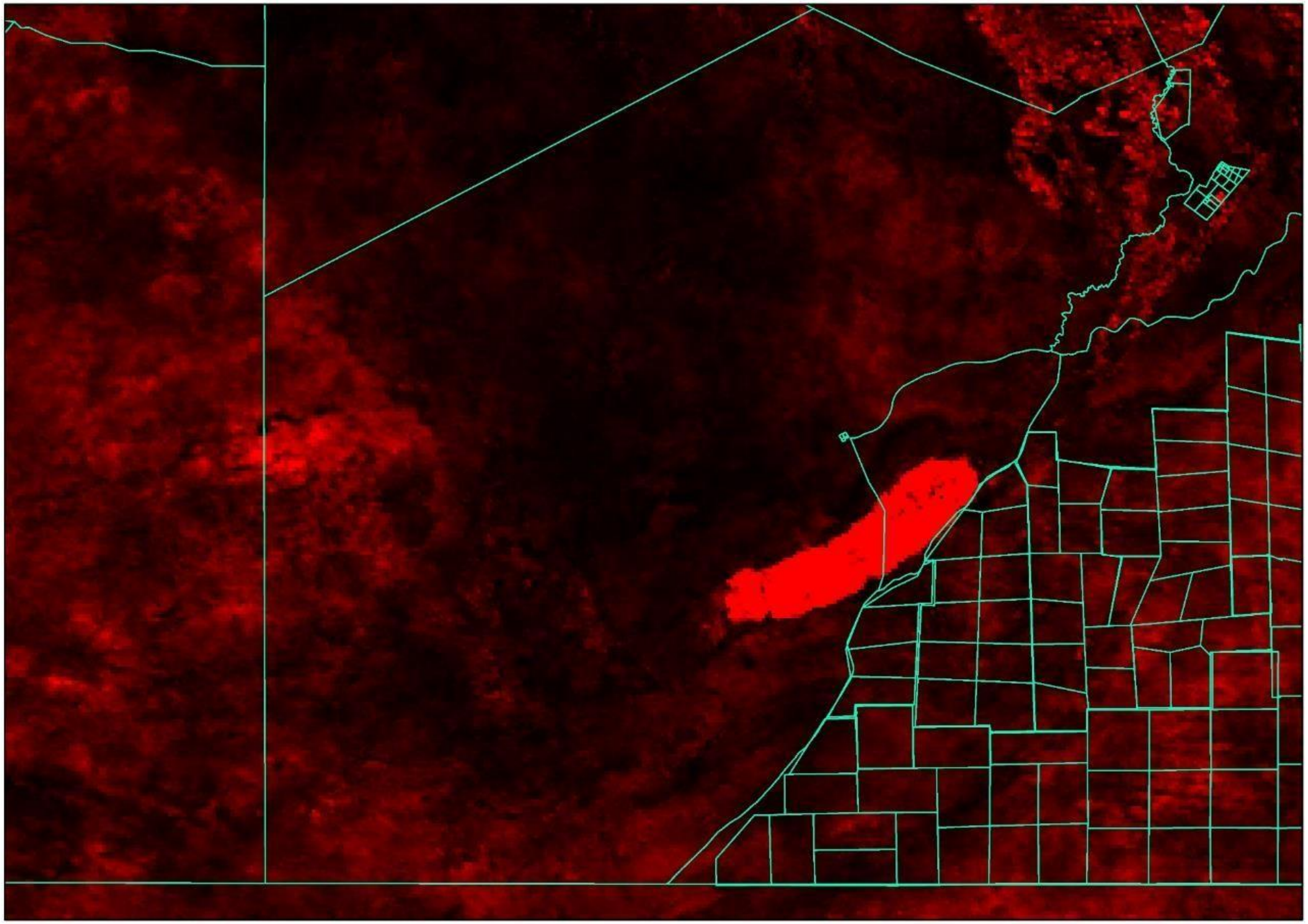
Although the interpretation of EVI for NG2 is affected to some degree by the need to stitch 2 different MODIS scenes together, it is still possible to explore some of the dynamism of that focal area‘s landscape. Even with the large (500m x 500m) pixel size, it is still possible to discern the fossil dune system, and how the differences in soil moisture properties between crests and valleys plays a major role in determining vegetation response to precipitation.

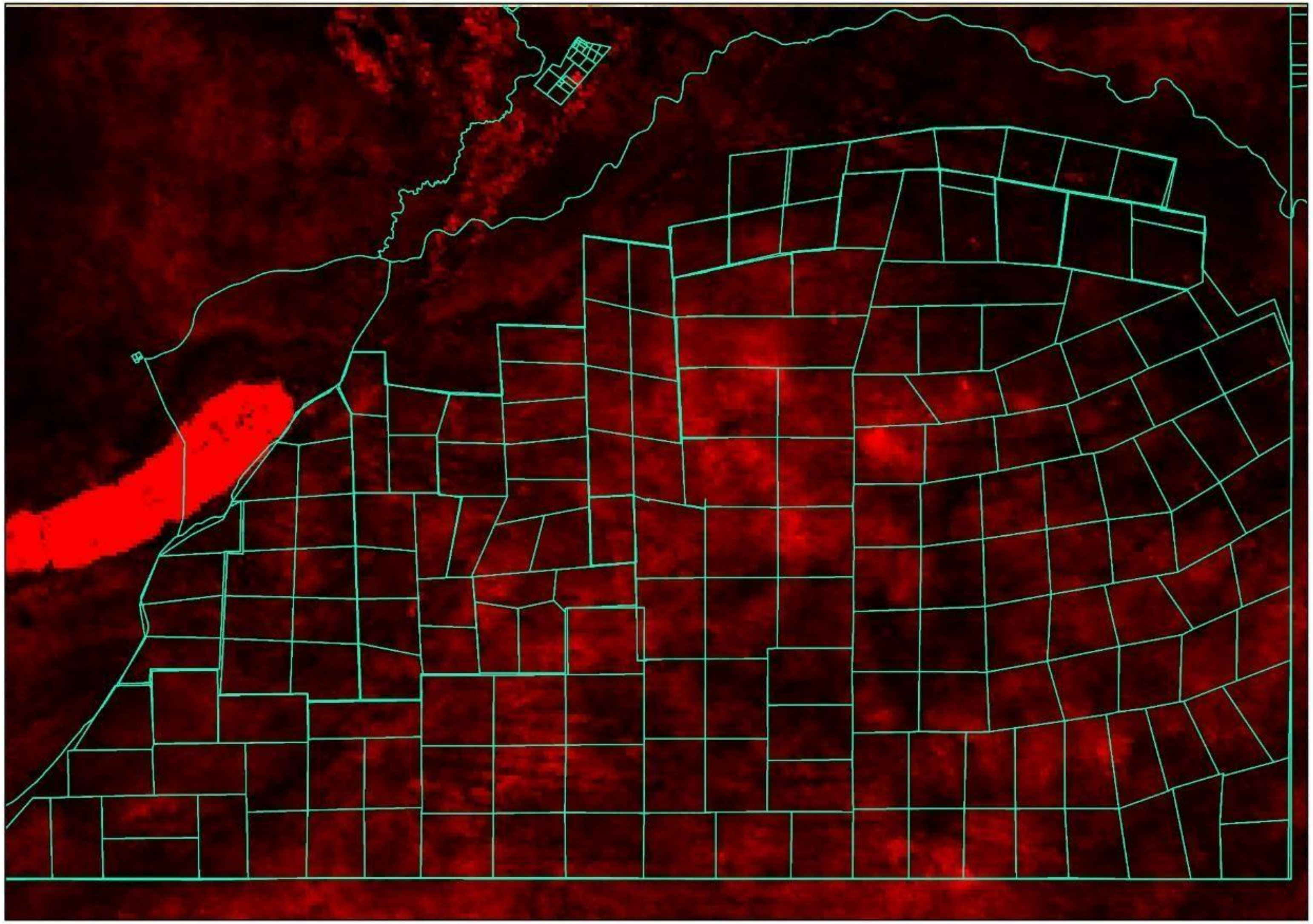
Figure 29 Variance in MODIS EVI data across time in the Lake Ngami focal area

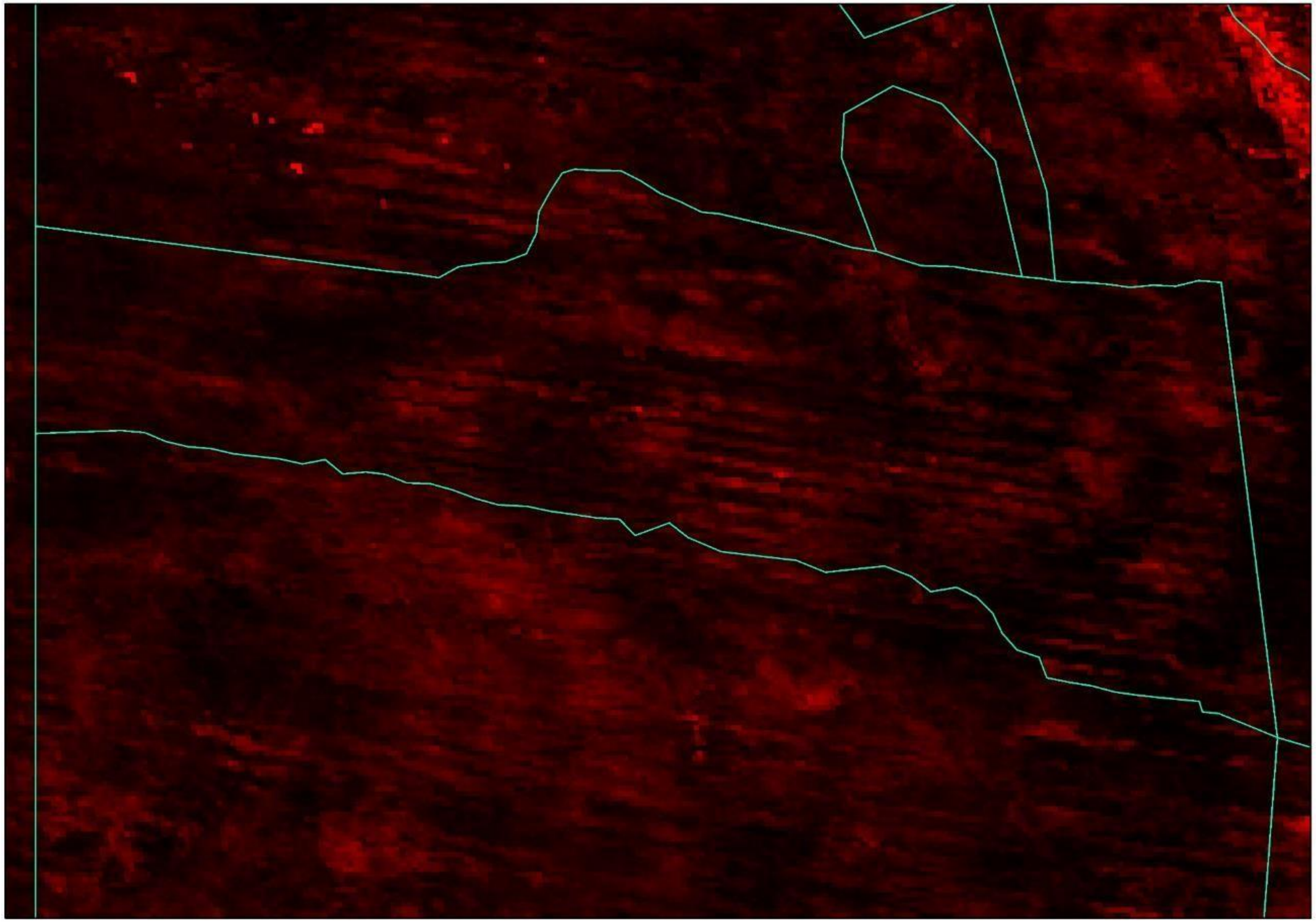
Figure 30 Variance in MODIS EVI data across time in the Hainaveld focal area

Figure 31 Variance in MODIS EVI data across time in the NG2 focal area

All Below - showing locations of most variability across the 6 different time-steps in brighter shades of red, with areas of less change in dark red to black.







Analysis of images on a year by year basis revealed that much of these changes are temporary fluctuations in primary productivity, and not changes in overall vegetation amount. This is borne out by the variance map (Figure 31), which again shows much of variability in primary production associated with the fossil dune system.

5.2.3 Identification of grassland vs. woody species proportions

Landsat imagery was selected for the analysis of more localised differences in grassland vs. woody species proportion, as it has an appropriate spatial resolution (approx. 30 m x 30 m pixels), good spectral resolution, and is available at little or no cost and temporal coverage is almost near-time. Pairs of images, corresponding as closely as possible to dates in mid-April and mid-June for both 2006 and 2016, were downloaded (Landsat TM5 for 2006, Landsat LC8 for 2016). Due to the extended location of the project's pilot areas, 4 different pairs of scenes were needed: p174r074, p175r074, p175r073 and p176r073 (Figure 32). Unfortunately, clouds obscured all available April to mid-May 2016 imagery for p176r073, so that parts of NG2 were analysed for a shorter gap, making interpretation of the current situation in that area corresponding to that scene more challenging.

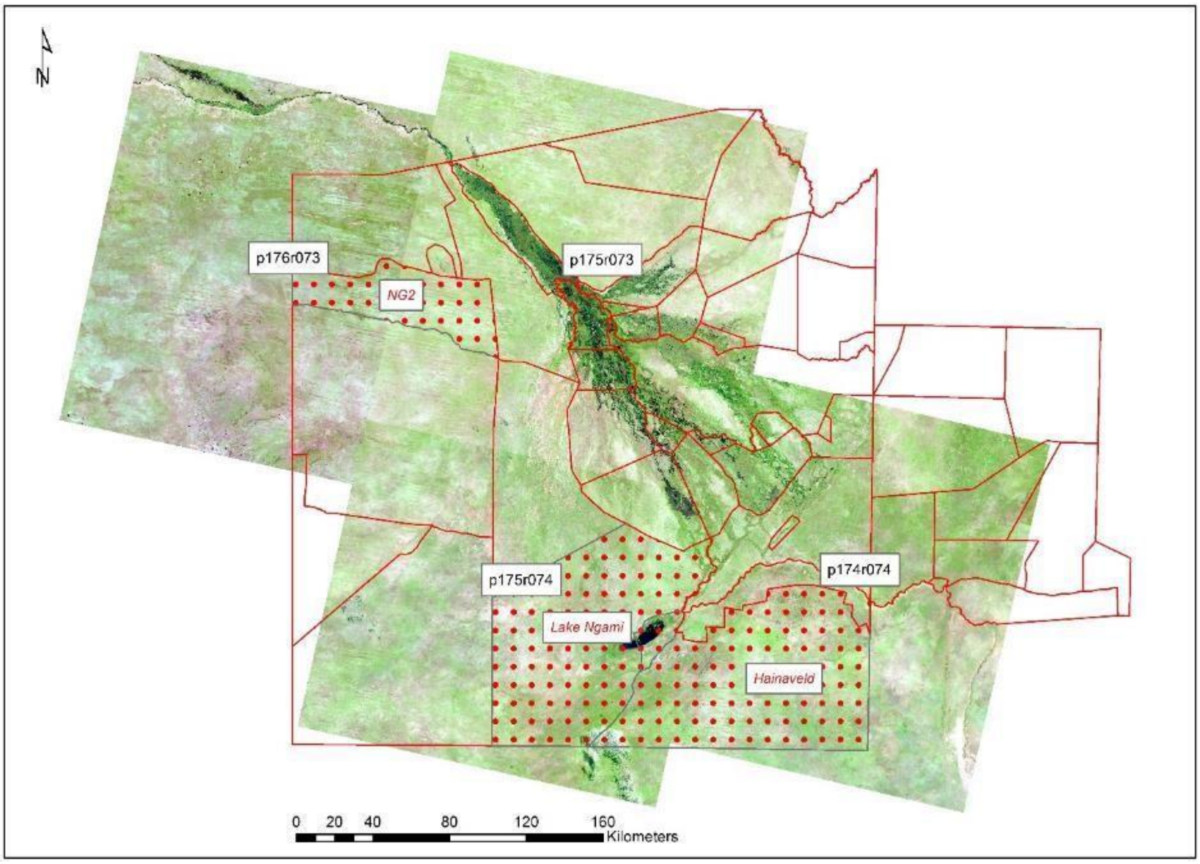


Figure 32 Schematic map showing footprints of Landsat 8 images relative to Ngamiland CHAs (layer source: DSM) and the study areas.

Once downloaded, the already-georectified imagery was processed and calibrated to surface radiance values. Two of 2006 images needed georectification. The images were then used to generate NDVI layers. The NDVI equation is based on the fact that photosynthesising plants absorb red light and reflect near-infrared, and is expressed as follows: ((NIR-Red)/(NIR+Red)) (Jensen 2000). This function creates an output that ranges from -1 to +1, where negative values can be assumed to be non-
photosynthesising areas (e.g., bare soil, open water, urban, etc.) and values ranging from 0.001 to 1.000 represent different amounts or photosynthetic activity.

At a landscape level, vegetation response in savannas is primarily driven by precipitation, and the timing of onset of primary production varies strongly from year to year dependent on when rains begin (Southworth et al 2001). However, the rate of decline in primary productivity at the end of the rainy season – as captured by NDVI data – is remarkably constant over the long-term (Figure 33). Primary production peaks at around Day 100-110, corresponding to mid-April. This rate of decline can be linked to both the phenological properties of different plant types, and to root-edaphic relationships, such as depth of root in relation to soil moisture. Thus shallow-rooted plants in the herbaceous layer senesce first, with deeper-rooted woody plants that form the shrub and woodland layers declining later.

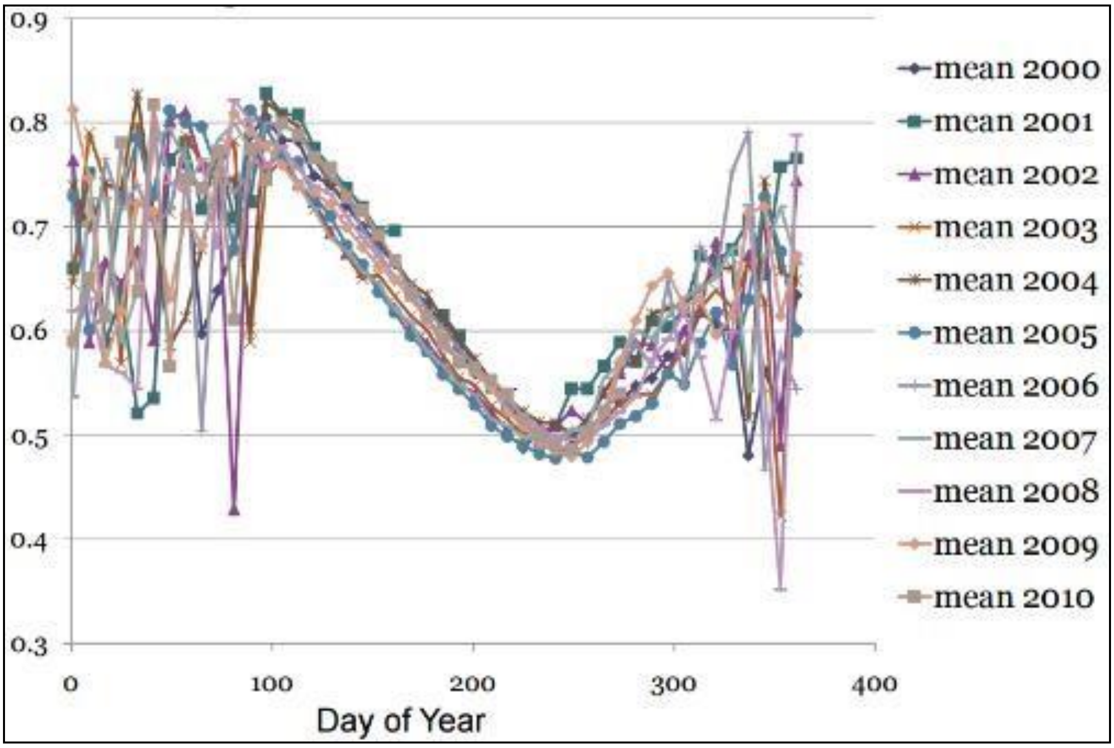


Figure 33 Southworth et al's 2011 graph showing MODIS vegetation index values averaged across the Okavango-Zambezi landscape, with data series for a 10-year period.

Field observations in northern Botswana savannas suggest that by mid-June – the early dry season, the herbaceous layer in this region is no longer photosynthesising, while shrubs and trees still carry photosynthetic growth. By exploiting the position of these different vegetation types along the NDVI-decline slope, it is possible to use the seasonal phenological differences between grassy species and woody species to tease out how much of the NDVI response can be attributed to each of these vegetation types. This information can then be used to identify areas along a landscape gradient from open grasslands through open canopy woodlands to enclosed shrubby areas.

For each of the two years of interest (2006 and 2016), the early dry season NDVI outputs were subtracted from the peak season outputs, to create layers with a continuous range of values from 0.001 to 1.000 representing almost no reduction to almost total reduction in photosynthetic activity. For ease of discussion, the range can be grouped into three main categories (Table 19), but it is also useful to use the continuous values as an indication of the amount of herbaceous layer present during the growing season across the landscape.

Table 19 Relation of different Landsat 8 NDVI ranges between peak growing and early dry seasons to assign categories for 2016 rangeland category

NDVI range: Peak growing season	**NDVI range: Early dry season**	**Range of difference**	**Assigned category**
High (>0.000)	Low	0.121 – 1.000	Mainly grassland
High (>0.000)	Medium	0.071 – 0.121	Mixed grassland / woodland (both grass and woody spp contribute to signal)
High (>0.000)	High	0.001 – 0.070	Shrub, or mainly woody species, including encroached areas
Low (<0.000)	Excluded as not vegetation	Assigned 0.000	Non-rangeland area

The resultant layers for 2016 were tested against the ~100 independent field samples collected as part of the other activities collected for the integrated range assessment project, and NDVI-difference is significantly correlated with total ground cover ($n = 101$, Kendall‘s tau-b = 0.151, $p = 0.017$).

Current available rangeland was defined on the basis of inclusion of any pixel with a positive NDVI value during the peak growing season in 2016. Based on the range of differences given in Table 19, the areas of grassland, grassland/woodland mix, and shrub/woodland are presented in Table 20 below. It is clear that the broader Lake Ngami area currently has the least open grassland areas, followed by Hainaveld, while NG2 have roughly a third of its area as open grassland. The figures suggest that only 6.7% of NG2 is shrub/woody areas that would be unsuitable for grazing; however this figure should be interpreted with some caution as the early image for this area was a few weeks after peak growing season. That ~40% of the available vegetated land around Lake Ngami is mainly shrub / woodland is of concern given the loss of grazing in the lake-bed due to the current high flood phase.

	Hainaveld	**Lake Ngami Area**	**NG2**
Total rangeland area (km^2)	8143.61	9100.86	2854.31

Area of mainly open grassland (km^2)	1778.57	1737.22	956.22
Area of grassland / woodland mix (km^2)	4590.38	3684.72	1706.24
Area of mainly shrub / woodland	1815.58	3678.92	191.85
	Hainaveld	**Lake Ngami Area**	**NG2**
(km^2)			
% of rangeland mainly open grassland	21.73	19.09	33.50
% of rangeland grassland / woodland mix	56.09	40.49	59.78
% of rangeland mainly shrub / woodland	22.18	40.42	6.72

Table 20 Calculated areas and proportions for different vegetation groups in 2016 based on seasonal NDVI differences

5.2.4 Identification of areas of change in grassland proportion over time

The main purpose of identifying the grassland-woodland gradient (as based on seasonal difference in NDVI) for the earlier time-step of 2006 was to assess the change between that point in time and the current situation in terms of the extent and location of areas of extreme change in grassland proportion. To achieve this, models were run for each of the three focal areas to generate maps of the two extremes. Firstly, pixels that had high range of seasonal difference in 2006 (inferring mainly grassland at that time) but which had low range of seasonal difference in 2016 (inferring mainly woody species or no vegetation), were classified as ―degraded‖, generating a layer showing the location of such areas. Next, pixels that had low range of seasonal difference in 2006 (inferring mainly woody species or no vegetation) but which had high range of seasonal difference in 2016 (inferring mainly grassland at that time), were classified as ―increased grassland‖ – again generating a layer that showed the location and amount of this type of change.

The spatial extent in each of the three categories along the rangeland gradient (mostly grassland, mixed grassland / woodland, mostly shrub or woodland) as derived for 2006 and 2016 based on seasonal differences in NDVI is given in Table 21. For Lake Ngami and the Hainaveld, it appears that the proportion of mainly grassland has held constant, while in the NG2 focal area, there appears to have been some increase in grassland.

Table 21 Calculated proportions for broad categories of rangeland vegetation association for 2006 and 2016, as based on grouping of ranges in seasonal differences in NDVI

	Hainaveld		**Lake Ngami Area**		**NG2**	
Year	**2006**	**2016**	**2006**	**2016**	**2006**	**2016**
% of rangeland mainly open grassland	22.23	21.73	20.06	19.09	17.91	33.50

% of rangeland grassland / woodland mix	51.94	56.09	53.86	40.49	53.15	59.78
% of rangeland mainly shrub / woodland	25.83	22.18	26.08	40.42	28.94	6.72

However, the idea of the proportion of the area in grassland as ―holding constant‖ is somewhat misleading, because it masks some of the variation recorded in the EVI assessments, and indeed, there have been some areas where grassland has been degraded either through the encroachment of woody species or through loss of all vegetation. Looking only at the more extreme values in the seasonal difference in NDVI, Table 22 shows that about 14.6 % of the Hainaveld area changed from mainly grassland to mainly shrub or woodland over the past 10 years, while only about 1 % of badly degraded land changed to grassland over the same period. The location of these extreme changes are shown in Figure 34. It is important to note that other changes may have occurred over (such as slight increases or decreases in woody biomass), but these are hard to assess within the confines of this study, and are simply reported as ―area with no extreme change‖.

At the same time, these subtle changes have clearly contributed to the dynamism of the landscape, as despite the extreme change of grassland to mainly woodland reflected in Table 22, other changes have allowed the overall amount of grassland to stay relatively constant across the broader Hainaveld area (Table 21).

Table 22 Calculated areas and proportions for changes in grassland proportion between 2006 and 2016, as derived from seasonal differences in NDVI. Results are colour-coded to link to the maps below.

	Hainaveld	**Lake Ngami Area**	**NG2**
Total rangeland area (km^2)	8143.61	9100.86	2854.31
Area (km^2) showing as grassland in 2006 seasonal NDVI difference, and as no veg or dense woody in 2016 seasonal NDVI difference	1169.64	564.39	22.33
Area (km^2) showing as no veg or dense woody in 2006 seasonal NDVI difference, and as grassland in 2016 seasonal NDVI difference	72.98	169.40	260.41
Area (km^2) with no extreme change	6900.99	8367.06	2571.56
% of area showing as grassland in 2006 seasonal NDVI difference, and as no veg or dense woody in 2016 seasonal NDVI difference	14.36	6.20	0.78
% of area showing as no veg or dense woody in 2006 seasonal NDVI difference, and as grassland in 2016 seasonal NDVI difference	0.90	1.86	9.12
% of area with no extreme change	84.74	91.94	90.09

For Lake Ngami focal area (Figure 35 and Table 22), The area of degradation is much less. Over and above the lake-bed, there are areas to the east of Tsau on the sodic soils, as well as in the far west of the area that have very low grassland fraction. Areas of increase in grassland fraction are associated with the floodplains of the Xudum/Kunyere, but there also appears to be and increase in grassland since 2006 in the areas south of Bodibeng toward the Kuke fence.

NG2 appears to show little sign of degradation (Figure 36).

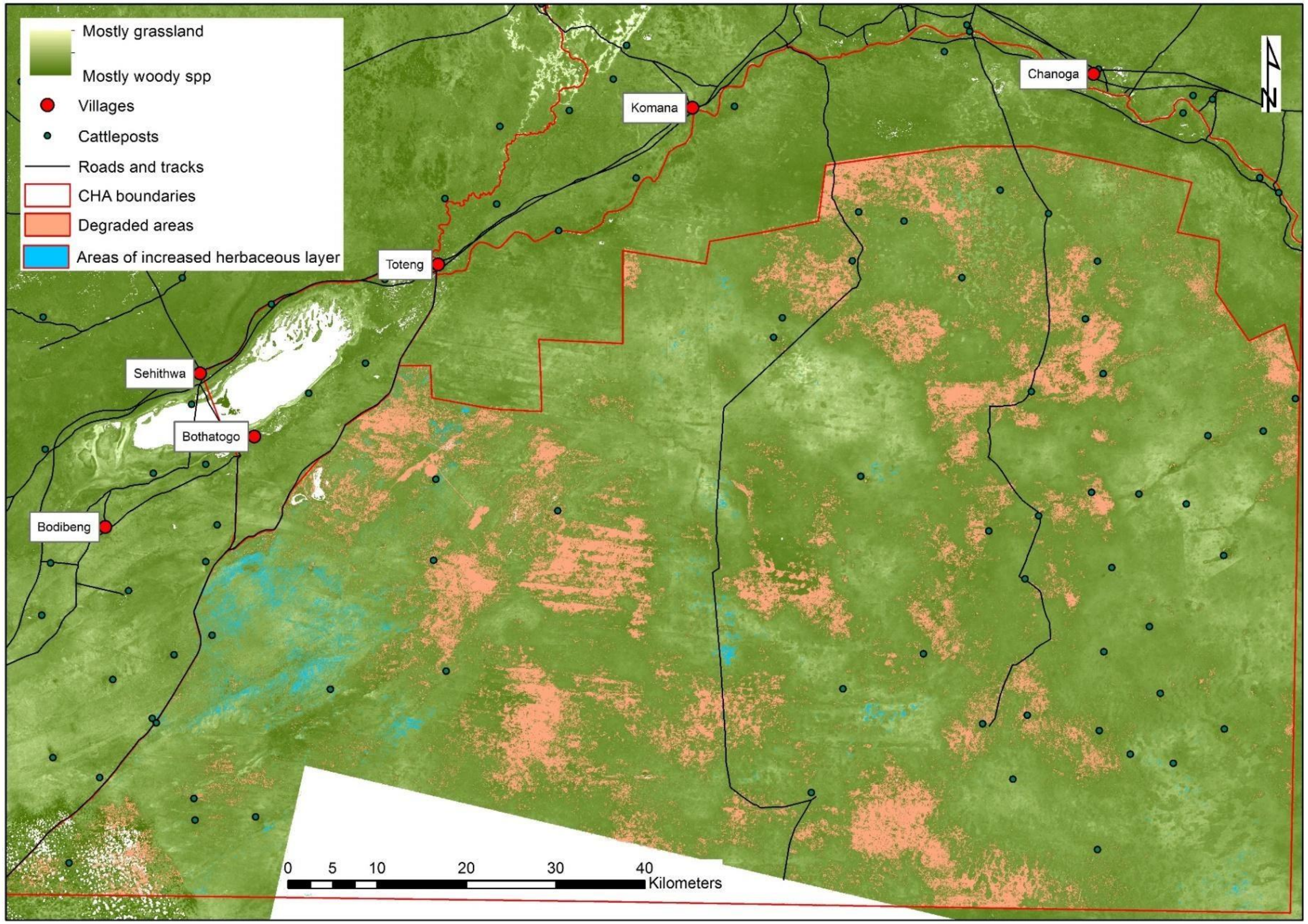


Figure 34 Map of the Hainveld focal area showing areas of degraded or reduced grassland and those of increased herbaceous layer, as inferred from the comparison of 2006 and 2016 areas of high seasonal difference and low seasonal difference in NDVI.

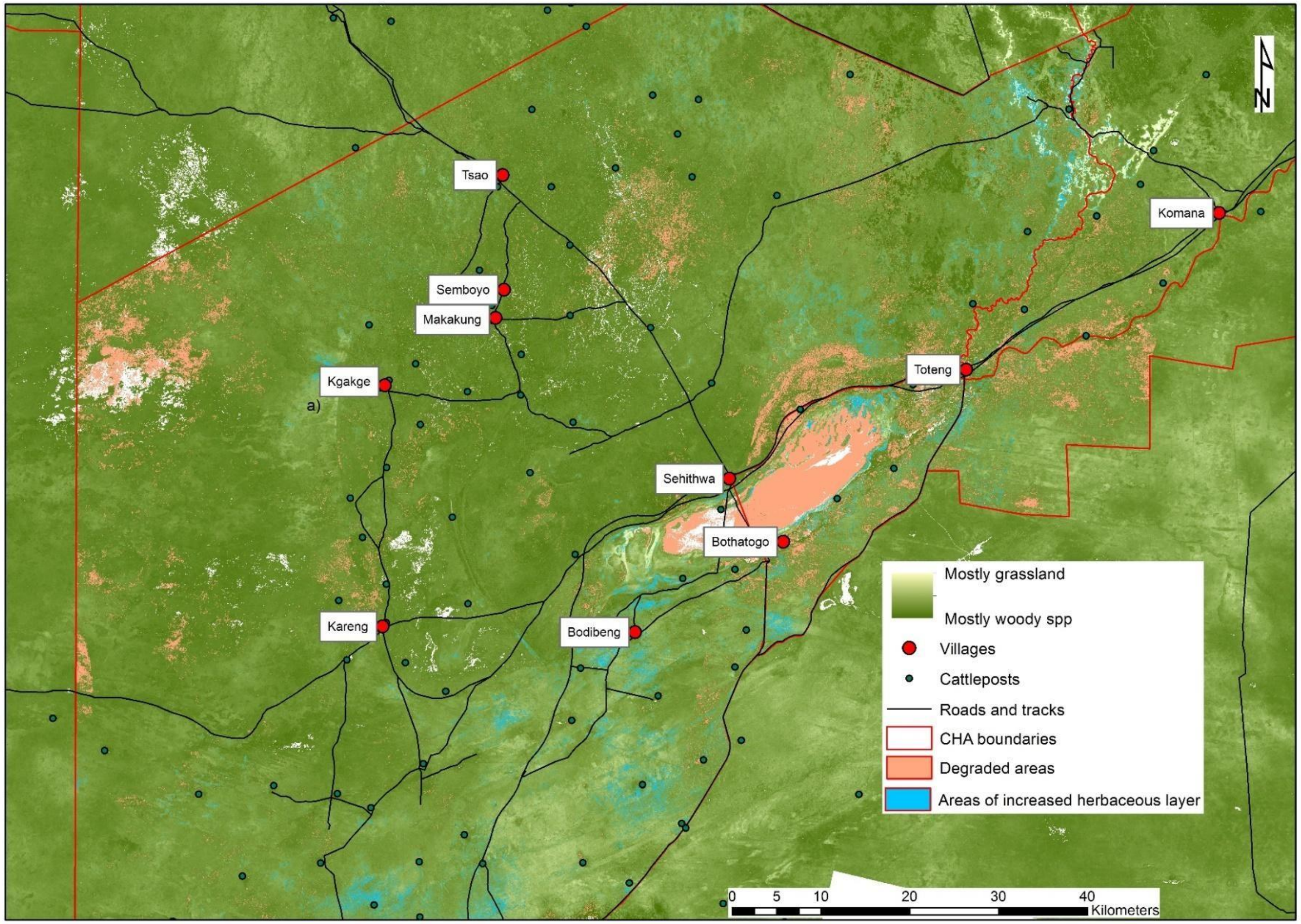


Figure 35 Map of the Lake Ngami focal area showing areas of degraded or reduced grassland and those of increased herbaceous layer, as inferred from the comparison of 2006 and 2016 areas of high seasonal difference and low seasonal difference in NDVI.

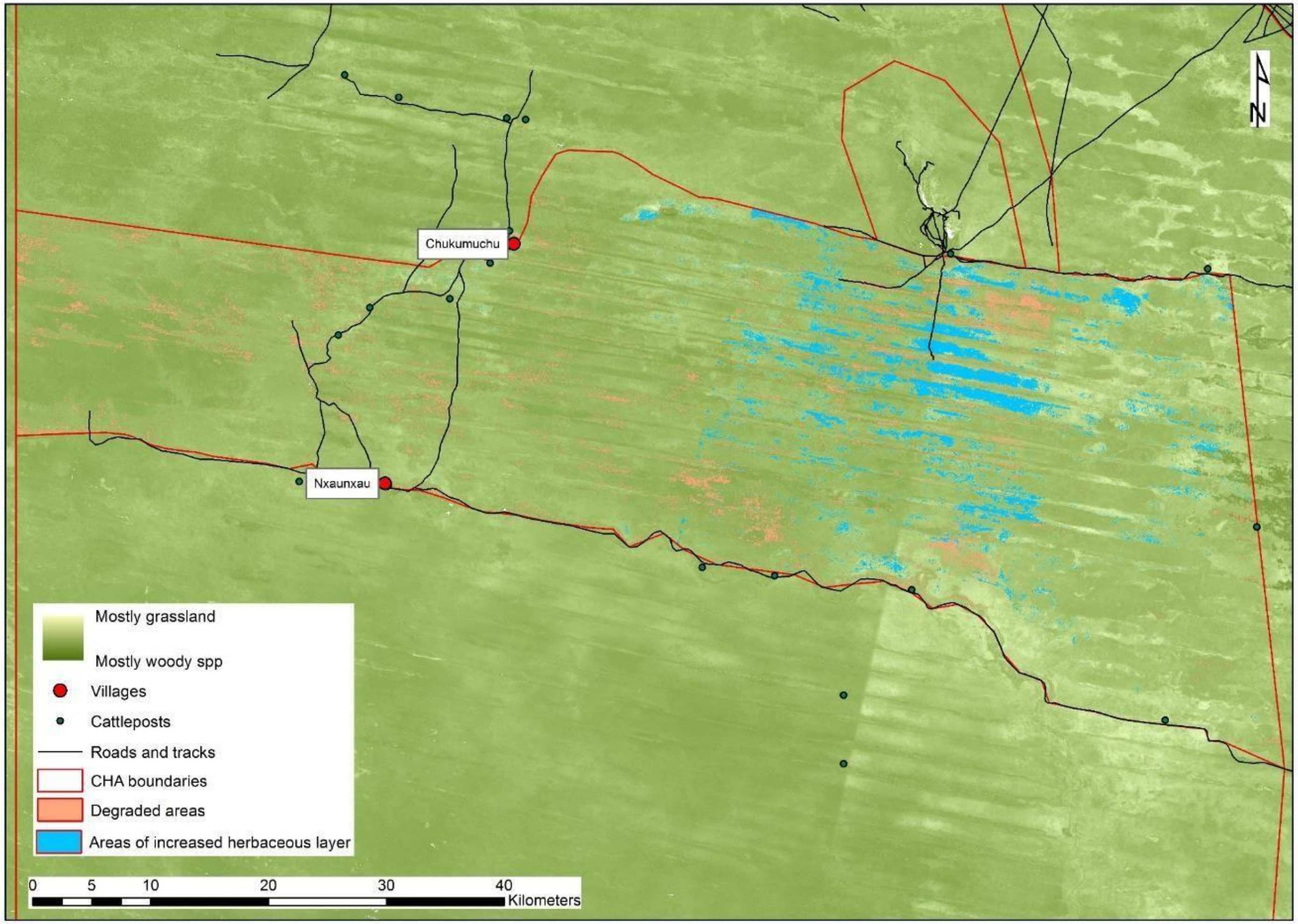


Figure 36 Map of the NG2 focal area showing areas of areas of degraded or reduced grassland and those of increased herbaceous layer, as inferred from the comparison of 2006 and 2016 areas of high seasonal difference and low seasonal difference in NDVI.

5.2.5 Land degradation and NDVI

In 2014 the USAID Southern African Regional Environmental Programme (SAREP) undertook a collaborative Project with the United States Forestry Service's (USFS) Remote Sensing Application Centre (RSAC), to assess the extent of land degradation in the Okavango Basin using the Normalised Differential Vegetation Index (NDVI). NDVI assesses the spectral reflectance from green vegetation and is a proxy for assessing photosynthetic activity / vegetation cover type and hence changes in land cover.

The remote sensing approach used by SAREP, which has a direct bearing on the IRA Project, included the following types of analysis:

- Change analysis monitored at fixed dates (1st of Nov & 1st of May) and using an 80 percentile over the entire year.
- Fire trends and patterns discerned through the use of the MODIS fire data set

The data provided by the USFS/SAREP Project was re-analysed for the IRP SLM Project with May 1st data used throughout, as this is the time when primary biomass or greenness (NDVI) can be expected to be at its highest point. The SAREP/USFS analysis defined ‗land degradation' as a long-term decline in ecosystem function and productivity, driven by land cover change or climatic change. Spectral vegetation indices derived from the NDVI product as provided by the Moderate-resolution Imaging Spectroradiometer (MODIS) can thus be used a proxy for land degradation, with local knowledge of the ecosystem used to attach some causal links to the observed patterns in NDVI.

The data analysed from the SAREP/USFS study shows negative trends to the west of the Delta around Gumare, as well as some of the core Delta areas and the Hainaveld commercial fenced ranches (Figure 37). The latter is more pronounced in November, while the positive trend in and around Lake Ngami seems likely to reflect the dominance of the invasive exotic cocklebur (*Xanthium strumarium*), rather than ‗useful' herbaceous biomass. The high negative values around Lake Ngami and Tsoe in May image are borne out on the ground by the absolute lack of grasses in these areas due to high stocking rates.

Variation in NDVI in May 2016 is shown below for the three focal areas, with lighter areas showing lower NDVI values than average.

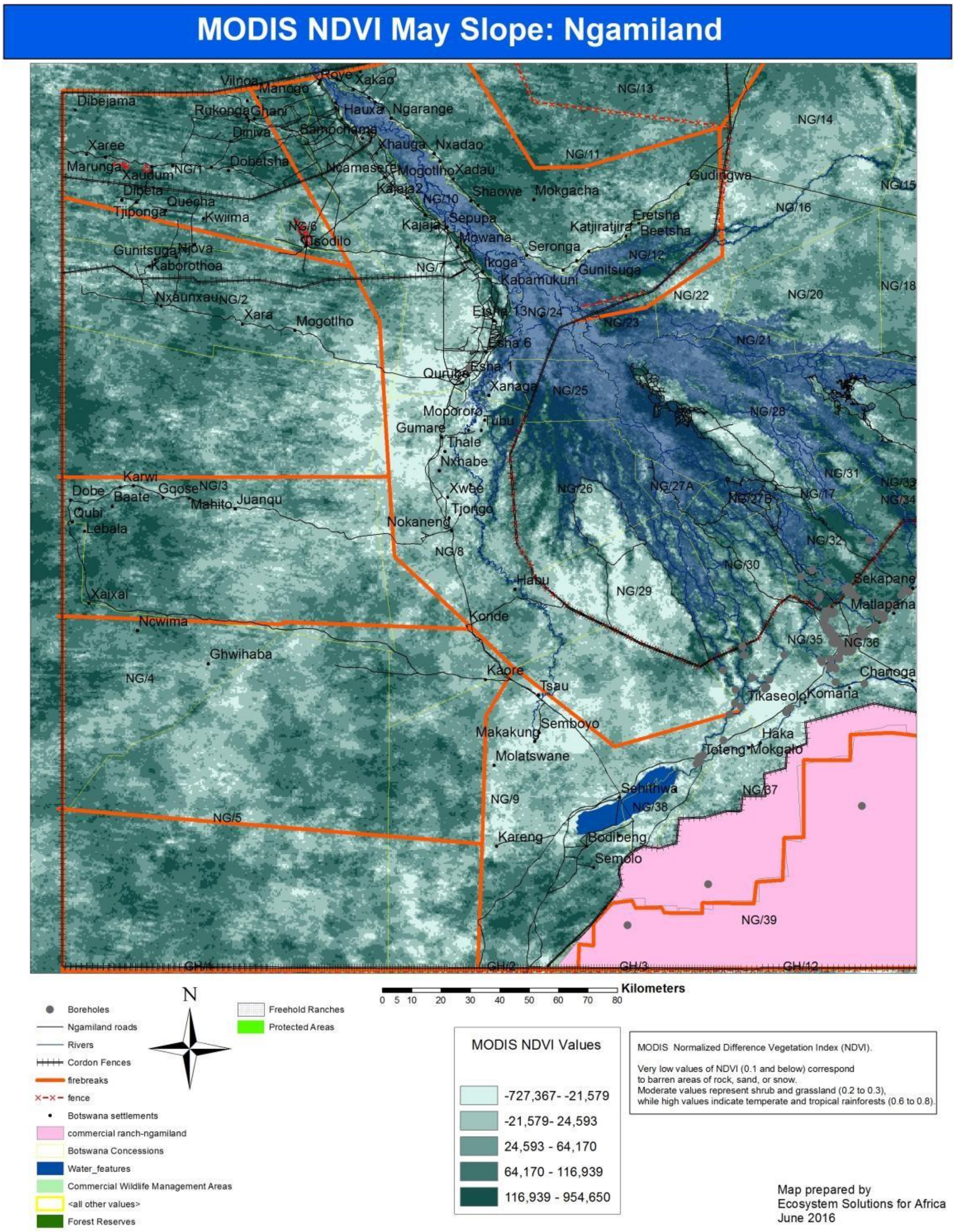


Figure 37 Variation in NDVI (May 1st, 2003 – 2012) for Ngamiland

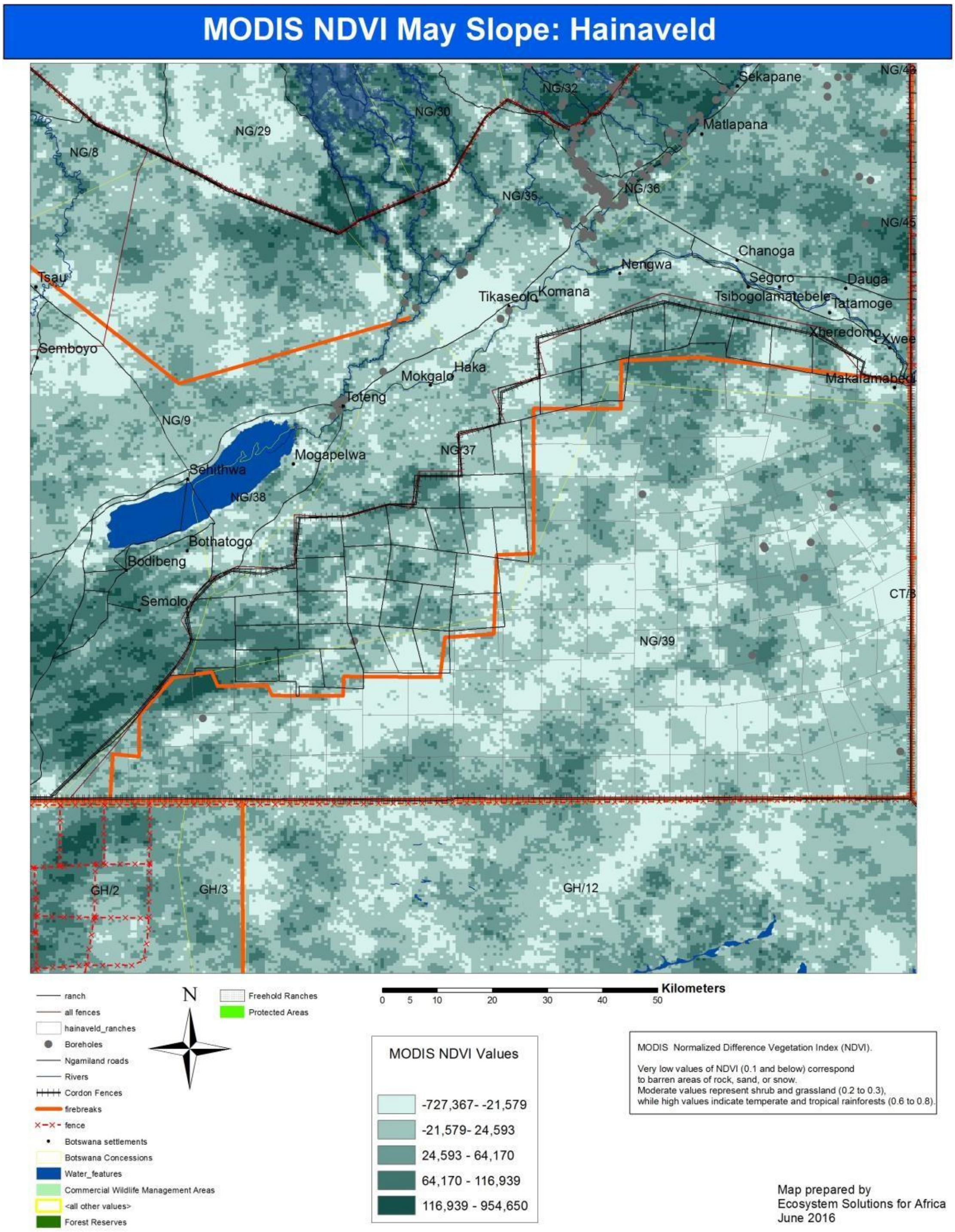


Figure 38 Variation in NDVI (May 1st, 2003 – 2012) for the Hainaveld Farms

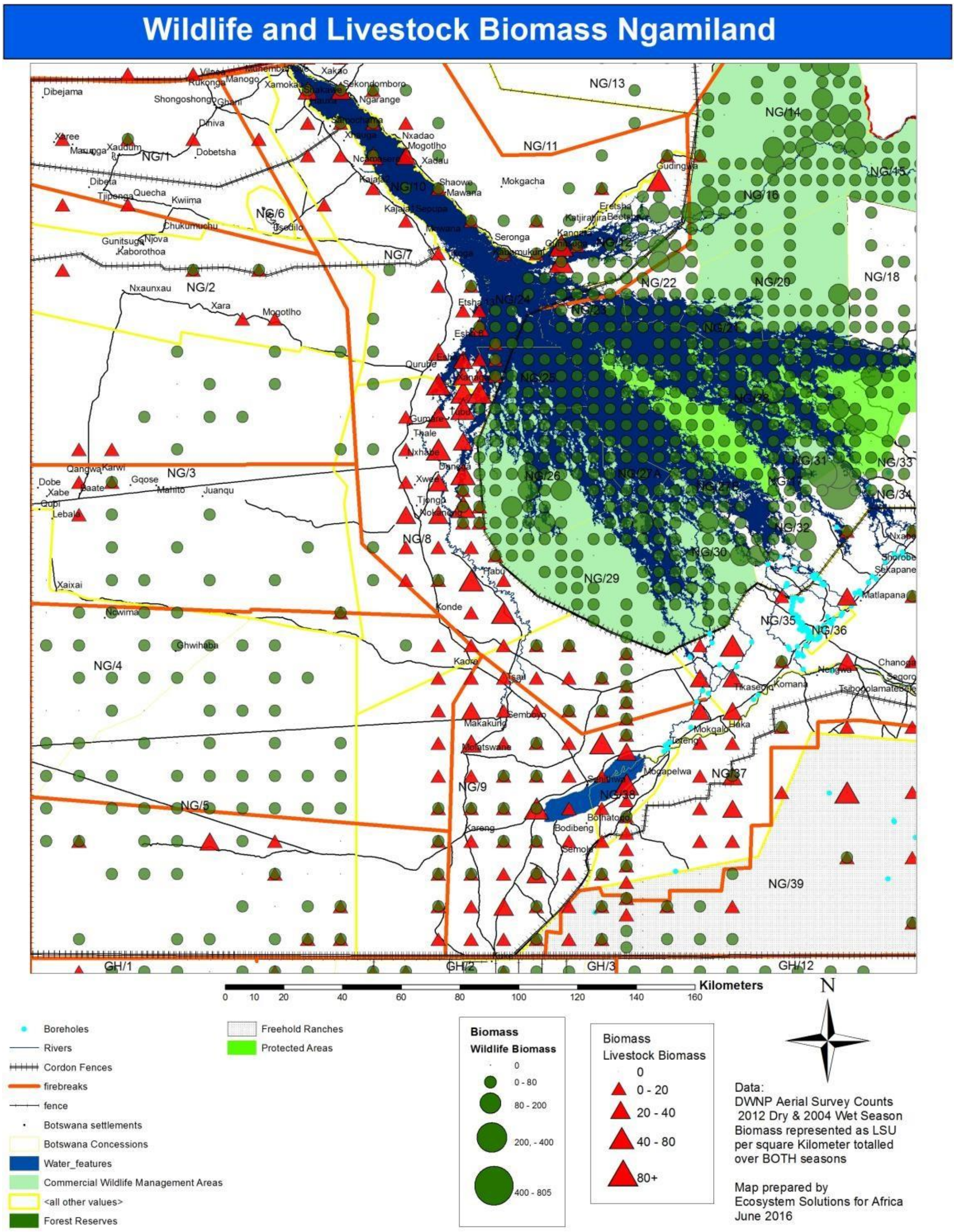


Figure 39 Wildlife and Livestock biomass in Ngamiland

Wildlife and livestock biomass in Ngamiland, on the basis of the DWNP, 2012) aerial survey data, shows the relative concentration of wildlife biomass in western Ngamiland and livestock concentration in the Hainaveld, Lake Ngami and along the fringes of the Okavango Delta (Figures 39-40). Portrayal of this data for each focal area is even more striking with graphical representation showing the relative dearth of animal biomass in western Ngamiland (Figures 41-42). The latter is in terms of large herbivore biomass relatively _empty savannah‘.

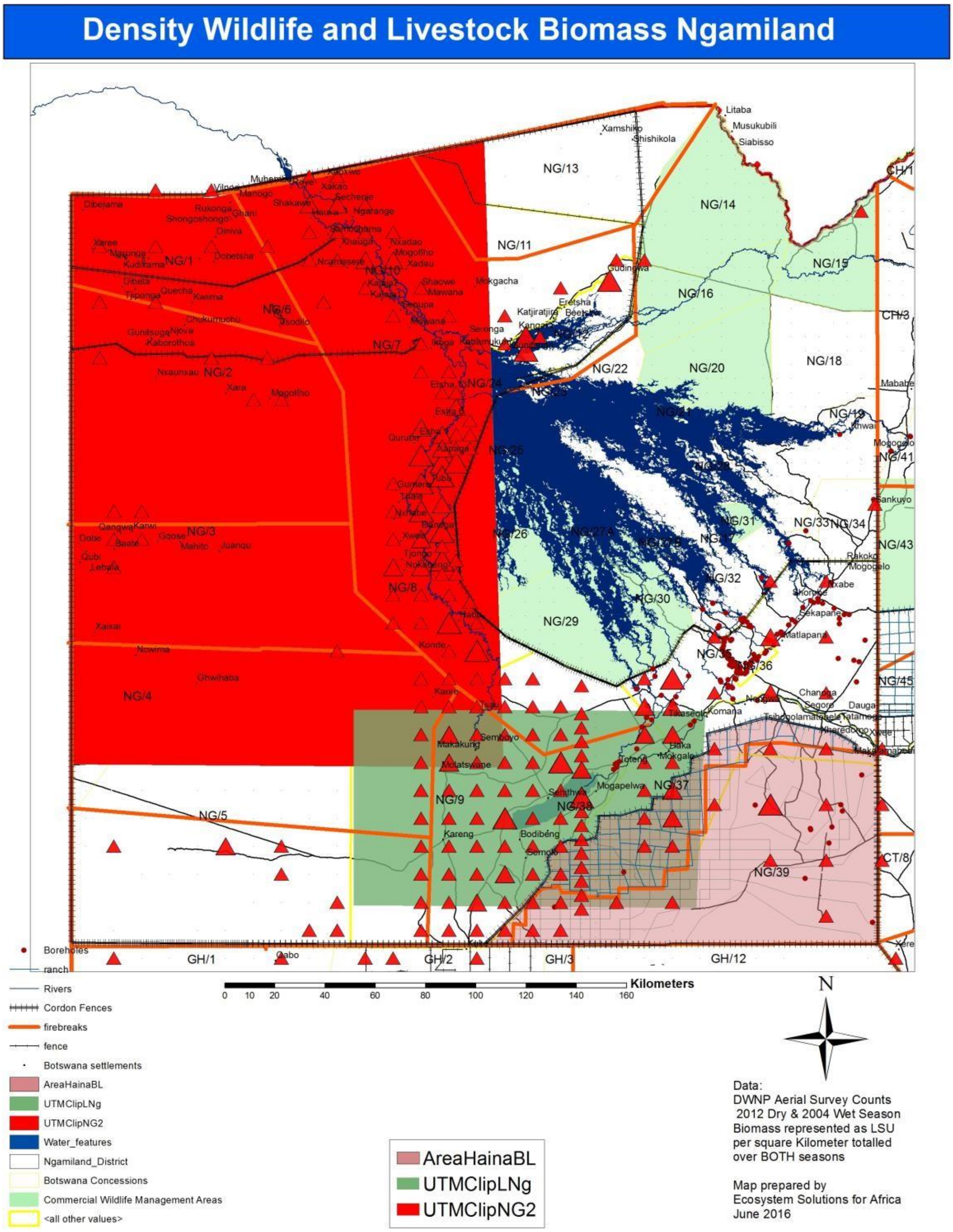


Figure 40 Wildlife and livestock biomass in the three Focal areas

Figure 41 Concentration of livestock biomass in Ngamiland

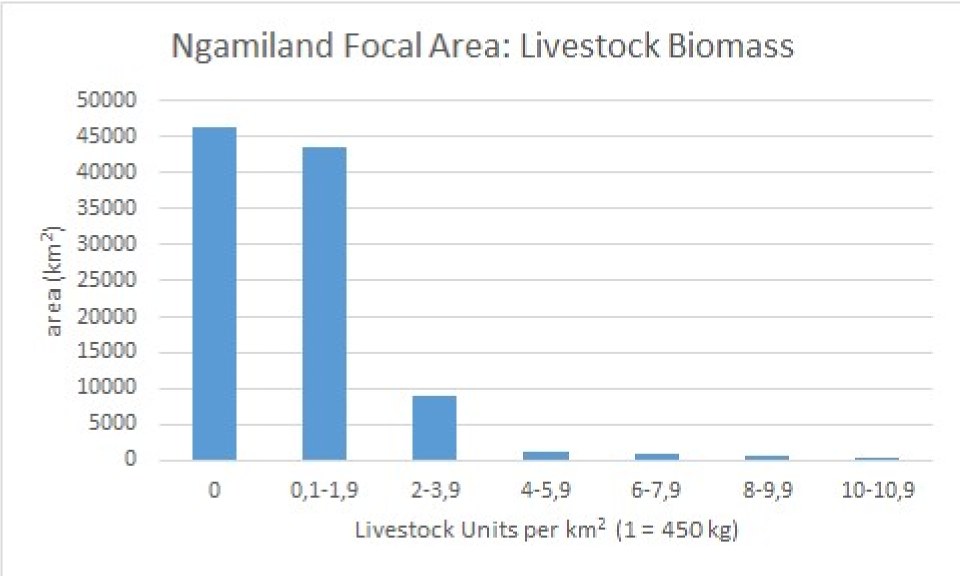
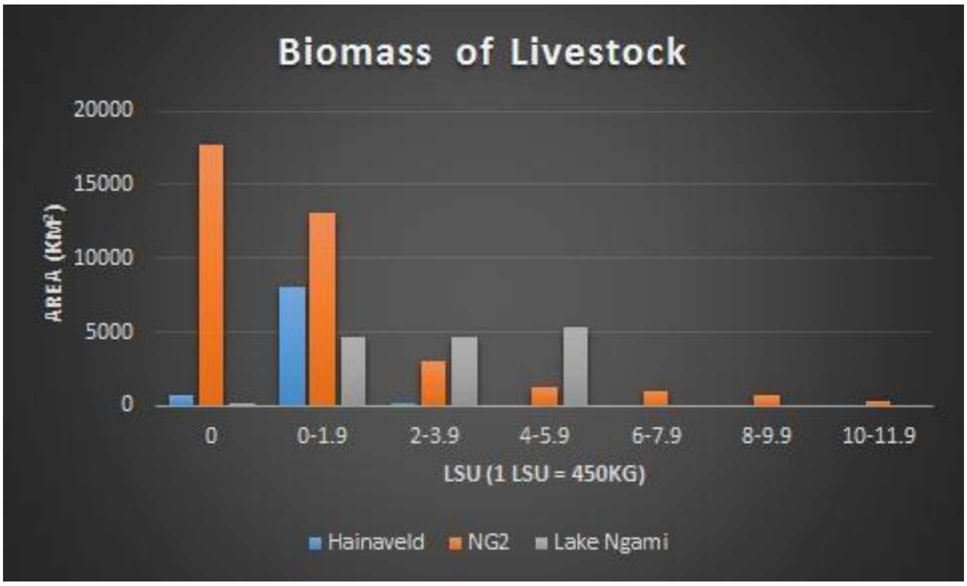


Figure 42 Biomass of livestock in each Focal area



5.2.6 MODIS Fire Analysis

The total number of hectares that have burnt in Ngamiland and Chobe District between 2001-2014 is as shown below in Tables 23 – 24).

Table 23 Total Hectares Burnt By District (2001 – 2014)

Year	Ngamiland	Chobe
2001	1,365,441	312,832
2002	1,091,652	311,676
2003	267,547	59,559
2004	299,998	359,722
2005	250,291	55,648
2006	1,553,027	712,571
2007	603,465	254,868
2008	920,799	661,483
2009	570,575	447,255
2010	1,646,626	462,093
2011	643,128	210,069
2012	2,145,199	397,279
2013	951,867	317,398
2014	280,632	252,876
Total Burnt Area	**12,590,247**	**4,815,329**

Analysis of MODIS data reveals that several hundred thousand hectares of Chobe and Ngamiland District can burn in any one year. The total seasonal burn areas of Ngamiland can exceed a million hectares, ranging from 10-20 per cent of the entire District. It is clearly a significant impact for over a million hectares of rangeland to burn at any one time, with the loss of timber, veld products and biodiversity this represents, undocumented, but likely to be substantial. Trollope *et al* (2006) make a number of recommendations for fire management in Ngamiland, such as _reduce fire frequency to a rate of one in 3-5 years and promote cool burns‘.

Table 24 Percentage of District Burnt (2001 – 2014)

Year	Ngamiland (%)	Chobe (%)
2001	12.2	14.8
2002	9.8	14.7
2003	2.4	2.8
2004	2.7	17.0
2005	2.2	2.6
2006	13.9	33.7
2007	5.4	12.1
2008	8.3	31.3
2009	5.1	21.2

2010	14.8	21.9
2011	5.8	9.9
2012	19.2	18.8
2013	8.5	15.0
2014	2.5	12.0
District size	**11,147,530**	**2,114,394**

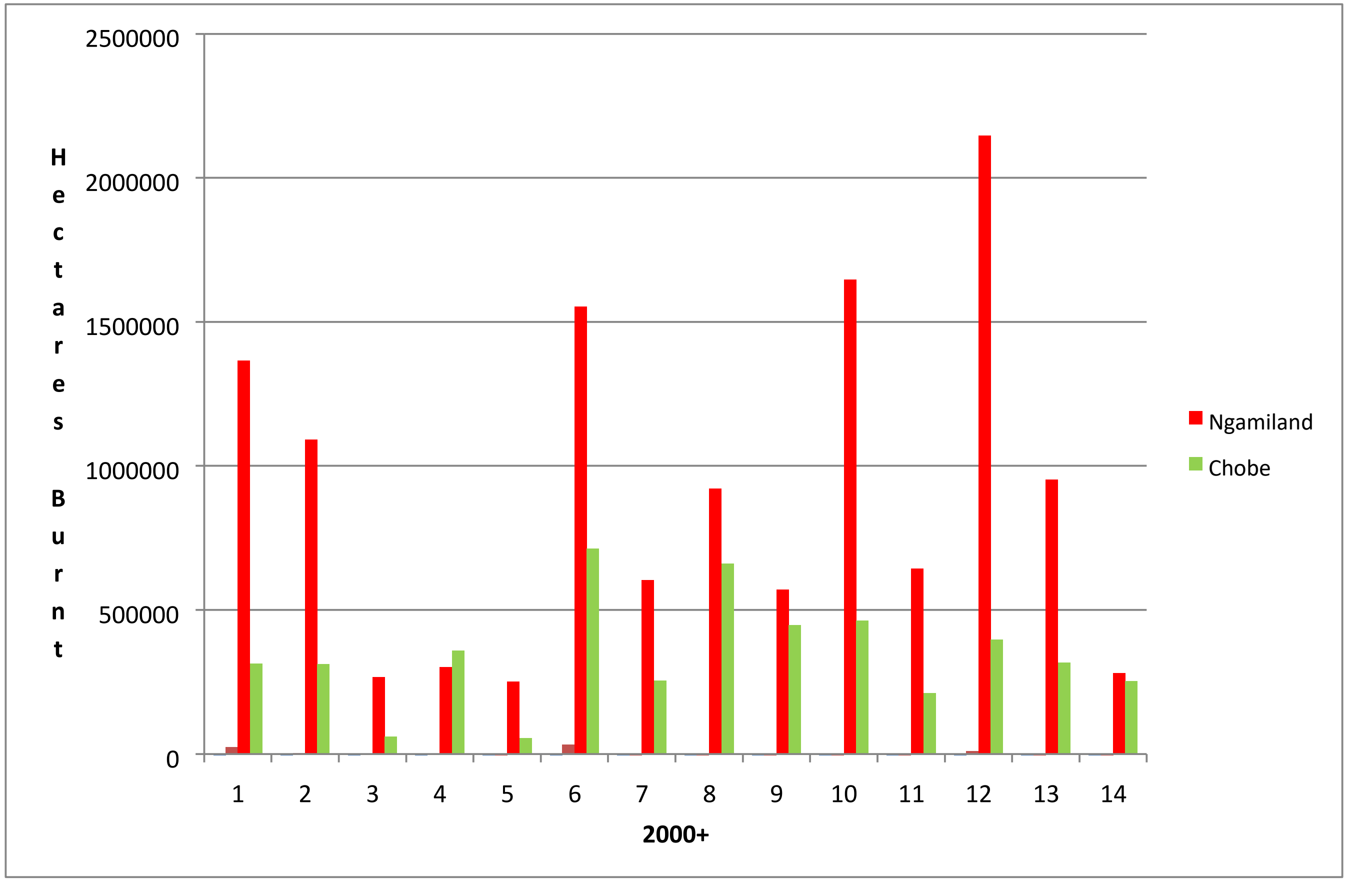


Figure 43 Hectares Burnt in Ngamiland and Chobe Districts between 2001-2014

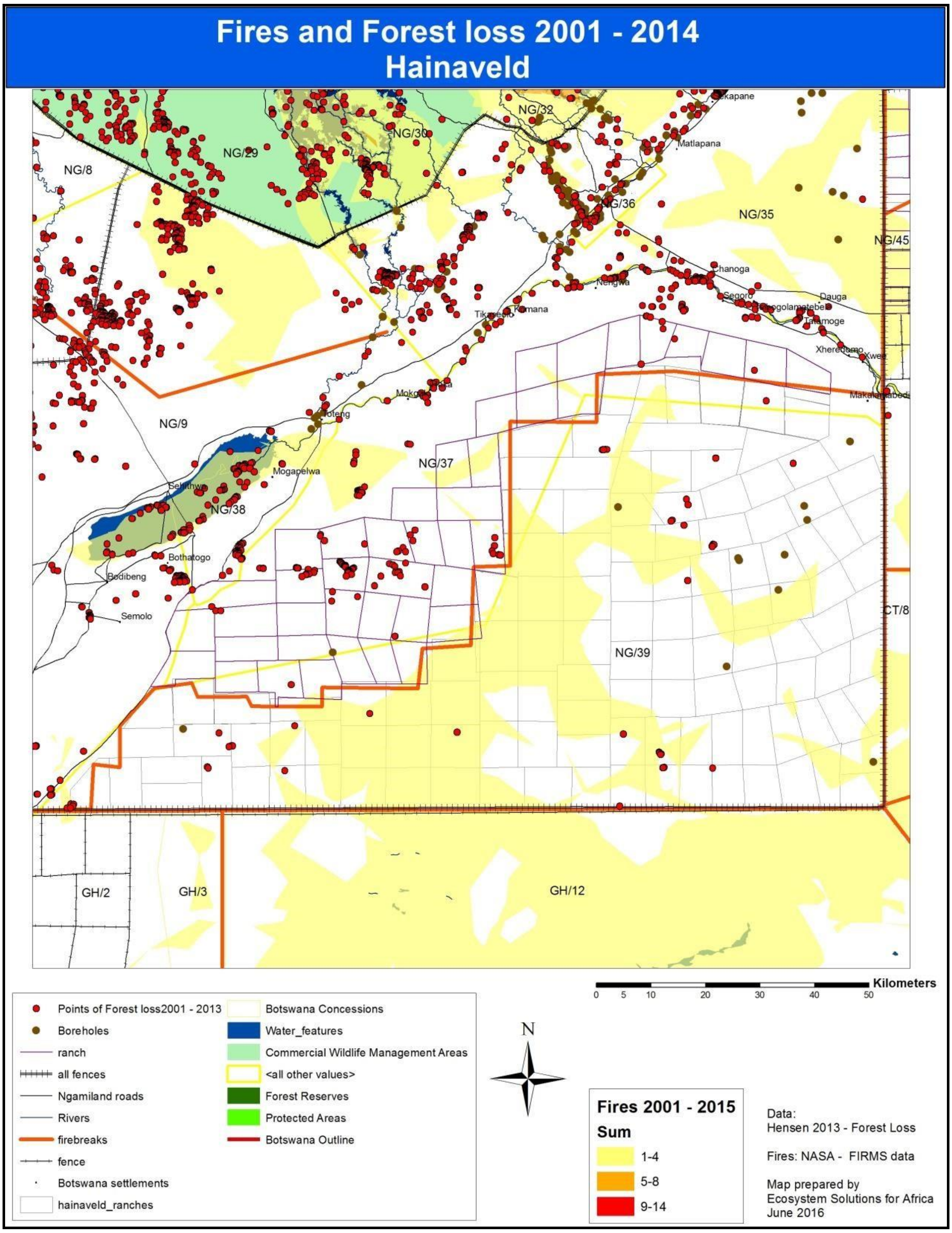

Fires and Forest loss 2001 - 2014
Hainaveld
NG/8
NG/29
NG/30
NG/32
NG/36
NG/35
NG/45
NG/9
NG/37
NG/38
NG/39
CT/8
GH/2
GH/3
GH/12
Matlapana
Chanoga
Segoro
Dauga
Nengwa
Komana
Xhereeomo
Mogapelwa
Bothatogo
Bodibeng
Semolo
Kilometers
0 5 10 20 30 40 50
Points of Forest loss2001 - 2013
Boreholes
ranch
all fences
Ngamiland roads
Rivers
firebreaks
fence
Botswana settlements
hainaveld_ranches
Botswana Concessions
Water_features
Commercial Wildlife Management Areas
<all other values>
Forest Reserves
Protected Areas
Botswana Outline
N
Fires 2001 - 2015
Sum
1-4
5-8
9-14
Data:
Hensen 2013 - Forest Loss
Fires: NASA - FIRMS data
Map prepared by
Ecosystem Solutions for Africa
June 2016

Figure 44 Fires and Forest loss (2001 – 2015) Hainaveld

Forest loss in the Hainaveld over 2001 – 2015 is largely attributable to the development of Boseto Mine (See Figure 44 above) rather than veld fires, which are in fact relatively infrequent (See Figure 45 below).

Number of Fires: 2001 - 2014: Hainaveld

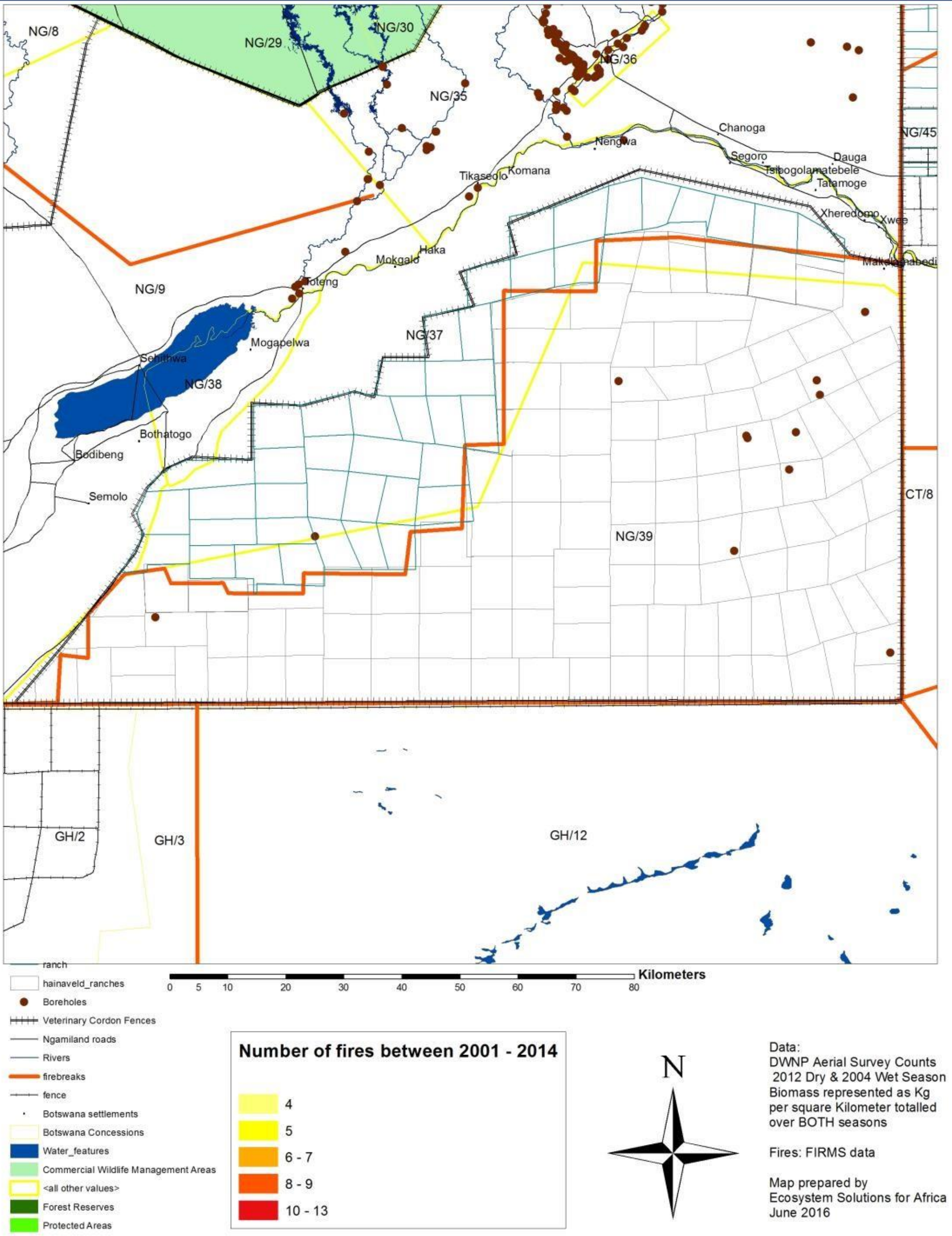


Figure 45 Number of fires 2001 – 2014 Hainaveld

The MODIS analysis undertaken by SAREP/USFS showed that most fires (2003 – 2012) occur in the dry season between July and September, with wet season (JanMarch) fires concentrated in the Okavango Delta and rare on the dry sandveld areas of Ngamiland District (Figures 46-49). The Hainavled Farms show relatively high fire occurrences in the period Oct-Dec.

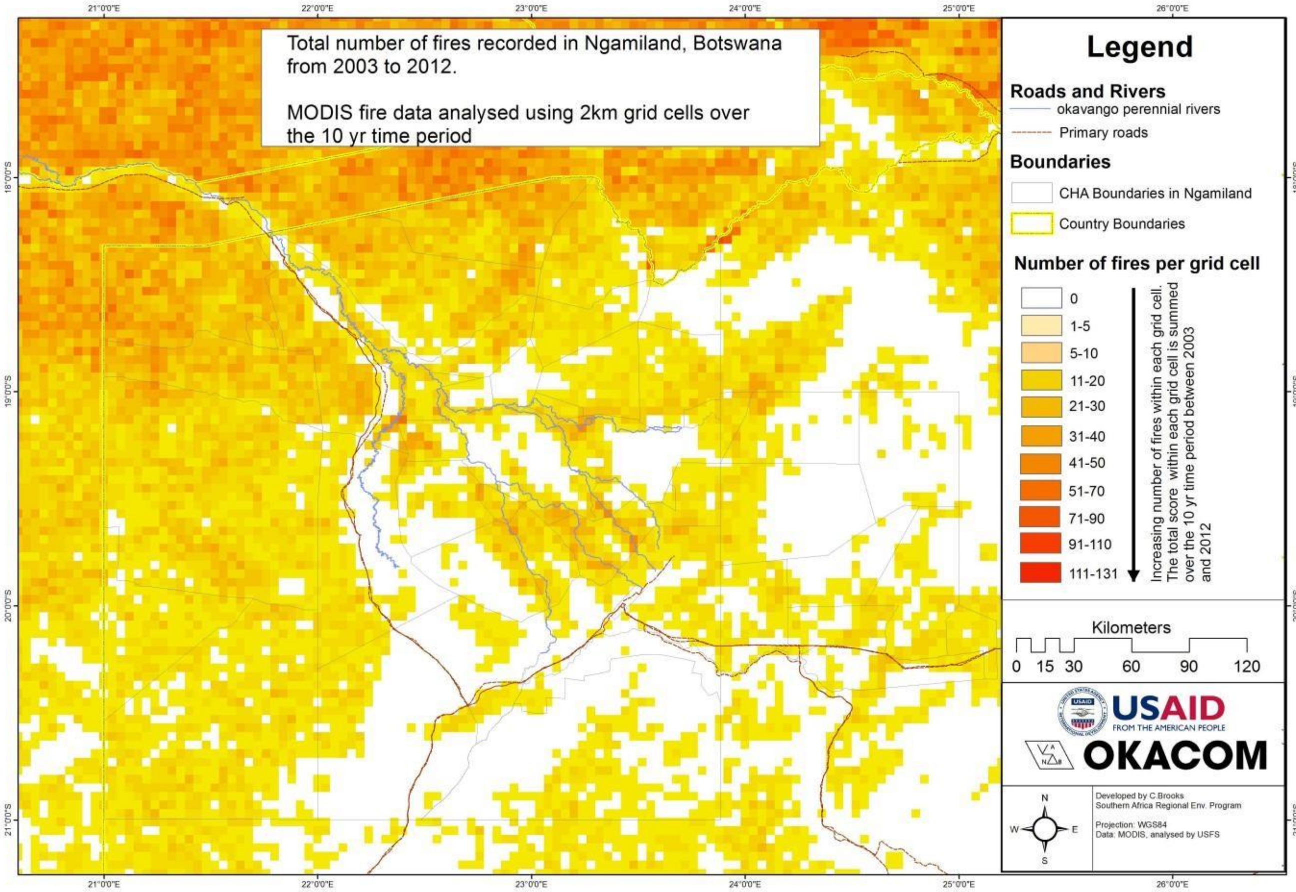


Figure 46 Total number of fires recorded in Ngamiland (2003 – 2012)

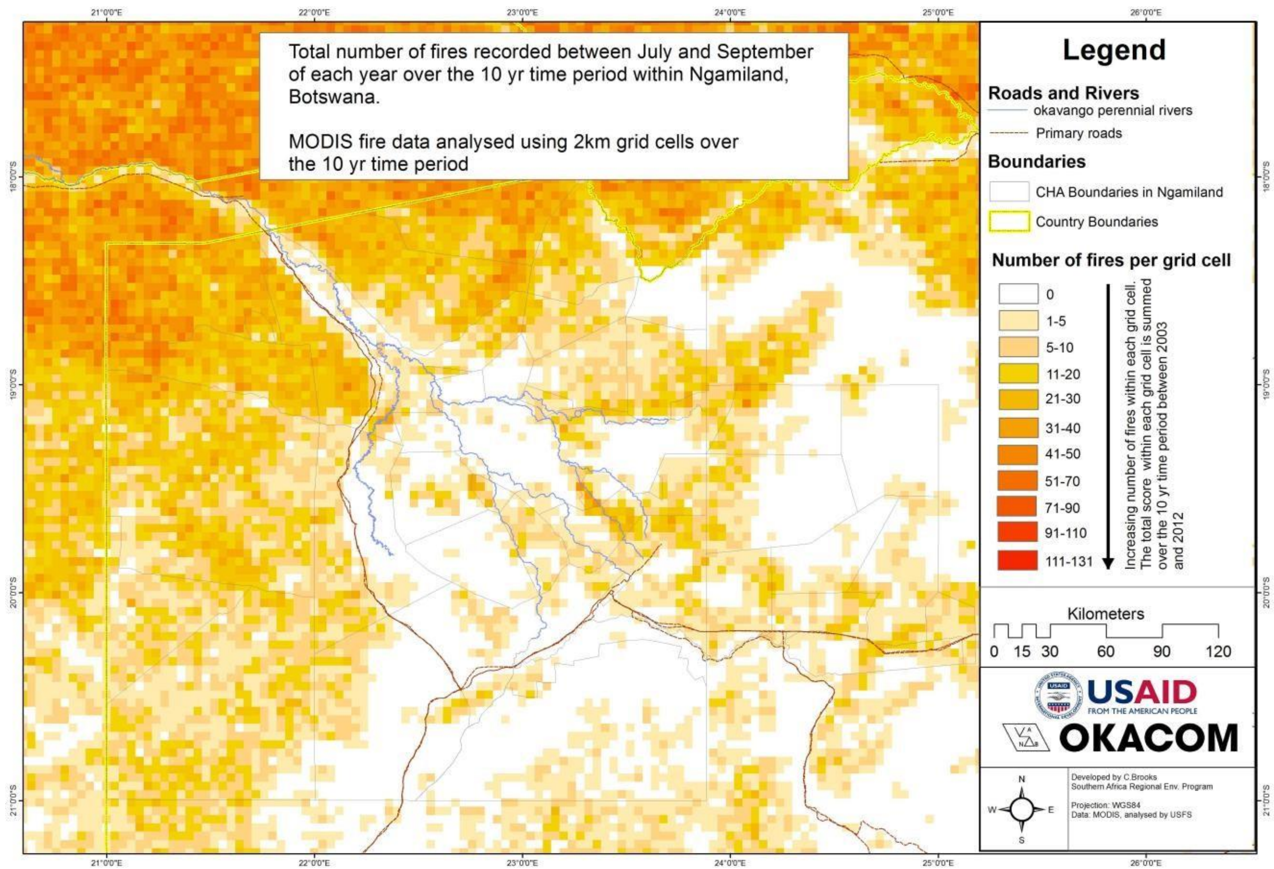


Figure 47 Total number of fires recorded between July and September (2003 – 2012)

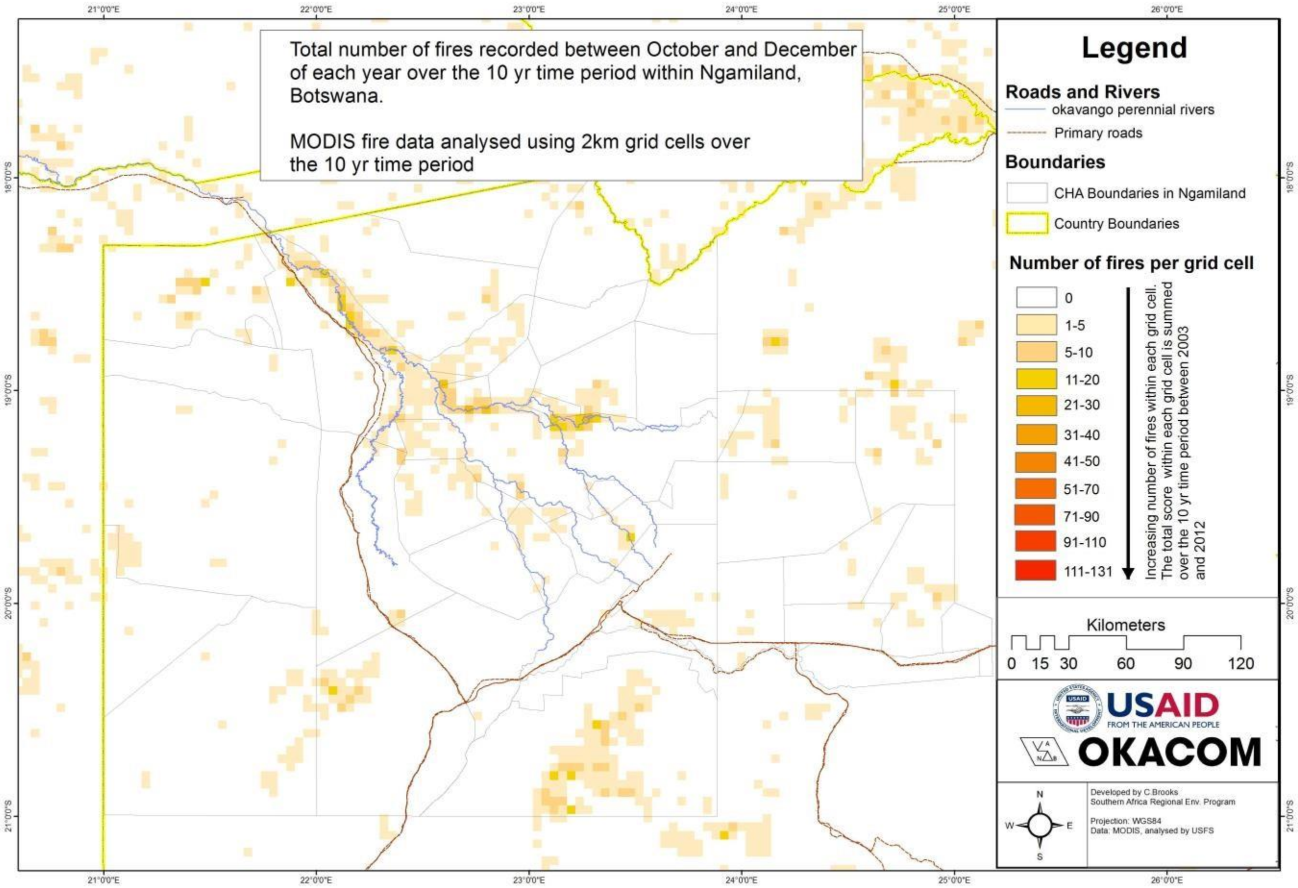


Figure 48 Total number of fires recorded between October and December (2003 – 2012)

African savanna fires annually burn thousands of square kilometres of vegetation and because of their vast extent have regional and global impacts (Laris, 2005). The fires emit large amounts of greenhouse gasses and aerosol particles and can drastically alter vegetation cover (Laris, 2005). Early dry season fires are generally considered to be damaging, having the effect of accentuating the seasonal drought (Gillon, 1983) by initiating the renewal of grass biomass at a time of declining soil moisture and nutrient availability.

Frequent burning of the savanna is also thought to result in land degradation and loss of biodiversity. Large trees (5 m in height or more) play an important ecosystem function, and are associated with a stable ecological state in the African savanna (Druce *et al,* 2008), with their loss therefore critical. Field experience indicates that when the standing crop of grass >4000kg/ha in African grasslands and savannas then the grass sward has become moribund and/or unacceptable to grazing animals and needs to be defoliated by burning or some other means (Trollope, 1999).

Lightning frequencies and related fires are highest at the end of the dry season, with this factor likely to have been important over an evolutionary time scale (Manry and Knight, 1987). Today it seems likely that recent fires in western Ngamiland are more severe and widespread than they were in the 1960s and 1970s, because:

- the current almost unprecedented low in large herbivore wild biomass in the Kalahari system, has meant that there is a large standing dead biomass of grass after good rainfall years on wildlife dominated rangelands; and
- the ban on veld fires resulted in the general absence of hunter-gatherer burning practices.

It seems likely that most fires that burnt in Ngamiland in the dry season (AprilOctober) appear to be associated with human movements in the area. The latter are concentrated upon the local road and track network, between settlements, that exists in the region and along fence lines. The Hainaveld Farms with their relatively dense network of access roads and fencelines constitue the most _accessible‘ part of Ngamiland District with the high number of dry season fires quite striking as a result, Accessible areas like Lake Ngami and Tsau simply cannot burn in the dry season because the high stocking rates on these communal lands have removed the available grass biomass.

NFS (1992) referred to a "savannisation" process occurring in the extensive rangeland areas of Northern Botswana, which were gradually becoming more open, following a reduction in total tree cover and an accompanying increase in fire and elephant resistant shrubs, such as *Dichrostachys cinerea, Baphia obovata, Combretum spp* and *Bauhinia macrantha.* The high incidence of fire was explicitly recognised as the principal cause of this structural and compositional change of the vegetation. It seems likely that primarily through extensive and severe bush fires a similar process of "savannisation" is occurring in north western Ngamiland.

Following from this, Trollope *et al* (2006) make a number of recommendations for fire management in Ngamiland, such as _reduce fire frequency to a rate of one in 3-5 years and promote cool burns'.

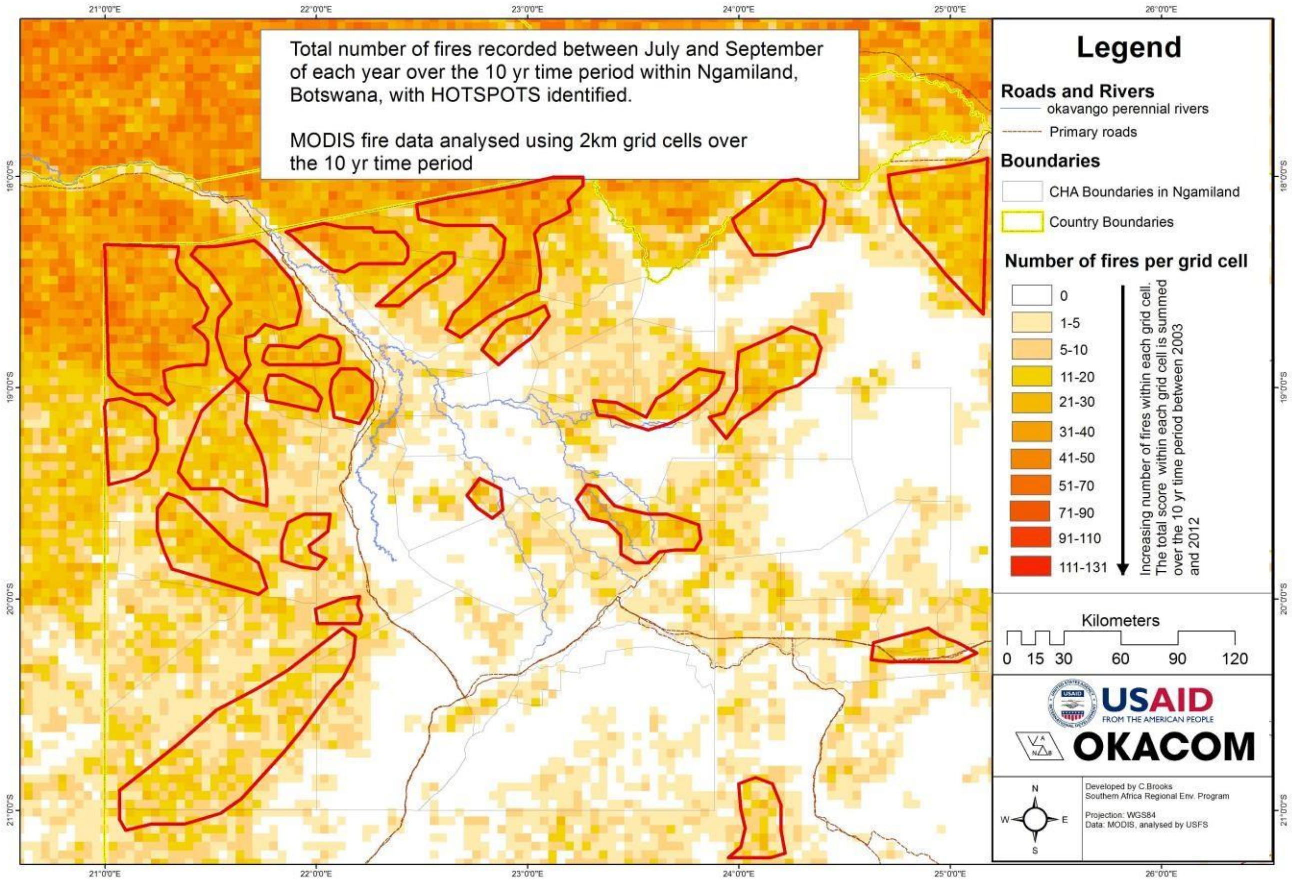


Figure 49 Total number of fires recorded between July and September (2003 – 2012) with hotspots identified

5.2.7 Livestock, fire and range degradation

The analysis of the SAREP/USFS remote sensing data reveals some interesting trends that are also clearly visible on the ground. In cases where livestock numbers are high, such as around Lake Ngami, there simply cannot be veld fires due to the absolute lack of herbaceous biomass. Fires can occur in livestock dominated areas such as the Hainaveld farms because:-

- Many Farms are unoccupied due to the lack of water and/or abandonment since the CBPP outbreak in 1995.
- Due to the piosphere effect many Farms have an _overgrazed' zone around the kraal-waterpoint axis and felatively abundant grass biomass at a distance of 12kms and beyond from the waterpoint.

See Figure 50 and 51 Below – From SAREP/USFS

5.2.8 Remote sensing of piosphere effect

Piospheres form as a result of grazing impacts around permanent water points, and are of particular concern in semi-arid savannas. Piospheres lead not only to a decline in vegetation cover, but also to a shift or decrease in species composition, and to changes in soil chemistry, resulting in rangeland degradation. Remote sensing provides an opportunity to assess the extent and distribution of the piosphere effect across the broader landscape (Washington-Allen et al 2004). For this study, Landsat 8 imagery for the peak growing season in 2016 was examined, drawing on the mid-infrared (showing soil brightness), near-infrared (showing vegetation reflectance) and red (vegetation absorption). The number of piospheres in the different areas were counted, and the average radiating extent of the piospheres was estimated.

Only a handful of piospheres were detected in the 2016 peak growing season Landsat 8 imagery for NG2. This provides a useful comparison with the other two focal areas. With water only available during the wet season, grazing in this area is based on short duration, intense usage, with nominal effect on vegetation composition and distribution. Those piospheres that do exist are primarily the villages of NxauNxau and Chuchumuchu, and the 5 settlements located in the west along the track connecting the two villages. By contrast, both the Lake Ngami area and the Hainaveld ranches are a polka-dot pattern of exposed soil points – even though this is the peak growing season (Figure 52). In this figure, yellow and pink tones indicate areas where soil is exposed, or where vegetation is extremely sparse.

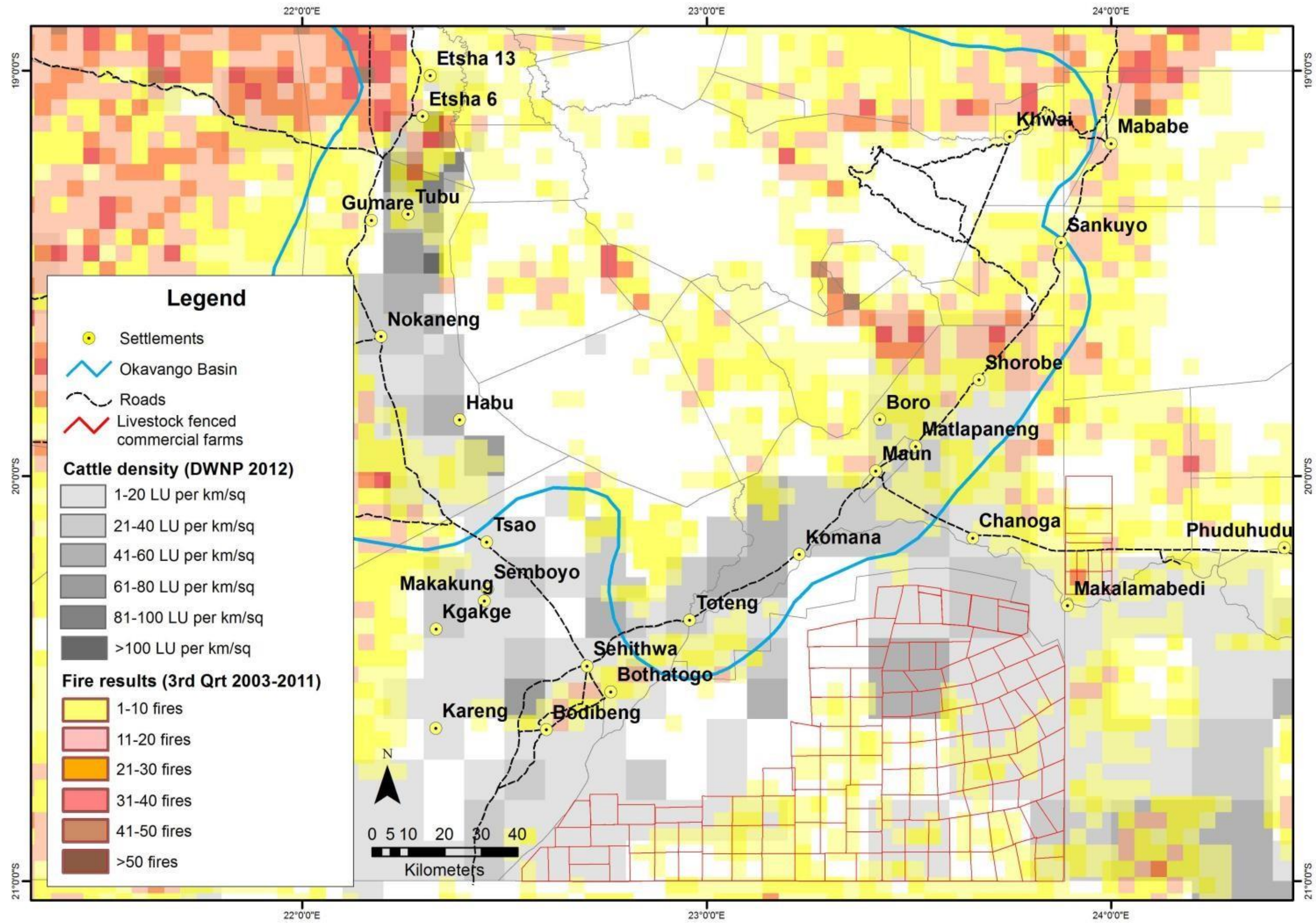
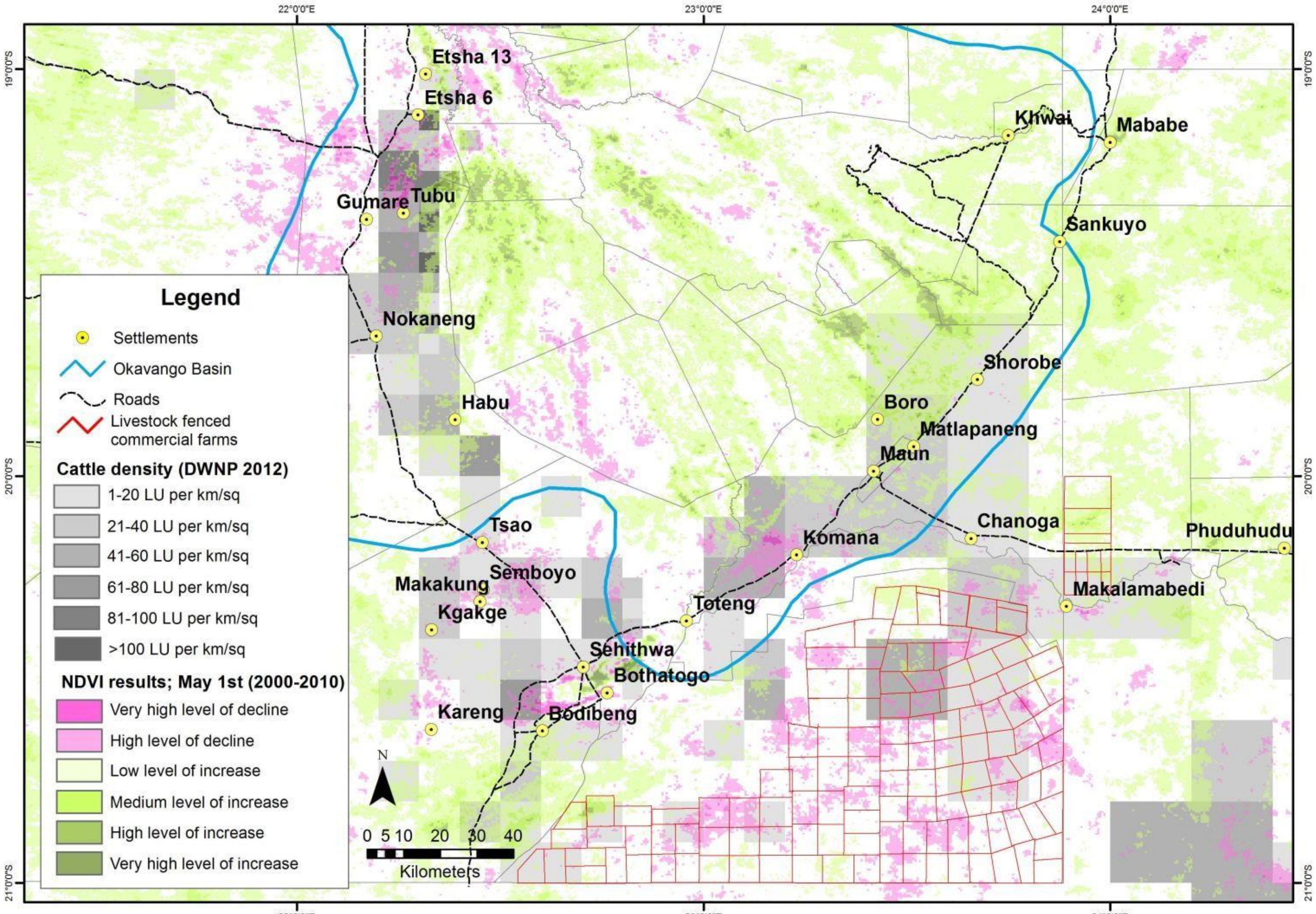


Figure 50 Livestock and fire distribution in the Hainaveld farms



22°0'0"E
23°0'0"E
24°0'0"E
19°0'0"S
20°0'0"S
21°0'0"S
Etsha 13
Etsha 6
Khwai
Mababe
Gumare
Tubu
Sankuyo
Nokaneng
Shorobe
Habu
Boro
Matlapaneng
Maun
Tsao
Chanoga
Phuduhudu
Komana
Semboyo
Makakung
Makalamabedi
Toteng
Kgakge
Sehithwa
Bothatogo
Kareng
Bodibeng
Legend
Settlements
Okavango Basin
Roads
Livestock fenced commercial farms
Cattle density (DWNP 2012)
1-20 LU per km/sq
21-40 LU per km/sq
41-60 LU per km/sq
61-80 LU per km/sq
81-100 LU per km/sq
>100 LU per km/sq
NDVI results; May 1st (2000-2010)
Very high level of decline
High level of decline
Low level of increase
Medium level of increase
High level of increase
Very high level of increase
N
0 5 10 20 30 40
Kilometers

Figure 51 Cattle density (2012) and NDVI (May 1st, 2000 – 2010

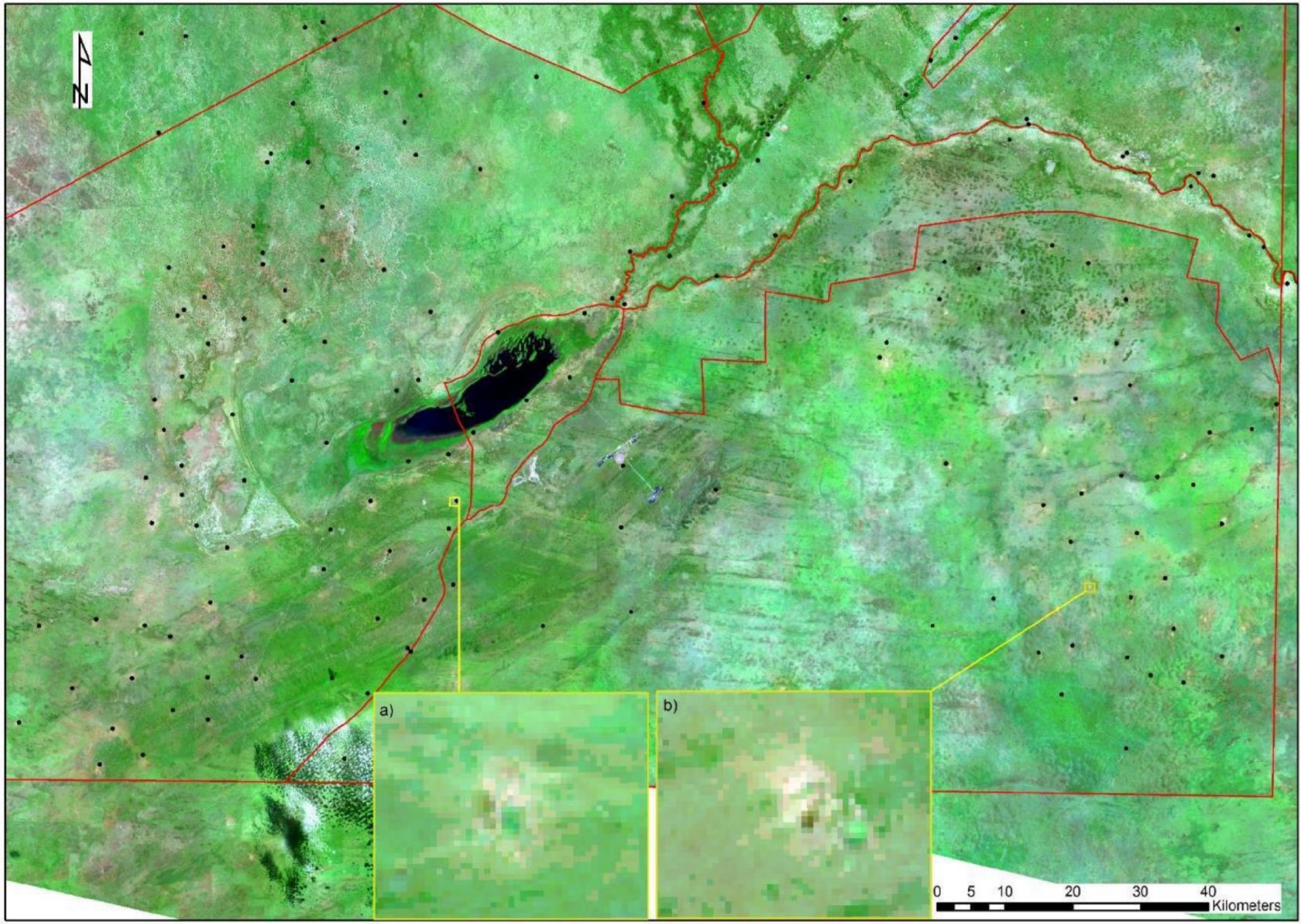
Although not verified by groundtruthing, the analysis of the imagery suggests that in the Lake Ngami area, there are approximately 60 piospheres, of which about 45 are wellestablished – either because they have existed for some time, or because they have large herds. In the Hainaveld, there are approximately 50 piospheres, almost all of which are well-established. There appears to be very little difference between the communal grazing areas of the Lake Ngami area and the privatised grazing ranches of the Hainaveld – whether in terms of the number, distribution or even size of the piospheres associated with water points. This would suggest that, for the most part, there is very little difference in the livestock and grazing management practices conducted by most farmers in the Hainaveld compared to those in communal lands. Typically piospheres form where animals are left to graze unherded, being drawnback to the kraaling area by the availability of the water.

The average diameter of complete denudation is around 500m around each water point (Figure 52, insets a) and b)). However, loss of vegetation typically extends across a 5 km diameter during the peak growing season, with this area increasing as the seasonal year progresses. This represents a substantial impact on available rangeland – a 500 m diameter of no vegetation represents a loss of 19.6 hectares per waterpoint, and a 5 km of impacted vegetation represents an area of degradation reaching 1960 ha per waterpoint. The combined impact, looking at all the piospheres together, represents localised impacts on about 78,400 ha in the Hainaveld, and about 117,000 ha in the broader Lake Ngami area. At the same time as these piospheres are a source of concern, they also indicate how water availability can be used to regulate grazing integrity. By piping water to a moveable point some distance from the borehole, the intense grazing effect can be shifted across the rangeland.

The ability to detect and measure piosphere effects using readily available and up-to-date satellite imagery provides an opportunity to monitor the extent to which farmers are succeeding in managing grazing intensity through rotational efforts either associated with water provision, or with paddocking.

Figure 52 Landsat 8 imagery for the Lake Ngami and Hainveld farm areas from peak growing season (mid-April – mid-May) in 2016

(See Below, highlighting grazing piospheres, most – but by no means all – of which are associated with the cattlepost GIS layer sourced from DSM. Insets from a) Lake Ngami area and b) Hainaveld are selected to indicate the similarity of the process under both the communal and the privatised grazing regimes).



N
a)
b)
0 5 10 20 30 40
Kilometers

6 GROUND BASED SURVEY

The principal aim of the field based survey is to provide greater detail on the nature and extent of the changes that are occurring in the herbaceous and woody layer as a result of range degradation within the three focal areas. A field assessment of each area in turn allows for a comparison both within and between the focal areas of key variables related to rangeland quality and resilience.

Methodology

Within Botswana and across Southern Africa a great diversity of rangeland monitoring and management techniques have been tried including for example the classic methods of rangeland assessment within the increaser (sour)/ decreaser (sweet) grass concept that has so characterised South African Range Assessment (Tainton, 1999). The Botswana Range Inventory and Monitoring Project (BRIMP) (Phase I) undertook an exhaustive review of range assessment methodologies and established a field approach and data sheet that served the needs of both DWNP and MoA (Perkins, 1997).

The assessment methods utilised can all be linked to the four principal ecosystem processes as detailed in Holistic Rangeland Management. These are: community dynamics, the water cycle, the mineral cycle and energy flow. The final datasheet developed was based on the BRIMP datasheet whilst also incorporating tried and tested Holistic Ecological Monitoring indicators (Savory Institute, 2015).

During the NG/2 and Lake Ngami surveys sample sites were provisionally identified along pre-defined survey routes prior to undertaking the survey based on an assessment of available satellite imagery. Sample sites were adjusted in the field as necessary to ensure an even assessment of habitats and to account for the influence of water points or kraals with sites separated by between 3 and 6 km.

The method used allowed the survey to take place across as wide and varied an area as possible to provide a good overview of the range conditions in each study site. Sites were surveyed that were both close to (250m – 1km) known kraals or water points as well as far away (>5km) from these concentration points.

Around Lake Ngami survey routes were selected, where possible, perpendicularly to either Lake Ngami or known concentrations of kraals/cattleposts to capture vegetation gradients as you move away from concentrated use areas. This meant that survey routes were restricted by the presence or absence of tracks or roads across the study area.

During the Hainaveld survey, the central kraal or homestead of each farm was visited prior to undertaking sampling. This allowed for the farm staff to identify to the survey team all water and kraal points on the farm as well as rested or grazed paddocks if applicable and the available road network. Sample sites were then identified along survey routes running perpendicular to the central kraal or water point. The external fences and clearly demarcated nature of the Hainaveld Ranches meant that sample sites were typically separated by 1 – 2 km with a minimum of 3 sites per farm or 3 sites per grazed/rested paddocks if the farm if applicable.

At each survey site a single circular area with radius 25m was assessed. An assessment was made of the ground cover and the contribution of herbaceous and woody plant material to that ground cover. Healthy soil should be covered with living plants and vegetative litter

with small gaps between plants and a low percentage of bare ground. The extent of soil capping was recorded at each site together with the amount of vegetative litter (dead leaves and stems) and the impact of domestic animals or wildlife on the soil surface.
A photographic record of each survey site was recorded through the capture of three photographs. One photograph was taken looking straight down, one at a 45 degree angle and one with the full vegetation line including 1/3 horizon in the photograph. This process allows you to record the available soil conditions and cover, the make-up of the available vegetation and specific vegetative characteristics of the site. Photographs can easily show changes over time and may provide significant insights into both positive and negative changes.

All of the grass species identified within a 25m radius of the site were recorded together with the ratio of annual to perennial grasses. Other herbaceous species (herbs and forbs) were recorded where identifiable and the five most abundant woody species were also recorded together with an assessment of the canopy cover.

Finally, the STAC method as practised in Holistic Range Management was utilised to assess the forage (Grass, Bush, Shrubs, Forbs, Leaves and Weeds) available to livestock and game animals at each site (Richardson 2011). STAC stands for Sole, Toe, Ankle and Calf. These are the points of measurement of the top of the bulk of the forage availability (plant): Sole – 15; Foot – 30; Ankle – 60 and Calf – 90. These values represent the available stock days per hectare (SDH), where 1 stock day is equal to 13kg of Dry Matter. This method permits farmers or assessors to quickly assess forage quantities by walking through their available range and measuring forage availability and volume to obtain critical information on how long the feed will last. This enables farmers to match their stocking rate to the current forage availability and help plan for future management decisions.

Alternative methods were considered to measure available forage biomass. This included the use of a Disc Pasture Meter (DPM) (Bransby & Tainton 1977) which relates the settling height of an aluminium disc 45cm in diameter and 1.5kg in weight with the biomass of the standing crop holding the disc up when dropped down a 1.5m pole which provides an estimation of biomass in kg/hectare. However, this method only measures grass biomass and cannot incorporate forbs or leaves which are also available forage to livestock or game animals. Whilst also requiring a specialised piece of equipment.

- **Processing of survey data**

The sampled sites can be grouped based on certain characteristics of the site including forage availability, ground cover, distance to water/kraals or, in the case of the Hainaveld farms, management strategy.

The surveyed sites will therefore be grouped according to the proportional availability of herbaceous and woody ground cover. This identified three classes of site which were mainly grassland (>60% Herbaceous ground cover), mainly woody species (>60% woody ground cover) and mixed vegetation (Between 40% and 60% of herbaceous ground cover) classes identified.

- **Limitations**

The principle limitation across all three of the study areas was one of access. Within NG/2 there is a very limited road network which principally follows the boundary of the area with only one road linking the northern and southern boundaries. Running through NG/2 is the Ikoga fence line but the fence line is not frequently driven and along the western end of the fence line the road is not cleared. Due to this limited access into the area it meant that significant areas were not able to be assessed on the ground, highlighting the importance of the remote sensing component. Lake Ngami, by virtue of being a well populated communal area with limited fencing, has a comparatively good road network although access through some areas, particularly to the north of Lake Ngami, was restricted. Within the Hainaveld, while many of the farms are open access with many farms only accessible by driving through neighbouring farms, there are still farms which have locks on the gates. Within each farm there is typically a limited road network, predominantly along the fence lines, which restricted site selection within each farm.

The most appropriate time to do range condition assessments is in the mid to late wet season when the seed heads are on the grasses, to ease identification, and the _recovery' of the rangeland, in terms of herbaceous cover and density can be assessed. Surveying at the end of the growing season presents some risks in assessing the quality of forage but it does allow for an identification of the quantity of forage available until the start of the annual rains. However, truly assessing species diversity is tricky as seed heads have dropped and certain annual grasses and forbs may have been heavily grazed making identification very challenging.

6.1 NG2

As a CHA the boundaries of NG2 have no biophysical, social/cultural or even land use justification for being where they are. The area is bisected by the Ikoga Veterinary Fence and access is limited to the calcrete road along the Xaudum River Valley that leads to Nxaunxau and then runs north, crossing the Ikoga fence before turning east towards Tsodilo Hills. Running east-west through the region are fossil dune and valley systems where ephemeral pans can retain water long after the last rains.

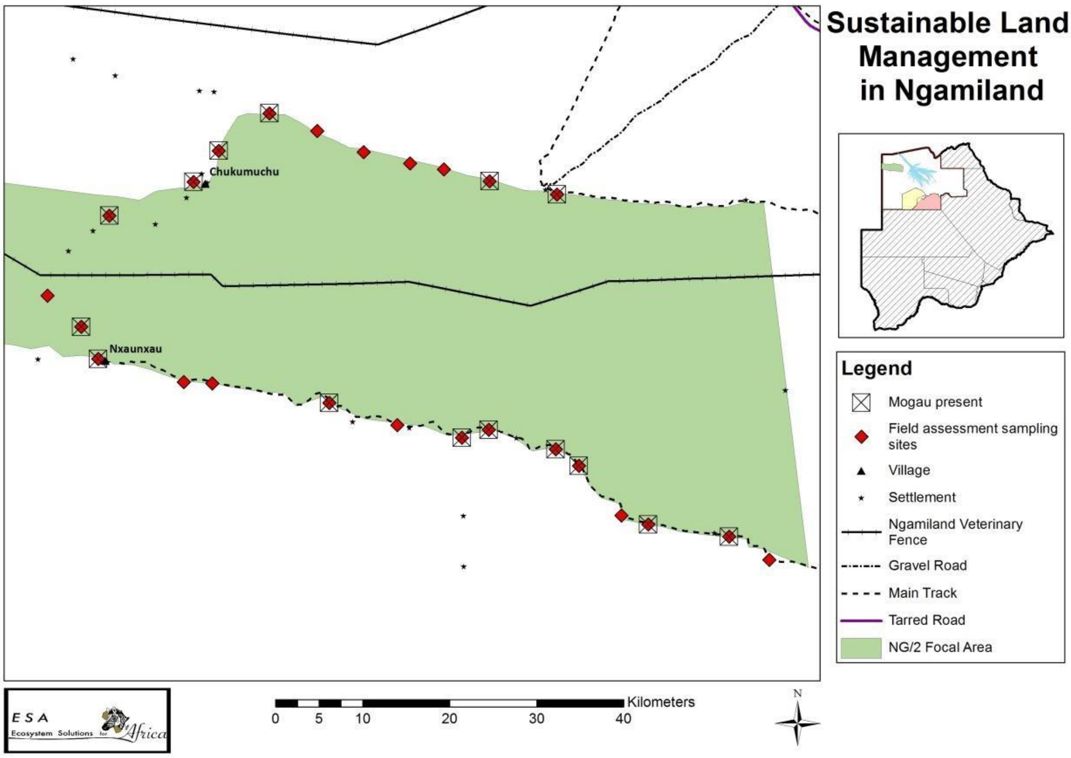


Figure 53 NG2 Focal Area with sample sites and indication of mogau presence

Cattleposts and sporadic ploughing fields are situated along the access roads to Nxaunxau and Chukumuchu with access rights to boreholes and well points. Cattle are kraaled at night and allowed to wander freely during the day with farmers keeping calves back to ensure the return of the cows each evening. Wildlife is free to roam through the area with significant elephant activity throughout the area.

6.1.1 Range Assessment

Cattleposts are located along the access roads to Nxaunxau and Chukumuchu boreholes and well points providing water which ranges from sweet to salty. Cattle use the roads as movement corridors to access ephemeral pans or preferred forage areas with a subsequent impact on the surrounding vegetation (Plate 13).

A total of 25 specific sites were assessed with range varying from heavily over-utilised within 500m of cattleposts to over-rested grasslands in areas more than 5km from the nearest known cattlepost. Across the survey sites total ground cover averaged 66% with herbaceous material making up the majority of this cover (63%). There was sporadic evidence of soil capping (7 sites) and soil erosion (11 sites) and good levels of vegetative litter at 18 sites as livestock trampled grasses while moving through the bush (Plate 13). Localised overgrazing was recorded within 500m of cattleposts or boreholes.

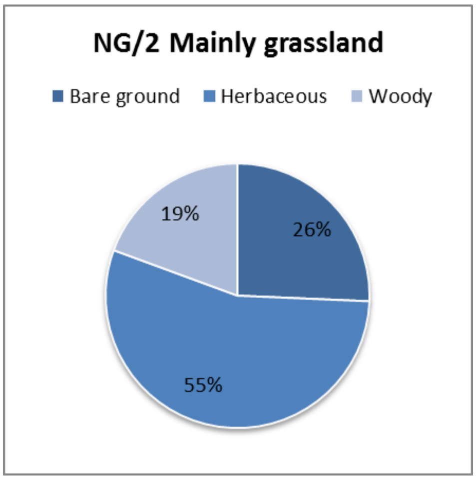
Plate 13 One survey site with a high diversity of grasses but quite sparse tufts, evidence of grazing and significant trampling to lay down vegetative litter.

Away from the cattleposts the available forage increased with vegetation ranging from bands of camelthorn woodlands to shrubbed grasslands dominated by established perennials. Within these grasslands there was very little evidence of either livestock or wildlife impact which leads to over-rested perennial grasses (*Digitaria eriantha, Schmidtia pappophoroides*) where moribund plant material builds up at the base of grass tufts and restricts fresh growth (Plate 14).

Plate 14 Over-rested *Schmidtia pappophoroides* grasses with significant evidence of moribund plant material which will inhibit fresh growth

6.1.2 Site Comparisons

Within NG/2 sample sites were grouped by the proportions of herbaceous and woody ground cover with mainly grassland, mainly woody species and mixed vegetation classes identified. In NG/2 only two sites were classified as mainly woody species with nine sites classed as mainly grassland and the remaining 14 sites classified as mixed vegetation (See Figure 54). Herbaceous vegetation provided 55% of the ground cover in the mainly grassland sites with woody vegetation only providing 19% of the ground cover (Figure 54). Mixed vegetation sites, which had an increased proportion of bare ground, had slightly more herbaceous than woody vegetation.



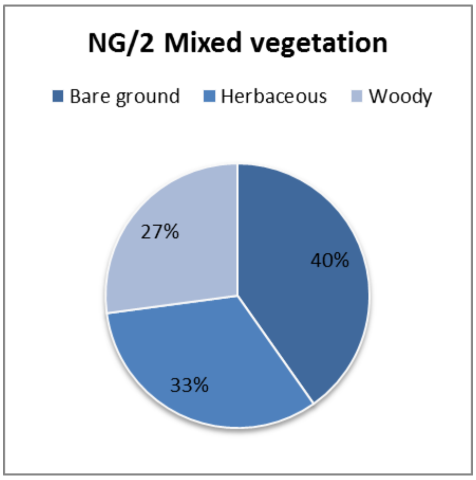


Figure 54 Proportional ground cover in mainly grassland and mixed vegetation sites

Perennial grasses comprised the major proportion of the herbaceous vegetation found in each group of sites with the proportion of annual grasses in both classes equal at 26% (Figure 55). However, in the sites which were classified as mainly grassland, 31% of the herbaceous vegetation was provided by mixed herbs and forbs.

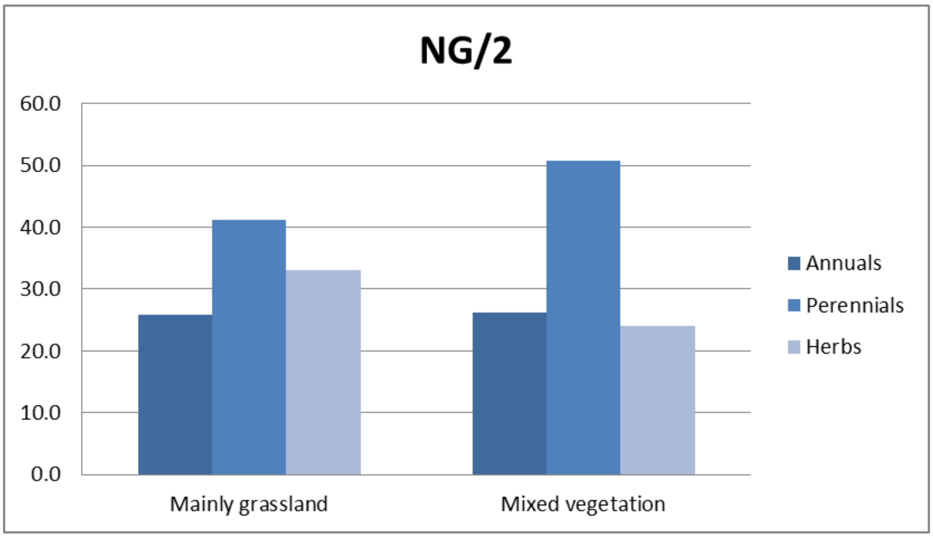


Figure 55 Proportional availability of herbaceous vegetation

Woody species availability was diverse and ranging from low lying shrubs including *Grewia* sp. to mature woodlands both along the fossil river valley (*Acacia erioloba*) and the dune ridges which comprise of soft sand and are populated by wild Seringa (*Burkea Africana*) (Figure 55). Kalahari apple leaf (*Lonchocarpus nelsii*) and purple-pod Terminalia (*Terminalia prunioides*), both woody species that provide good browsing for livestock and wildlife, were present at 14 and 12 sites respectively. Bush encroachment by *Acacia mellifera* was limited to localised areas along the Xaudum river valley access road to Nxaunxau.

Of additional interest is the presence of *Baphia massaiensis* which comprised of more than 10% of the recorded woody species in all three site classifications. *Baphia massaiensis* is commonly found in areas that are frequently burnt and provides further indication of the impact of fire in this region.

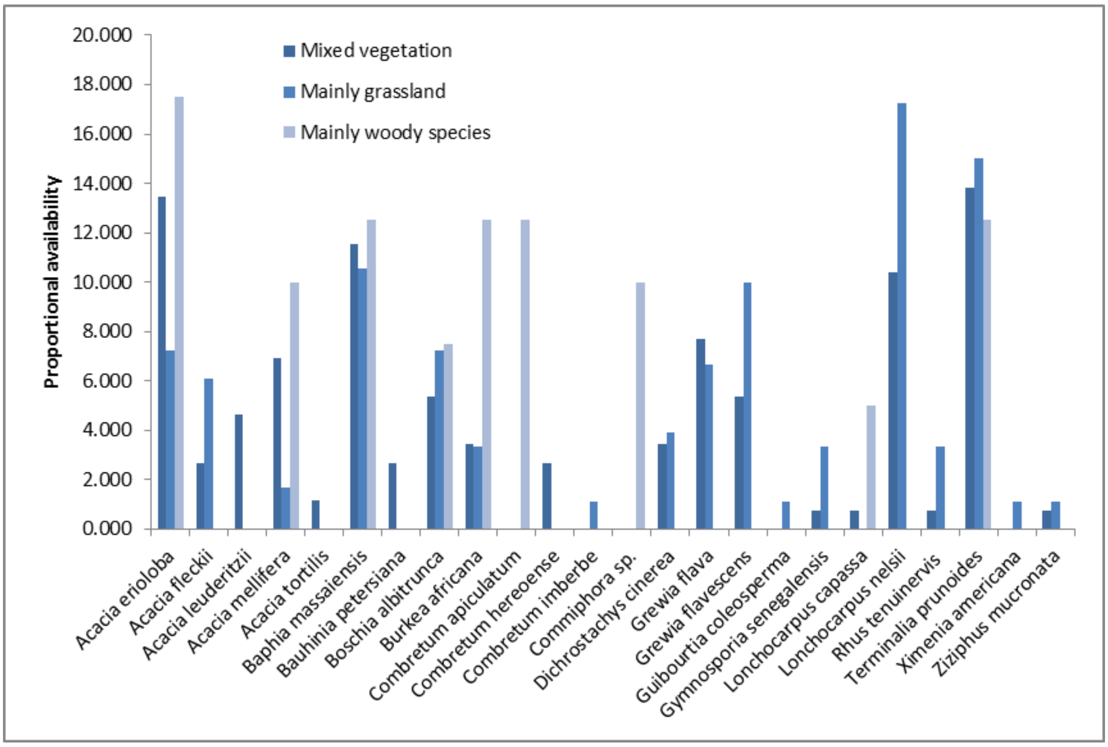


Figure 56 Proportional availability of woody vegetation at sites classified by vegetated ground cover

Overall there was good forage availability across the survey range (Figure 58). However, there was no observed piosphere effect as there was no correlation between forage availability and distance to kraals or water points ($r = 0.12$, $n = 25$, $p = 0.57$) (Figure 57). It is likely that this was influenced by livestock using the access roads, which served as the survey routes, as movement corridors with a consequent influence on the vegetation.

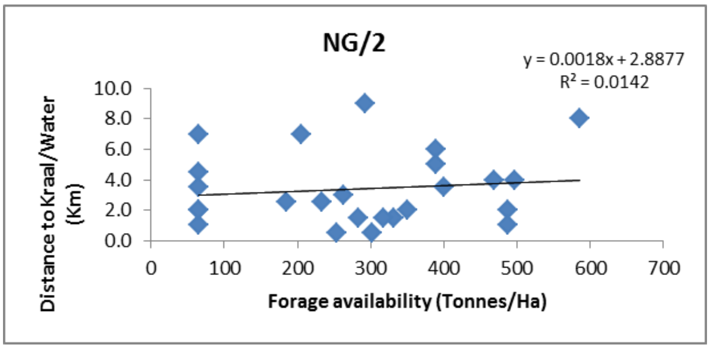


Figure 57 Correlation between forage availability and distance to kraal / water point

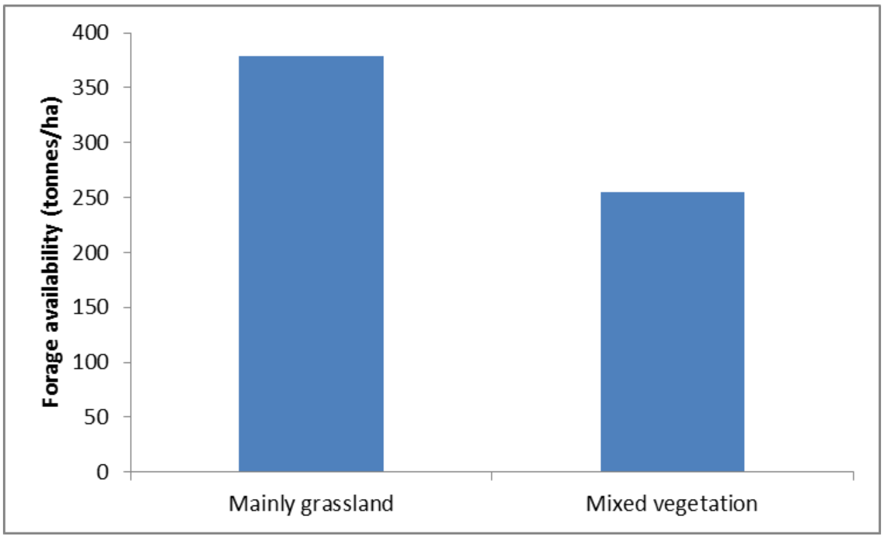


Figure 58 Forage availability at mainly grassland and mixed vegetation sites

The northern boundary of the survey area provided the greatest concentration of forage availability in open shrubbed grasslands where there is a low density of cattleposts. Along the dune valley‘s running east-west through the centre of NG/2 it is anticipated that there will be similarly high volumes of available forage together with over-rested vegetation due to low animal density and movement. A negative effect of this high biomass is an increased fire risk.

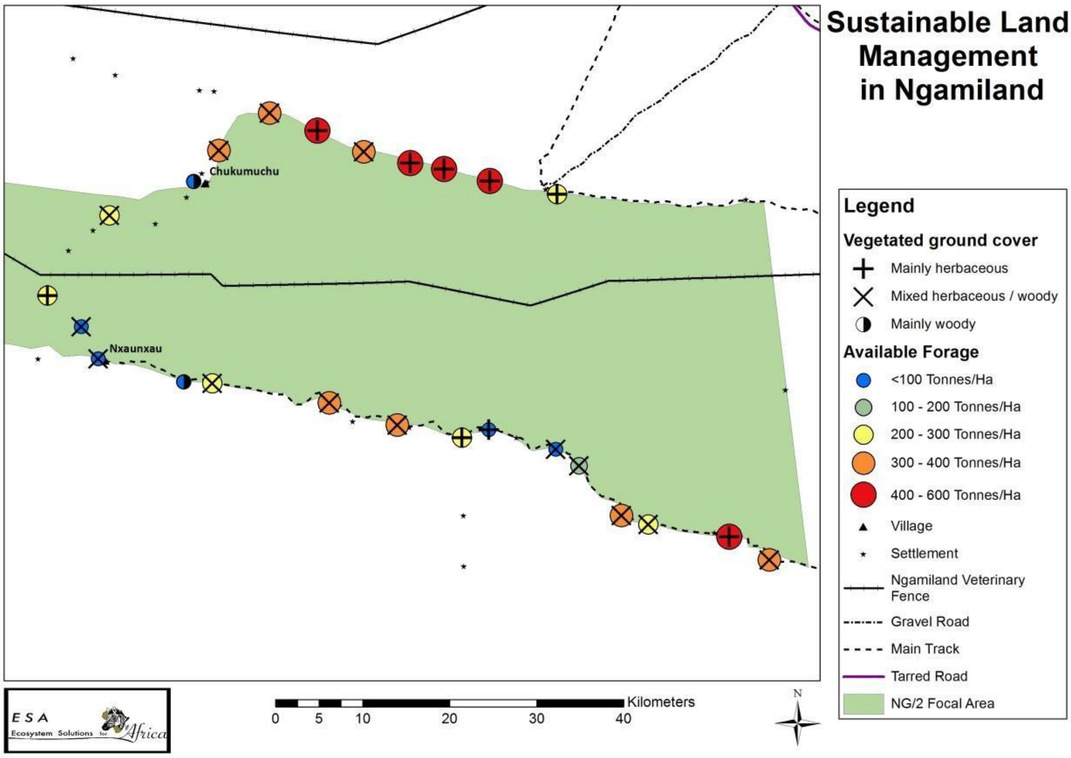


Figure 59 Forage availability and classification of sites based on vegetated ground cover in the NG/2 focal area

Across the study area elephant (*Loxodonta africana*) spoor were recorded, with particularly high densities along the Xaudum river valley on the road to Nxaunxau. Additional wildlife spoor was sparse and was predominantly steenbok (*Raphicerus campestris*) or duiker (*Sylvicapra grimmia*). The spoor of kudu (*Tragelaphus strepsiceros*) and impala (*Aepyceros melampus*) were recorded at one site each.

There was evidence of recent fires across the assessed area and typified by the presence of *Baphia massaiensis* and *Bauhinia petersiana* in the shrub layer (Plate 15). There are no fire breaks to stop the spread of fire across the region with the prevailing east winds able to drive fires along the dune valleys which run east-west.

Plate 15 Evidence of fires across NG/2 with blackened trunks of mature trees with a canopy layer above the reach of fires and low-lying pioneer shrubs and grasses

6.1.3 Dichapetalum cymosum

Within NG/2, as with much of north-western Ngamiland, the poisonous plant Mogau (*Dichapetalun cymosum*) is prevalent. *Dichapetalum cymosum* was recorded at 15 of 25 sampling sites as well as being seen widely in disturbed areas, particularly along the edges of roads. *Dichapetalum cymosum* is deep rooted and emerges before the rains commence or immediately after fires – when there is a distinct absence of green shoots. After sufficient rainfall, Mogau leaves become old and leathery, and appear less appealing to cattle (GCS, 2007).

6.1.4 Summary

Access into and across NG/2, together with the prevalence of the poisonous plant *Dichapetalun cymosum*, has limited the establishment of livestock production within this area. Much of the range is underutilised, however, the cattleposts present along the access roads are causing localised overgrazing. *Dichapetalun cymosum* is prevalent across the whole region, particularly in disturbed areas yet there was no evidence that Mogau had been grazed at any location, indicating that the livestock of the region have adapted to its presence.

Forage availability is high across much of the study area providing a large volume of flammable biomass which exposes the area to large bush fires. The impact of fires across this area was particularly noticeable with changes in vegetation structure and diversity evident.

- Mogau (*Dichapetalun cymosum*) is prevalent across the region.
- Limited accessibility and limited water availability, together with the presence of Mogau, results in the under utilisation of large areas of NG/2.
- There is good forage availability across much of the assessed area with a good diversity of established perennial grasses and some evidence of over-rested plants.
- Localised overgrazing occurs within 500m of cattleposts.
- Fires play a significant role across the study area affecting vegetation structure and diversity.
- There was limited evidence of large herbivores other than elephants.
- Elephants move through the dune valleys and farmers are reporting an increasing. level of conflict with them as they visit cattle posts at night searching for water.

6.2 Lake Ngami

Lake Ngami attracts cattle from up to 10km away as a source of drinking water, even when water is also provided at the kraal. Surrounding the lake is a dense ring of kraals which were previously established on the lake bed prior to the return of the water.

The areas surrounding Lake Ngami are a communal grazing area with no fenced rangelands extending north from the Hainaveld protection fence up to the Setata veterinary fence. North of the Setata fence there are also the communal rangelands surrounding the village of Tsau. Between the fences livestock are able to move freely, constrained only by the requirement for water. Cattle are free to graze in any area they choose with limited herding of cattle practiced.

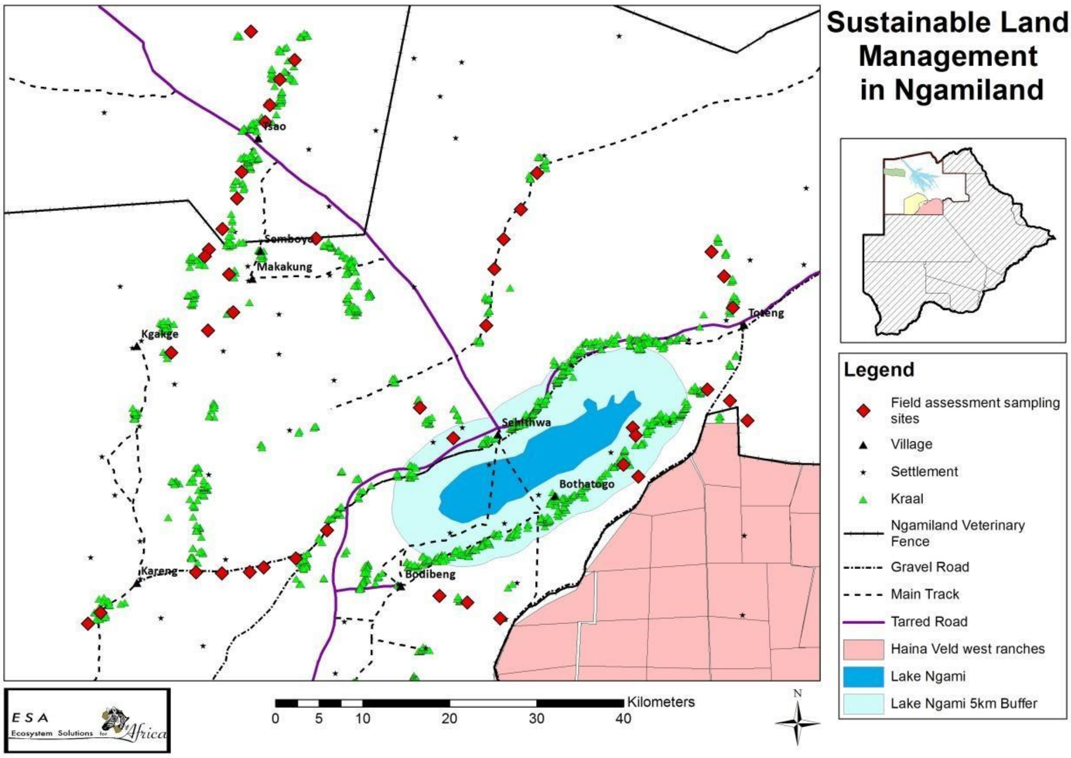


Figure 60 Lake Ngami focal area

Along the eastern and southern edges of the lake the available foraging area has been compressed following the installation of the Hainaveld protection fence. At its closest point the fence is <6km from the lake edge. This fence prevents cattle from the communal areas from foraging within the Hainaveld West area, whilst also preventing cattle from these ranches from drinking at the Lake and grazing within communal lands. However, during the recent field surveys this fence was seen to be damaged and laid flat in at least two locations, allowing the free movement of livestock between the areas (Plate 16) whilst also compromising the protected nature of the Hainaveld Ranches.

Plate 16 The Hainaveld protection fence, damaged in places allowing the free movement of livestock and wildlife between Hainaveld west and the Lake Ngami area

6.2.1 Range Assessment

A total of 43 specific sites were assessed both around the fringes of the lake and across the surrounding rangelands. Around the edges of the lake bed are reeds *(Phragmites australis*) and various sedges (e.g. *Cyperus, Eleocharis spp,* etc.,) as well as mat-forming perennial herbs such as *Glinus oppositifolius* and annual *Hibiscus sp.* Herbs (Plate 17). The alien invasive, the common cocklebur (*Xanthium strumarium*), forms densely packed thickets and can form a monoculture over the Lake bed (Plate 18). The plant is a host for a number of pathogens and the young leaves are poisonous to stock.

Plate 17 Vegetation around the edge of Lake Ngami


Plate 18 The alien invasive *Xanthium strumarium* around the edge of Lake Ngami


Within 5km of the lake edges the available rangelands were typically heavily over-grazed with bare soils and relatively open stands of mature *Terminalia* and *Combretum* sp. interspersed with camel thorn (*Acacia erioloba*) and umbrella thorn (*Acacia tortilis*) (Plate 20). The high concentration of livestock movement through these areas ensure that the soils are not capped and with little vegetative litter on the soil surface. As you move away from the principal access roads and water sources then forage availability increases with some pockets of good vegetation remaining.

To the north-west of Lake Ngami, towards the villages of Semboyo and Kareng, are lowlying pans surrounded by acacia shrubland. The underlying substrate is very fine clay to sandy loams and years of high intensity grazing has left the soils bare, with little herbaceous vegetation, and evidence of soil capping and erosion (Plates 19 and 20). Where grasses are present then annual grasses such as *Schmidtia kalahariensis* and *Urochloa tricopus* dominate yet these grasses are sparse and heavily over-grazed leaving little vegetative litter on the soil surface.

Plate 19 Pan grassland on the road to Kareng with well-defined livestock trails

(Well defined livestock trails and low-lying acacia shrubs. Livestock drink at these watering points and then walk 20-25km to find suitable forage resources)

Plate 20 Heavily over-utilised areas to the west of Kareng with no grasses remaining and little, if any, herbaceous ground cover

6.2.2 Site Comparisons

The 43 sites surveyed across the Lake Ngami region can be grouped according to proportional availability of herbaceous and woody ground cover with mainly grassland, mainly woody species and mixed vegetation classes identified. At nine sites herbaceous vegetation provided 57% of the ground cover with woody vegetation comprising of only 16% and bare ground 27% (Figure 61). In mixed vegetation areas, 18 sites, the proportion of bare ground had almost doubled to 48% whilst the availability of woody vegetation had also increased. In sites classified as mainly woodland, 16 sites, only 33% of the ground was covered by either herbaceous or woody vegetation. Of this ground cover, only 7% was provided by herbaceous vegetation.

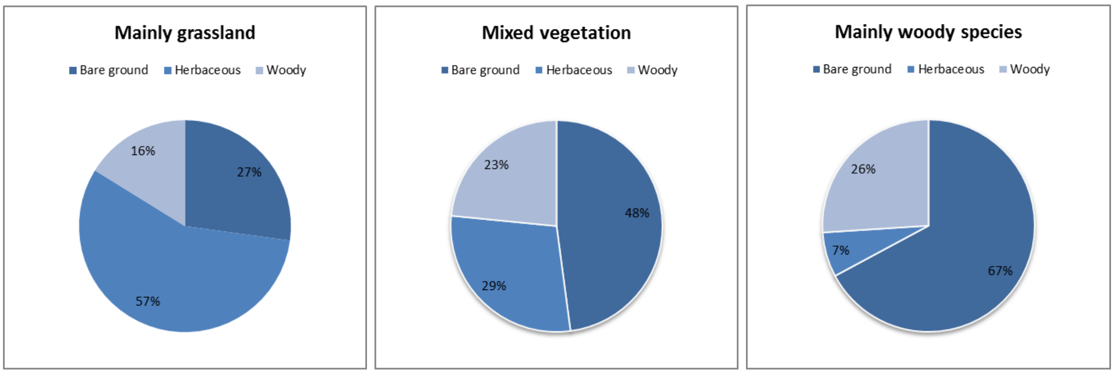


Figure 61 Proportional ground cover in mainly grassland, mixed vegetation and mainly woody species sites near to Lake Ngami

Of the herbaceous vegetation present at both the sites classified as mainly grassland, and those with mixed vegetation, more than 50% comprised of annual grasses (Figure 62). The sparse tufts of annual grasses such as *Urochloa trichopus* are heavily overgrazed. Mixed herbs and forbs comprised of 20% and 30% of the groundcover respectively. The herbaceous plants present in these areas are dominated by forbs including Devil‘s thorn (*Tribulus terrestris*) and Paper thorns (*Alternanthera pungens*). Herbaceous vegetation covered only 7% of the sites classified as mainly woodland and the high utilisation of these sites ensured that it was very dificult to classify this vegetation.

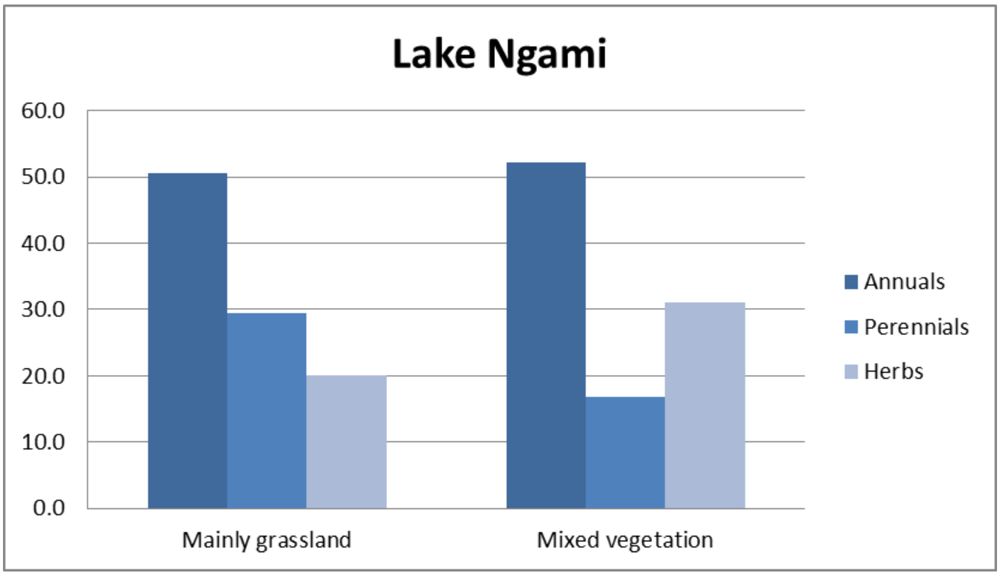


Figure 62 Proportional availability of herbaceous vegetation near Lake Ngami

When foraging within these areas livestock are largely reliant on browse with a clear browse line at approximately 2m seen on many of the trees and shrubs. Of particular importance are the *Combretum apiculatum* and *Terminalia prunoides* shrubs and trees.

Whilst there was a diverse array of woody species identified during the survey, the proportional availability of many of these species was less than 5%. The region is dominated by acacia species with *Acacia mellifera* comprising of 30% of the available woody vegetation across all sites and *Acacia tortilis* adding a further 15% (Plate 21). Particularly dense stands with little understorey herbaceous vegetation are located to the north of the tar road linking Maun with Ghanzi (Plate 22).

Plate 21 Treed vegetation in the areas surrounding Lake Ngami

Plate 22 Dense stands of *Acacia mellifera* and *Acacia tortilis*

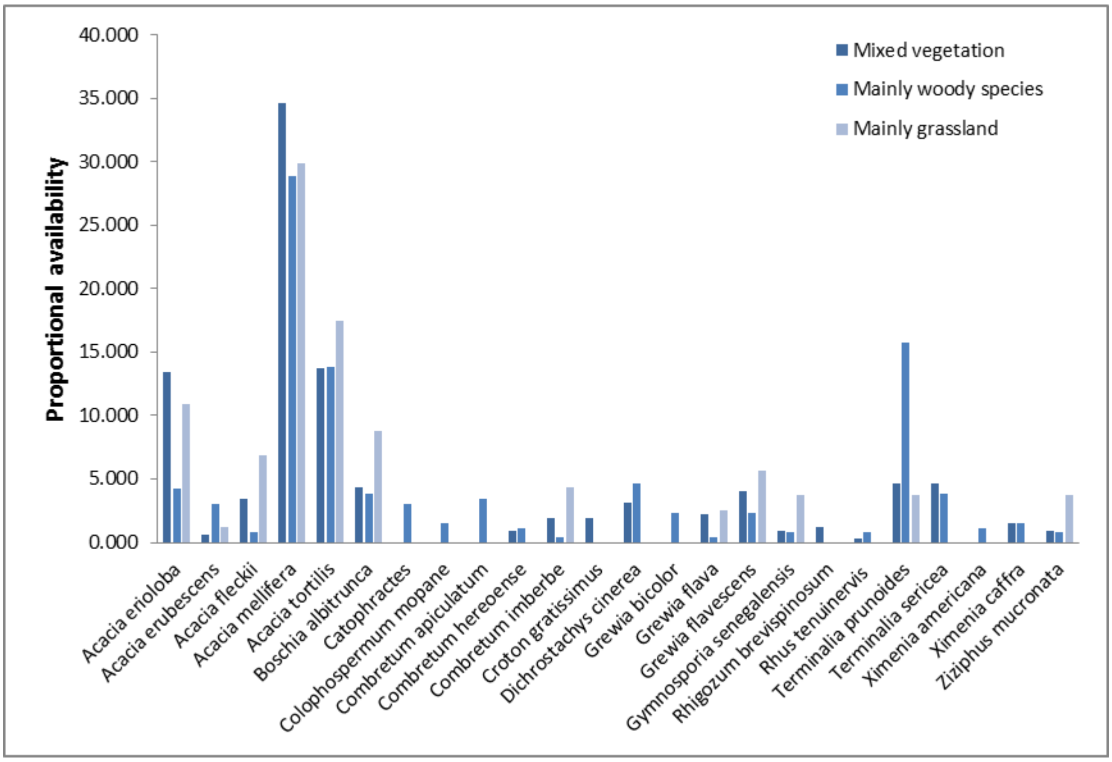


Figure 63 Proportional availability of woody vegetation around Lake Ngami

Forage availability in the area around Lake Ngami was significantly correlated with the distance from kraals or water points (r = 0.41, n = 43, p = 0.006) demonstrating the piosphere effect discussed earlier in this report (Figure 64). Overall forage availability is low across the different sites with mainly woody areas providing only 65 tonnes/ha of available forage (Figure 65).

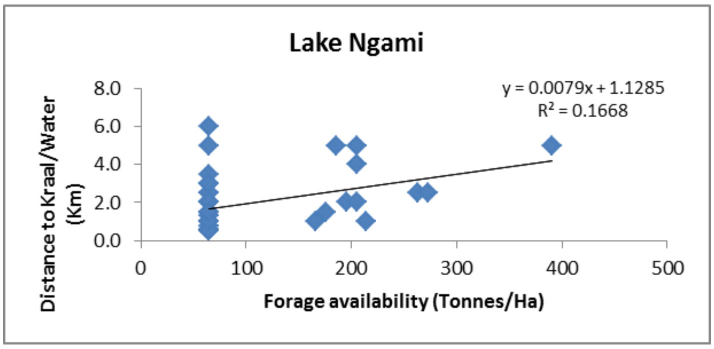


Figure 64 Correlation between forage availability and distance to kraal / water point

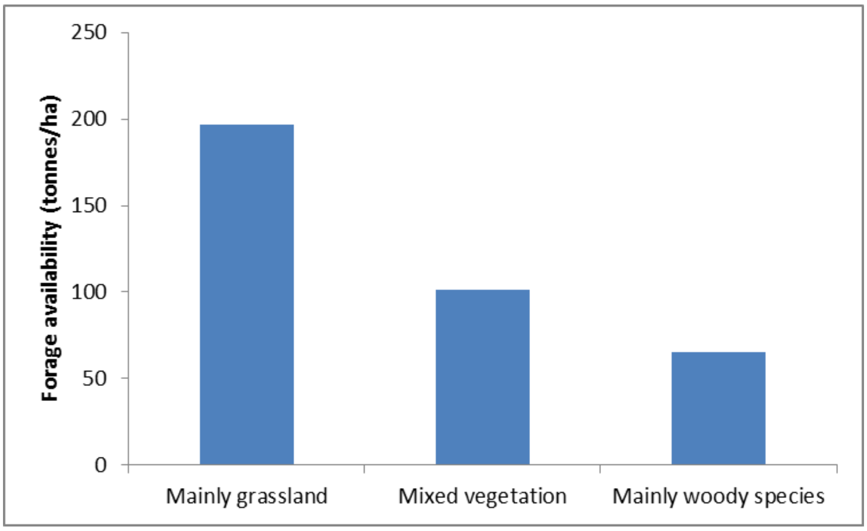


Figure 65 Forage availability in the three different site classifications

Yet even though much of the study area has been over-utilised there are still areas where vegetation quality and quantity increase as you move away from Lake Ngami or from human settlements and large numbers of cattleposts (Figure 66). North of Sehitwa, >12km from the lake edge, lie areas with good vegetative cover in open mixed acacia shrubland (Plate 23). Available forage in this area was as high as 390 tonnes/Ha dropping to 175 tonnes/Ha within 1km of cattleposts (Plate 23). South of the lake there are also pockets of good forage availability close to the Hainaveld protection fence where there is 215 tonnes/Ha of available forage.

Plate 23 Two sites to the north of Sehitwa with good ground cover and significant volumes of forage available with good diversity of established perennial grasses

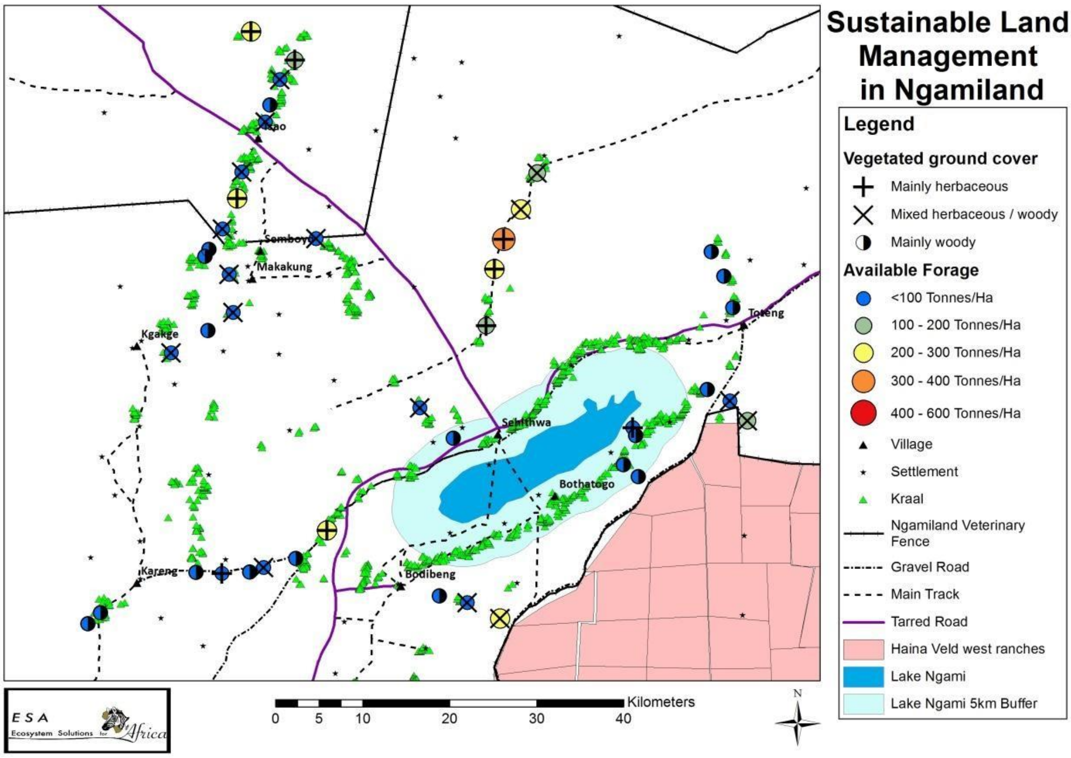


Figure 66 Forage availability and vegetated ground cover classification in the areas surrounding Lake Ngami

North of the Setata fence the rangeland adjacent to the tar road hints at significant overutilisation. This initially continues as you move away from Tsau village where there is a high concentration of cattleposts with open *Acacia erioloba* woodlands with little available forage and herbs and forbs forming the understorey layer (Plate 24 and 25). However, as you move further away from Tsau village rangeland quality and forage quantity increases with increased species diversity and the presence of annual grasses in the herbaceous layer. Plate 24 Herbs seen during the range assessment


(Wild sesame (*Sesamum triphyllum*), wild sage (*Pechuel-loeschea leubnitziae*) Golden crownbeard (*Verbesina encelioides*) and Tumbleweed (*Acrotome inflata*) as seen during range assessment).

The negative effects of large numbers of cattle within the communal areas and a subsequent lack of forage availability can be clearly seen across the area (Plate 25). The current low forage availability at the start of the dry season across much of this region provides significant reason for concern.

Plate 25 Evidence of dead cattle near to Lake Ngami and to the west of Kareng respectively


6.2.3 Summary

The areas surrounding Lake Ngami are heavily over-utilised in many areas yet there are still pockets of rangeland where there is significant forage availability. As the dry season progresses it can be expected that the remaining grazing reserves will become increasingly utilised. Particularly poor conditions were recorded in the areas to the west of the A35 Sehitwa – Shakawe Tar Road where the pan substrates, which are fine and brittle, combined with high densities of livestock and geographically limited access to water have contributed to these areas being heavily degraded. These areas currently have little available forage material, thus requiring cattle to walk 20-25km on a daily basis to find suitable forage.

Large areas of bare soil have resulted in soil capping and erosion together with low levels of vegetative litter. This negatively affects the four ecosystem processes which are critical for healthy rangeland. The open access nature of the communal rangelands ensures that no area is allowed to rest and recover for an extended period of time, resulting in rangeland degradation and bush encroachment.

- Overall forage availability and quality across the assessed area is low and within 5km of the lake the range is heavily degraded with areas of high density *Acacia mellifera* encroachment, particularly along the tar road to the north of the lake.
- There are pockets of better quality rangeland with good forage availability in areas with lower stocking density away from the lake and the communities in the western extent of the study range.
- To the west of Lake Ngami rangeland is heavily degraded with bare soils and very low forage availability
- Soil capping and soil erosion are evident across much for the assessed area with little vegetative litter on the soil surface.
- Cattle are reported to be travelling up to 25km away from sources of water to find suitable foraging sites.
- The alien invasive, the common cocklebur (*Xanthium strumarium*), forms densely packed thickets and can form a monoculture over the Lake bed.
- The Hainaveld protection fence is damaged in at least two locations allowing for free movement of livestock between the communal areas surrounding Lake Ngami and the Hainaveld west ranches.

6.3 Hainaveld

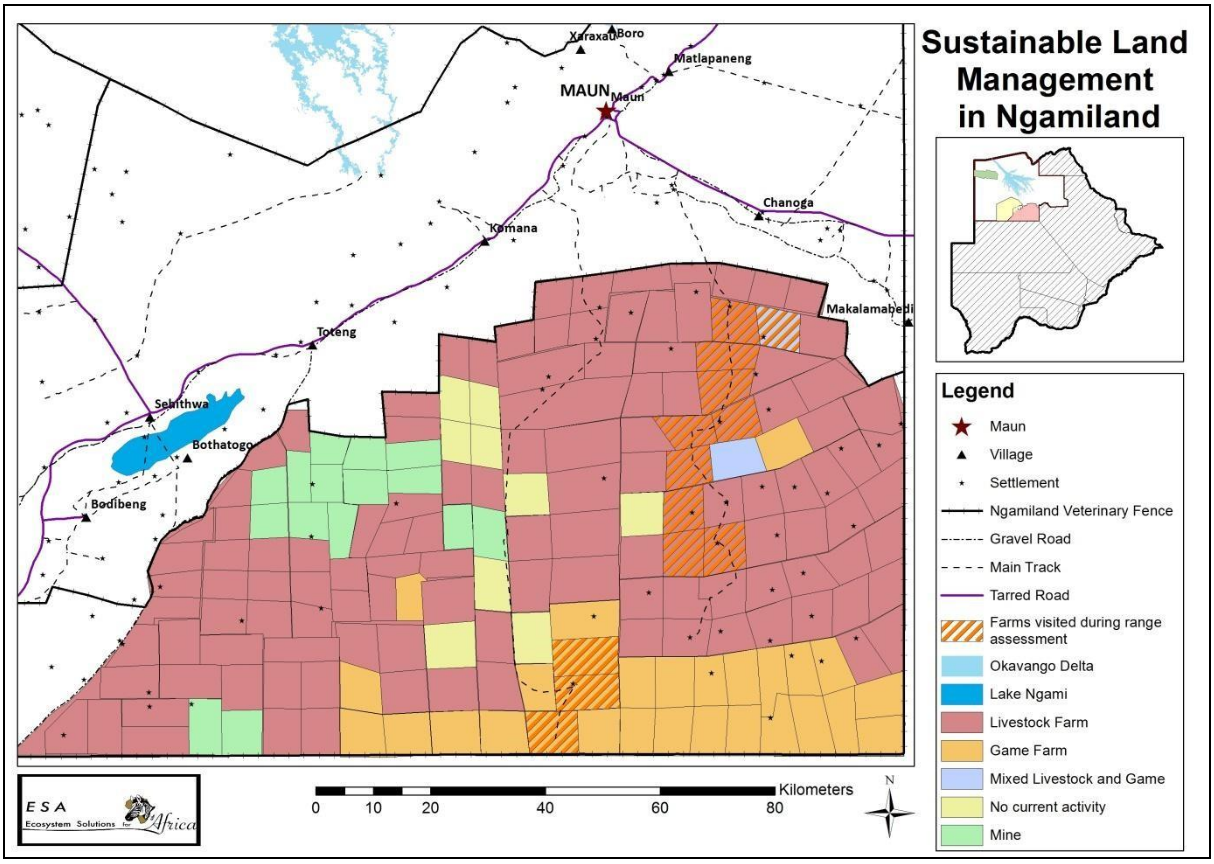
The Hainaveld farms are dominated by livestock – cattle, goats and sheep – farms and an increasing number of game farms along the southern boundary of the region, bordering the Central Kalahari Game Reserve. There are also two mixed livestock and game farms in the north-eastern part of the region. A number of farms have also been taken over by copper mining enterprises with explorations conducted on many more farms.

As with much of northern Botswana rainfall can be very localised across the Hainaveld region. During the 2015/16 wet season a total of 180mm of rainfall was recorded on the most northerly farms while a total of 422mm was recorded on the central southern boundary of the Hainaveld region.

A mix of management methods are practiced across the farms from unfenced farms allowing livestock to roam freely with a central waterhole and kraal, to farms with multiple paddocks following a rotational grazing policy. The maximum distance from water within any of the farms visited was <6km and, if the farm was paddocked, was often <4km.

Due to marketing challenges and the lack of access to abattoirs many of the farms are significantly over-stocked which results in significant overgrazing and encroachment of shrubs such as *Dichrostachys cinerea*. One farmer reported that he currently had nearly 1,000 head of cattle on a 5,000Ha farm and he believed that this was double the number of animals that the farm should have. Because of these numbers he felt he wasn‘t able to rotate grazing through the available paddocks and instead opted to allow the cattle free movement across the farm.

Figure 67 Land use of the Hainaveld farms and the farms incorporated in the field range assessment



6.3.1 Range assessment

A total of 36 specific sites across eight farms, along a spectrum of ―good‖ to ―bad‖, were assessed in detail whilst a further five farms were visited during the field assessment. Farms were confirmed with the Chairman of the Hainaveld Farmers Association as providing a good cross-section of management practices and farm quality. The selection of ranches close to each other allows a comparative approach as differences in range condition can be attributed to different management strategies rather than variation in vegetation-soil conditions.

Plate 26 Adjacent sites within 250m of each other on the same farm

The photos on the LHS showing a rested paddock and photos on the RHS showing a grazed paddock approximately 4km from the central kraal and waterpoint (Top photos taken looking straight down, middle photos at 45 degrees and bottom photos including 1/3 horizon).

The soil surface was typically quite bare (Plate 26 and 27), with an average ground cover of 55% comprising equal proportions of woody and herbaceous vegetation. Despite the bare soil there was little evidence of soil capping recorded due to the high intensity of animal movement throughout the assessment area. However, there was evidence of soil erosion through plant pedestalling or surface movement and there was only a small amount of vegetative litter evident on the surface.

Plate 27 Site within the Hainaveld displaying predominantly bare, disturbed soil with large distances between over-grazed grass tufts and low volumes of vegetative litter


Across the assessment area annual grasses and weak perennials were dominant at the majority of sites with *Dactyloctenium giganteum*, *Schmidtia kalahariensis* and *Eragrostis lehmanniana* seen frequently. Established perennial grasses such as *Stipagrostis uniplumis, Digitaria eriantha* and *Eragrostis rigidior* were in the majority at only 10 of 36 sites. The availability of forbs across the range was typically quite low with grasses forming the vast majority of herbaceous plant material.

Shrubs and trees were relatively low-lying with varying density across the farms and with sickle bush (*Dichrostachys cinerea*) recorded at 75% of all sites (Plate 28). Shrubs and trees were typically multi-stemmed with sporadic mature trees and occasional bands of *Terminalia prunoides* woodlands. Other common species recorded across the range included Brandy bush (*Grewia flava*), Shepherd's tree (*Boscia albitrunca*) and Kalahari apple leaf (*Lonchocarpus nelsii*). All of these species were heavily browsed and were typically between 1-2m in height although heavy browsing occasionally resulted in a stunted growth form (Plate 29).

Plate 28 Typical shrubbed vegetation recorded across the region with stands of sickle bush with bare soil, heavily disturbed and little herbaceous vegetation


Plate 29 Heavily browsed *Boscia albitrunca* resulting in stunted growth

On one mixed cattle and game farm the available grasses had been able to out-compete the woody vegetation and this was evident through sickle bush dying naturally (Plate 30). Browse usage up to 2m was high across the range and, due to the relative paucity of available grazing, browse will contribute a significant proportion of the diet of cattle.

Plate 30 Sickle bush dying naturally as a result of competition with grasses

6.3.2 Site comparisons

The sample sites were sub-divided based on the management strategy and/or stocking density of the farms surveyed. Unfenced farms (n=4) were grouped based on stock density, with two farms having a high stock density and two farms with a medium-low stock density (Figure 68). Fenced farms (n=2) were sorted by sampling grazed or rested paddocks. Additionally, sample sites within the game farms surveyed (n=2) were grouped.

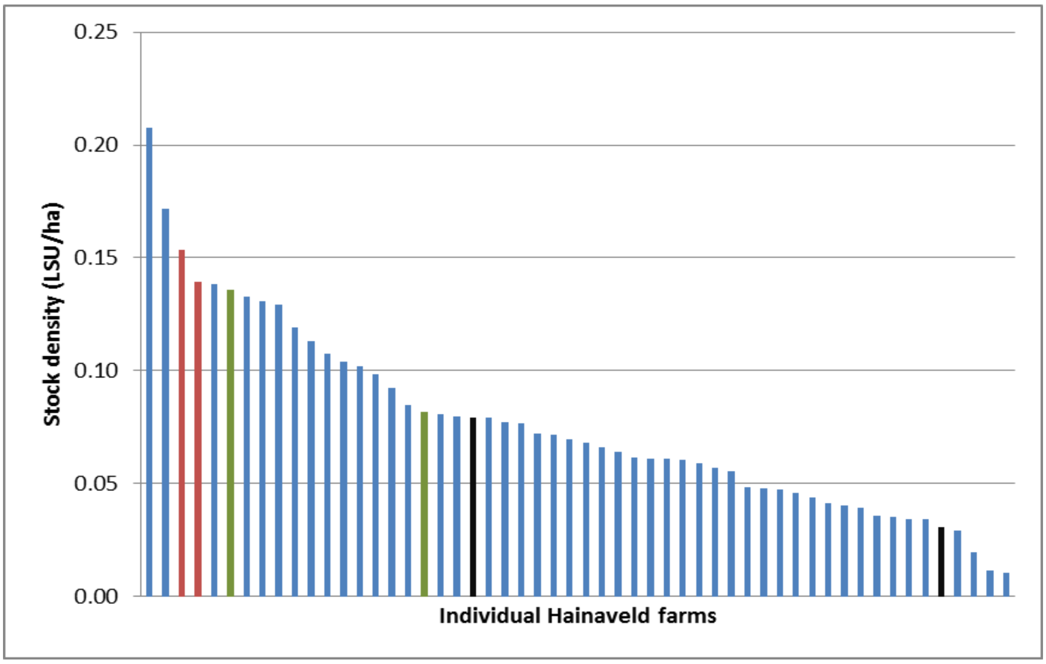
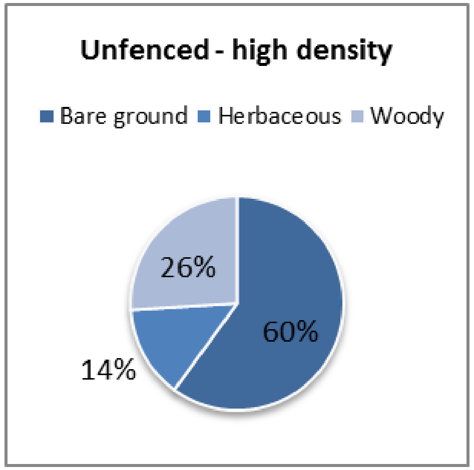
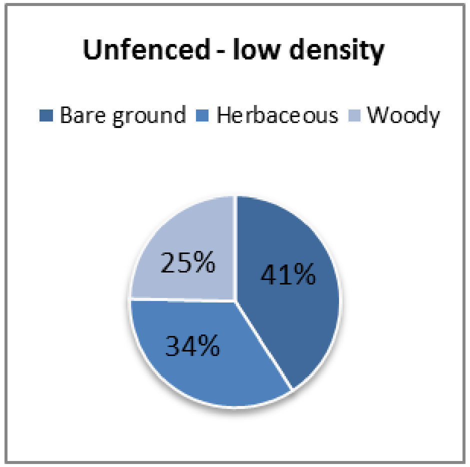


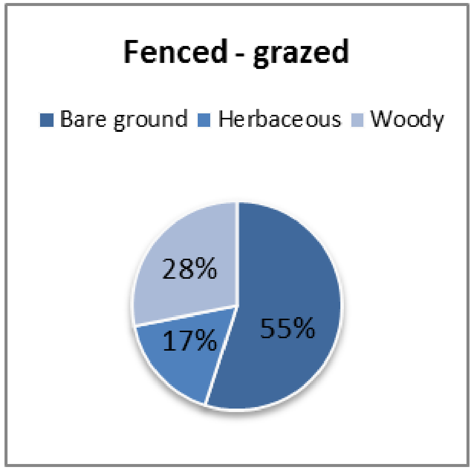
Figure 68 Stock density of livestock farms across Hainaveld east

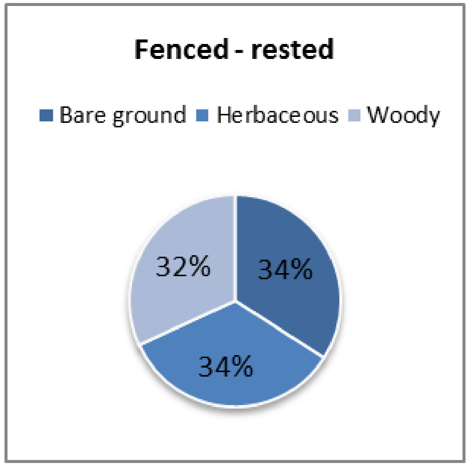
Highlighted farms correspond with the livestock farms surveyed (Data provided by Department of Veterinary services following a FMD vaccination programme)

There are noticeable differences in vegetative ground cover between high and low density, unfenced farms as well as between rested and grazed paddocks on fenced farms (Figure 69). For unfenced farms, whilst the proportional availability of woody species remains largely the same, there is a much higher proportion of bare ground, and consequently lower proportion of herbaceous vegetation, in the farms with a high stock density. A similar pattern can be seen when comparing resting and grazed paddocks on fenced farms. The woody ground cover is comparable but there is a much higher proportion of bare ground, and consequently lower proportion of herbaceous vegetation, in the grazed paddocks. The game farms provide an interesting comparison with almost 50% of the ground covered by herbaceous vegetation.


Unfenced - high density
Bare ground Herbaceous Woody
26%
60%
14%


Unfenced - low density
Bare ground Herbaceous Woody
25%
41%
34%


Fenced - grazed
Bare ground Herbaceous Woody
28%
17%
55%


Fenced - rested
Bare ground Herbaceous Woody
32%
34%
34%

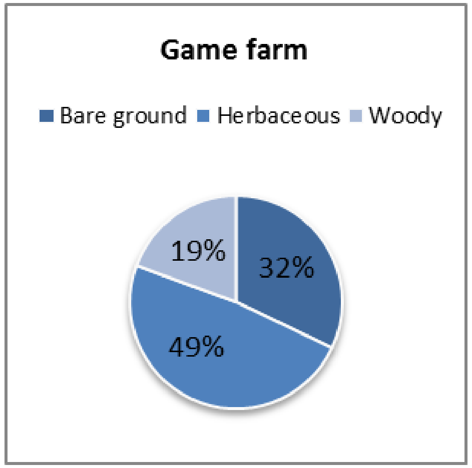

Game farm
Bare ground Herbaceous Woody
19%
32%
49%

Figure 69 Proportional ground coverage on Hainaveld farms with different management practices

To look at this further we looked at the composition of the available herbaceous and woody forage. Annual grasses comprise more than 50% of the available grasses on the unfenced farms with a high stock density whilst on unfenced farms with a low stock density perennial grasses comprised 66% of the available grasses (Figure 70). The ratio of annual:perennial grasses was almost identical between grazed and rested paddocks on fenced farms at 61:39. Again, the game farms provide an interesting comparison with 90% of the available grasses comprising of perennial species.

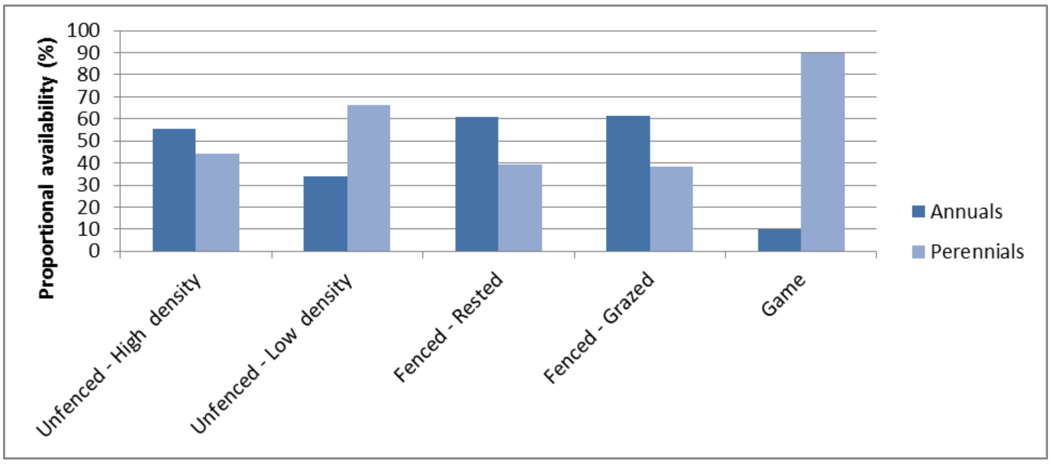


Figure 70 Proportional availability of annual and perennial grasses on Hainaveld farms

Dichrostachys cinerea was the dominant woody species on all of the livestock farms, regardless of management practice, with a proportional availability of between 21 and 34% (Figure 71). Broad leaf shrubs or small trees including *Croton gratissimus*, *Grewia flava* and *Lonchocarpus nelsii* comprised around 10% of woody species availability each. The notable difference can be seen when looking at the game farm where *D. cinerea* comprises less than 5% of the available woody forage.

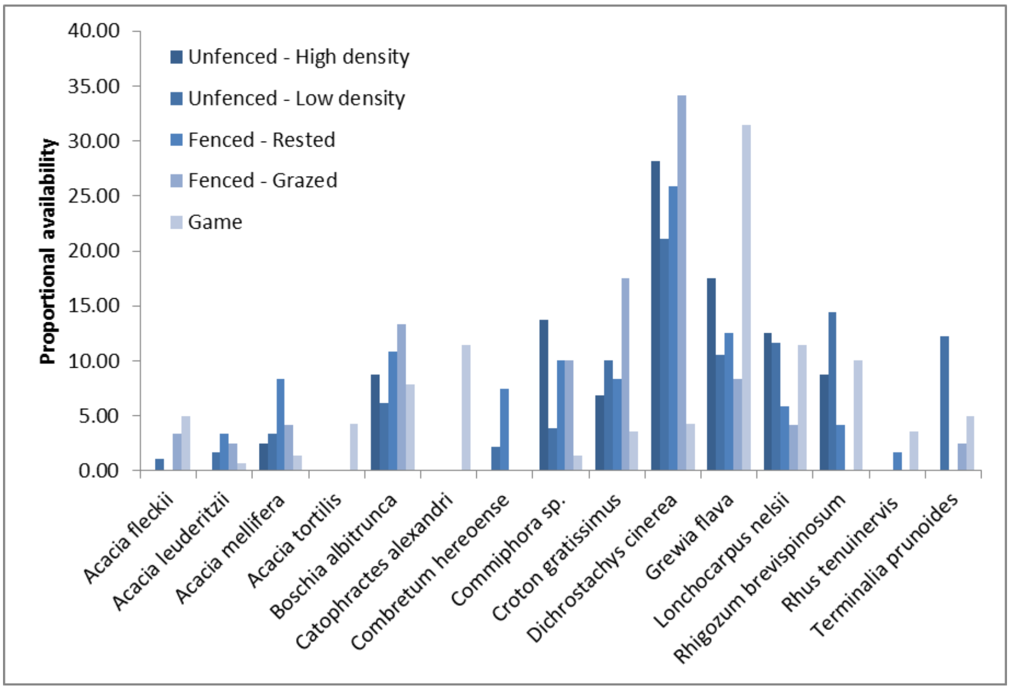


Figure 71 Proportional availability of woody vegetation across the surveyed Hainaveld farms

Available forage (grass, leaves, herbs and weeds) across the farms was mixed with some sites heavily over-utilised and with fewer than 5 stock days per hectare (SDH) (65 tonnes/ha) remaining while others had more than 40 SDH (520 tonnes/ha) (Figure 72). The unfenced farms with a high stock density had comparable forage availability to the grazed paddocks in the fenced farms with 10 and 9 SDH respectively (135 and 121 tonnes/ha). The low stock density unfenced farms had more than double the available forage of the high stock density farms at 307 tonnes/ha.

Unsurprisingly the game farms, with a lower stock density and increased herbivore species diversity, had the highest volume of available forage at 32 SDH or 409 tonnes/ha of forageable material.

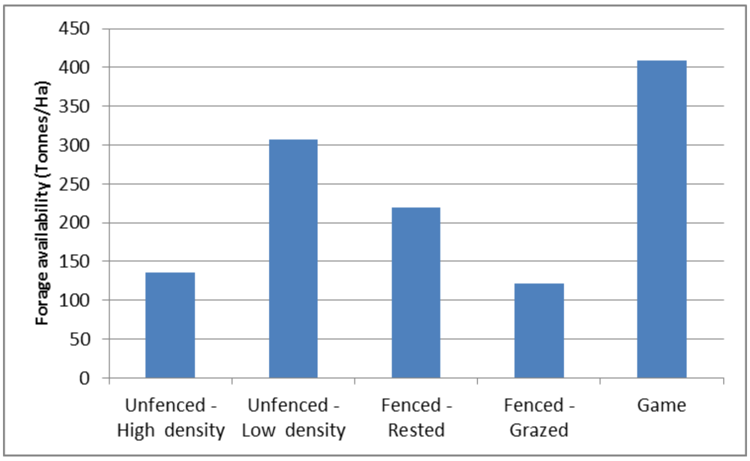


Figure 72 Forage availability across the surveyed Hainaveld farms

Across the Hainaveld sites there was also no significant correlation between forage availability and the distance to kraals or water points (r = 0.30, n = 35, p = 0.08) (Figure 73).

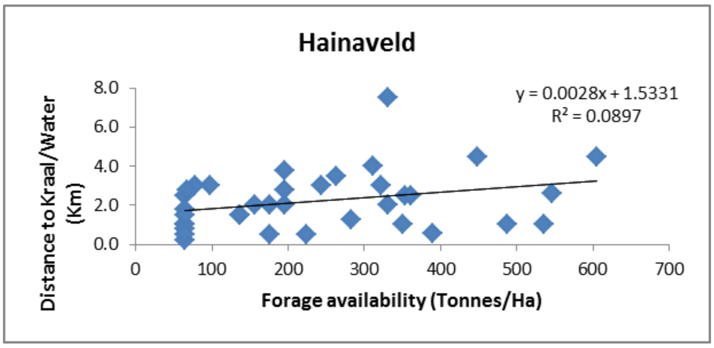


Figure 73 Correlation between forage availability and distance to kraal / waterpoint across the surveyed Hainaveld farms

The limited forage availability on unfenced farms with a high stock density (average 0.1466 LSU/ha) may provide significant challenges to these farms as they progress through the dry season. On these farms there is an average of 10.41 SDH, as calculated by the STAC method during the ground surveys in June 2016. When we multiply this by the number of hectares available for each LSU (6.8 ha) then we see that there are only 71 stock days of forage available to each LSU until the onset of the rains and the start of the next growing season. This is less than half the number of stock days required until the start of the next growing season in December 2016.

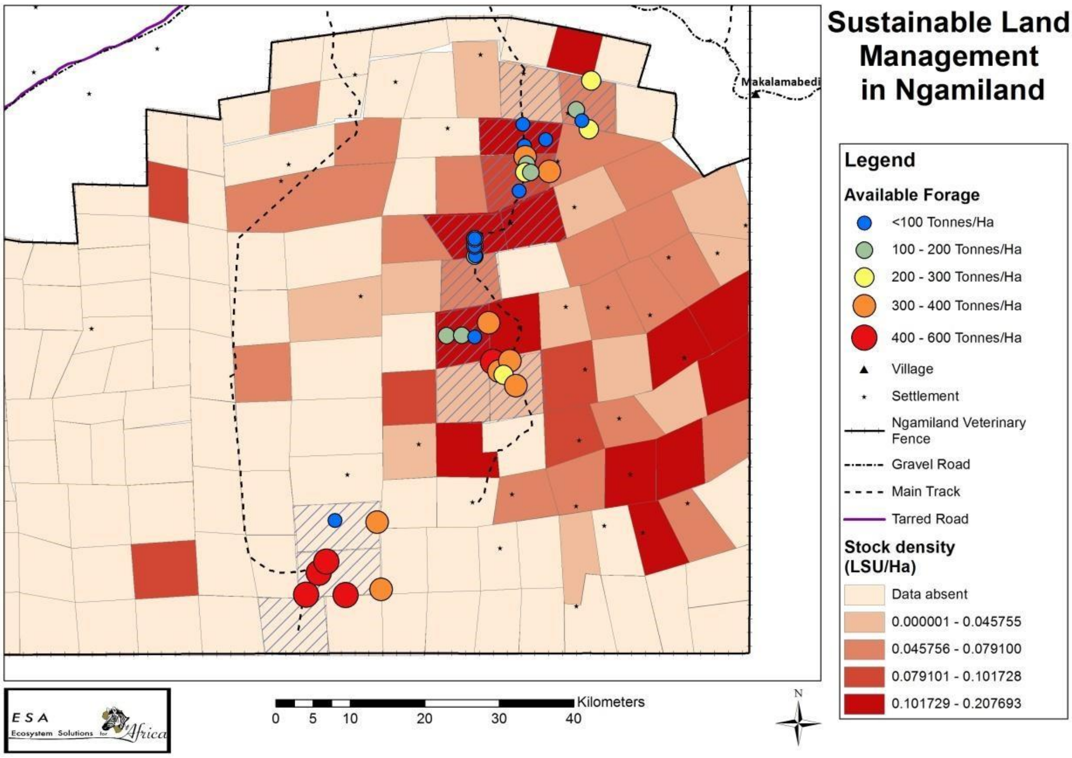


Figure 74 Forage availability and livestock density across the Hainaveld study farms

Evidence of fire was only documented within the southern band of farms adjacent to the Central Kalahari Game Reserve. The only wildlife recorded, by either spoor or visual confirmation, outside of game farms were the occasional steenbok while farmers are increasingly worried about the increasing prevalence of elephant in the region. The game farm assessed displayed good levels of vegetative cover across the farm with a high percentage of established perennials. However, the relatively low animal density across the farm meant that there was evidence of over-rested plants and a low animal impact on both the browse and grazing vegetation. The sacrifice zone around water points (<250m radius) was also considerably lower than on livestock farms.

Plate 31 Opposite sides of an adjoining fence between farms operating different management practices

(LHS farm allows free movement of livestock all year round and the RHS operates rotational grazing with this paddock un-grazed since March)

- **Invasive species**

Prior to the assessment we had received reports from farmers within the Hainaveld region of an increase in the presence of *Cenchrus biflorus*, a highly unpalatable invasive annual. However, this grass was not identified during the current survey in the Hainaveld region.
The only record of the grass across the assessed area was near to Bodibeng village to the south-west of Lake Ngami (Plate 32).

Plate 32 *Cenchrus biflorus*

6.4 Summary

The range assessment was carried out following the end of the growing season and so the vegetation present is what will be available for forage until the start of the next wet season. The low volume of available forage across much of the livestock farms within the range is worrying and with little herbaceous material available livestock will become increasingly reliant on browsing.

There was significant evidence of overgrazing and overbrowsing across the assessment range with large areas of bare soil, large inter plant distances, little vegetative litter as well as evidence of soil erosion.

There were noticeable differences observed between farms when accounting for management practices. Unfenced farms had the highest proportion of bare ground and lowest forage availability although the grazed paddocks of fenced farms were comparable. However, farms which are fenced have a forage reserve in the rested paddocks, allowing them to move livestock to these rested paddocks during the dry season. Unfenced farms do not have this luxury and will face significant challenges in providing sufficient forage resources to livestock at the end of the dry season.

On farms where paddocks were utilised, which allow for one or more paddocks to be rested at any given time, there was increased forage availability in the rested paddocks. However, both rested and grazed paddocks were dominated by annual grasses. Due to the general levels of over-stocking across the region, combined with recent years of low rainfall, paddocks are not able to rest and recover sufficiently which would allow perennial grasses to establish.

Unfenced farms with a medium to low stocking density had more herbaceous than woody ground cover whilst also supporting the largest volume of forage availability. The herbaceous grassed vegetation was dominated by perennial grasses at a ratio of 2:1. It is likely that the low stock density has allowed for the establishment of perennial grasses across the farms but the free-roaming nature of the livestock will still lead to areas of overgrazing near to kraals and waterpoints.

- Noticeable differences in ground cover, species availability and diversity as well as total forage availability are observed when accounting for farm management practices
- Unfenced farms with a high stock density had more bare ground with less herbaceous vegetation and low forage availability with less than half the required number of stock days of forage available for the remainder of the dry season
- Farms which followed a strict rotational grazing policy allowing paddocks to rest during the growing season had a greater diversity of species and increased proportional availability of established perennial grasses
- The sacrifice zone surrounding central kraals or water points extends for between 500m and 1km with a subsequent change in vegetation at 2.5km from the central point. Grazing reserves remain in the corners of farms or paddocks, 3-6km from the central point, but with no active herding taking place to push livestock towards these areas
- Annual and weak perennial grasses dominated across the Hainaveld with established perennial grasses in the majority at only 10 of 36 sites
- Browse contributes significantly to the diet of livestock across the Hainaveld as herbaceous vegetation is utilised quickly leaving bare soils
- Soils were frequently exposed with large spaces between plants and low vegetative litter on the surface of soils leading to erosion of the top soils
- Bush encroachment through localised dense stands of *Dichrostachys cinerea* were recorded on all farms to varying extents. On one farm where grasses had been able to become established they were seen to be out competing *Dichrostachys cinerea* shrubs causing the shrubs to die
- Farmers reported that farms were overstocked with negative effects on rangeland quality but they were unable to reduce numbers due to marketing challenges
- The relatively low stocking density on the game farms resulted in double the forage availability evident on livestock farms
- Apart from the game farms along the southern boundary of the Hainaveld there is insufficient herbaceous biomass to allow for fires to establish and spread across the region

There were notable differences in vegetated ground cover and the composition of this cover across the Ngamiland region with the NG/2 study area providing the greatest availability of forage with the highest proportion of perennial grasses and a broad diversity of woody species.

Across the communal areas the free-ranging nature of livestock has resulted in significant areas of degradation in concentrated locations near to water points and human settlements as rangeland is never allowed the time to rest and recover, even in the wet season.

Management practices across the Hainaveld farms have a noticeable impact on rangeland quality and forage availability but farmers may not feel able to follow their preferred management route through external constraints such as a lack of markets for their livestock which consequently affects the time and resources they are prepared or able to invest in their farm.

7 CONSULTATIONS

The key objectives of the stakeholder engagement were to:

- inform and educate stakeholders about the Project;
- gather local knowledge to improve the understanding of the socio-economic context, livelihoods, and land access and management;
- better understand locally-important issues and challenges;
- enable stakeholders to input into the project recommendations; and
- lay the foundations for future stakeholder engagement during project implementation.

(See Annex I)

7.1 Introduction and Methodology

Focus Group Discussions (FGDs) were carried out in the following villages: Nxaunxau, Semboyo, Tsau, Makakung / Kgagae, Bodibeng, Bothothogo, Toteng, Sehithwa, and Kareng over the period 1st June – 13th June. Community mapping was conducted as the primary tool during the FGDs to guide the discussion the various areas used, location of roads, fences, firebreaks, cattle posts, boreholes, wells and natural pans, quality of grazing and water quality and general livestock movements that occur. A series of semi-structured questioned were asked following the completion of the map. The questions focused around livestock husbandry methods, markets, challenges and changes in the last 20 years.

Key informant interviews (KII) were conducted in Gumare with farmers with cattle in NG2, the game farm owner and manager of the Okavango Game Farm in NG2, The Hainaveld Farmer‘s Association Chairman and a varied selection of farmers from the Hainaveld, and Ngamiland Abattoir.

KII were all conducted with the Plant Manager of Botswana Meat Commission (BMC) in Maun and the Principal Veterinary of the Department of Veterinary Services (DVS) in Maun and are contained in Annex 2.

During ecological field data collection informal discussions were conducted with cattle post herders and owners in the three areas.

7.1.1 Introductory Letters

During the scoping phase, an introductory letter was drafted by UNDP and the Department of Forestry and Range Resources. This letter introduces ESA as the contractor implementing the Integrated Rangeland Assessment Project and explains the project and requests support from the relevant stakeholders in the engagement process.

In addition to this a letter from ESA was drafted to introduce the relevant team members so that the two letters were presented to stakeholders during introductions (See Table 25). Copies of the letters were presented to stakeholders consulted.

These are presented below in Annex 1.

7.1.2 Multi-Stakeholder Platforms

The Vision of the proposed Multi-Stakeholder Platform (MSP) according to the Terms of reference of the Project is:-

—*An ongoing platform / forum for learning and exchange of ideas and the future development of a shared vision centred on rangelands and sustainable land management (SLM)".*

The proposed MSP will serve as a platform for the exchange of ideas, centred on a participatory approach and bring together actors from diverse backgrounds, including local farmers (as represented by their associations), researchers, government extension workers, NGOs, community leaders and others (including for example a representative of Botswana Meat Commission) who all have interests in the same aspect of sustainable land management, but would not normally come together to share knowledge or development strategies.

The first meeting (held on the 15th June 2016) was to introduce the integrated range assessment component of the SLM project AND the concept of the Multi-Stakeholder Platform (MSP). The focus was upon:

- Sustainable development
- Sustainable chains of production for livestock and wildlife
- And an introduction to the multi-stakeholder platform concept

The second meeting (held on the 6th July 2016) focussed upon the following:

- The sustainability of the MSP moving forward,
- to define spatial criteria for the Land Use Conflict Identification System (LUCIS) analysis,
- to introduce Management Oriented Monitoring Systems (MOMS)

A separate MSP Report has been developed which presents the stakeholder identification, mapping, minutes of the meeting, challenges faced so far and the way forward for the MSP. During the two MSP meetings there were members of the press present. To assist with the documentation of the MSP two press releases were developed, one for each meeting.

The following questions were raised at the Final MSP meeting and need to be discussed and finalised before the MSP can become a permanent feature of SLM in Ngamiland.

- How can we make this Platform a regular feature / sustainable?
- Structure? Who will be the Host? As the main purpose is on SLM it would be best housed in the DFRR with support from DAP.
- Funding? Over what time period? Are various government departments able to contribute to the running once the initial two years have been financed by a donor, e.g. UNDP?
- Who attends? Two tier approach?
- How often? Frequency? It was agreed in the first MSP that it should be held quarterly but activities in-between this should be discussed.

- Location? Some recommendations were that it should be rotated; other that is should be in Maun.
- Lobbying? Policy development or influencing?
- What information do you (as a stakeholder) regularly need and what do you have that you could share? (e.g. DAP may need information on the status of the farms the livestock and the infrastructure, but would also like to share information on improved livestock husbandry)
- How can this platform help them / what are the advantages?
- What are the challenges to making this platform work? Discuss challenges from the two MSPs so far.
- What does it look like? Training? Presentations? Visits? (The MSP does not necessarily need to be held as a meeting but there are other forms of platforms that could be adopted to accommodate and overcome some of the challenges faced so far).

There should be some discussion about how this may be able to fit in to some already existing structures, e.g. the Wetland Management Committee or the DLUPU.
Finally the participants should discuss seriously if the various stakeholders within Ngamiland are ready for an MSP of this level.

Table 25 Stakeholders

Stakeholder Group	Stakeholder Name	Stakeholder Level			Engagement Level							
		National	**Regional**	**Local**	**FGD**	**KII**	**Questionaires**	**Letter for 1st MSP**	**Attended 1st MSP**	**Letter for 2nd MSP**	**Attended 2nd MSP**	**Letter for MOMS**
Ministry of Environment, Wildlife and Tourism	Department of Wildlife & National Parks (DWNP); Department of Environmental Affairs (DEA) Department of Forestry & Range Resources (DFRR) Department of Tourism	X X X X	X X X X					X X X X	X X X	X X X	x x x	X
Ministry of Agriculture	Department of Crop Production (DCP) Department of Animal Production (DAP) Department of Veterinary Services (DVS)	X X X	X X X			X		X X	X	X X	X X	
Ministry of Local Government	District Councils District Administration Tribal Administration Councillors		X X X	X				X X X X	X X X X	X X X		
Ministry of Lands and Housing	Sehithwa Land Board Gumare Land Board Shakawe Land Board Maun Land Board			X X X X				X X X	X	X X X	X	
Ministry of Minerals, Energy &WR	Department of Water Affairs	X	X					X		X		
Ministry of Youth, Sport and Culture	Department of Culture and Youth	X	X					X	X			
Local Businesses	Ngamiland Abattoir Khoemacau Copper Mining (KCM)			X X		X X		X		X		
Parastatal	Botswana Meat Commission (BMC)		X			X		X		X		

Communities and Trust in the focal areas	Nxaunxau Toteng Sehithwa Bodibeng Bothothogo Kareng Makakung Tsau Semboyo Legothwana Somelo Chuchumuchu Hainaveld farmers Lake Ngami Conservation Trust			X X X X X X X x x x x x x x	X X X X X X X x x x		X	X		X X X X X X X X X X X X X X	X X X X X X X X	X X X X X X x
Farmers' Associations	Hainaveld Farmers' Association North West Integrated Farmers' Association Nhabe Agricultural Association Botswana Game Farmers' Association	X	X X	X	X			X X		X X X		
NGOs / Donor Funded projects	CCB Ecoexist SAREP	X X	X					X X X		X X X	X	X

Services from various government departments include the following:

- The Department of Veterinary Services (DVS): for the provision of veterinary services for sale of cattle and vaccinations.
- The Department of Wildlife and National Parks (DWNP): inspection of wildlife damage to fences and livestock losses and compensation for the losses.
- Police service: for the verification of the proof of ownership during sale of cattle.
- Botswana Agricultural Marketing Board (BAMB) has recently (March 2016) taken over the Livestock Advisory Centres (LAC) previously housed at the Ministry of Agriculture under the Department of Veterinary Services. The LAC sells livestock inputs such as animal drugs, medicines, dips,

vaccines, livestock husbandry equipment and livestock feeds. There are a total of 33 branches country wide with branches located in Gumare (accessible by NG2), Sehithwa (accessible by Lake Ngami villages and settlements) and in Maun (accessible by the Hainaveld farmers).

- The Department of Animal Production (DAP): supporting animal production activities in all areas of Ngamiland.

7.1.3 Focus Group Discussions and Community, Resource Mapping

There were a total of 6 Focus Group Discussions (FGD) carried out in the focal communities. These included Nxaunxau, Tsau / Semboyo (combined), Makakung / Kgakgae, Kareng, Bodibeng/ Bothothogo/ Toteng (combined), and Sehithwa. The Focus Groups were made up groups of between 11 and 18 people. The participants had been selected by the village leaders as representatives of the villages and the area. They were asked to select people that were willing to talk openly about their livelihoods and livestock rearing and land management practices that they utilise.

The meetings were held within the grounds of the Kgotla at each village. Following greetings and introductions with the Kgosi, the meetings were started with a prayer and introduction of participants, followed by the signing of the register. The project team explained the purpose of the UNDP SLM project and our component of the IRA, and the FGD as a contribution to this project. Participants were given a chance to ask questions.

The meeting began with the community and resource mapping as the initiation of the focus group discussions. This started by drawing a map of the village in the sand and asking about the village and the area that is used by the village.

Following the completion of the map, discussions and questions were asked about the grazing areas, the seasons, water availability, livestock numbers, livestock husbandry practices, marketing, and assets and challenges in different areas e.g. water access, human wildlife conflict areas, mogau, movement and restriction of movement.

7.1.4 Key Informant Interviews and Questionnaires

Key Informant Interviews (KIIs) were held with a range of stakeholders within the three focus areas. In addition a few questionnaires (with the same group of questions being asked) were distributed to some of the Hainaveld farmers with a view to being able to reach more famers in a shorter space of time.

Key government departments and other stakeholders involved in the marketing of cattle within Ngamiland were further interviewed separately. The people interviewed and the type of engagement used is presented below. It is important to note that although questionnaires were distributed several were not returned or completed.

7.1.5 Key Assets, Concerns and Aspirations

The key assets, concerns and aspirations from the three focal areas are compiled below.

Table 26 Key Assets, Constraints and Challenges and Community Aspirations

Key Assets

	NG2	Lake Ngami	Hainaveld
Water	Good seasonal pans for watering cattle in the wet season and beyond. Relatively shallow water – most water points are hang dug.	When the lake is flooded residents of this cattle post water their livestock in the lake. They also collect firewood from the lake Government recognizes that they use the lake to water their livestock and even when they get grants from government to buy goats they meet water requirement by sighting the river as their source of water They catch fish from the river to supplement their diet. Toteng uses a lot of seasonal wells not like other areas – this is because they've tried boreholes further away but they are too salty – so use the lake and wells instead. Most of us do Molapo farming along the river.	Good yielding borehole Palatable for cattle to drink Some farms have fresh water boreholes. Natural pans are used for watering cattle too during the rainy season, this saves on fuel for pumping water. Good water supply (quality and quantity) on the game ranches consulted.
Veldt and management	Good grazing but cattle are able to browse too.	Lake also very important because besides, providing water for livestock, they also provide livestock feed. There is a particular type of grass like reed that grows in the lake which is eaten by livestock. Pastures are good- both quality and quantity (Sehithwa). There is good grazing this year as there as there have been good rains around Kareng so grazing _this' size (east) will last the whole year and will not need to go to the west.	Good grazing. More palatable grass is further away from the water points. Land with good carrying capacity, remoteness and aesthetically pleasing for game ranches with tourism. Farmers having individual farms are able to managing the grazing in their own way and make their own decisions. Some farmers use horses, donkey, walk or drive around their farms to get a feel for and to know their paddocks and their available grazing. Then farmers are able to assess if paddocks need resting or now. They watch cattle on which grasses they eat. One farmer who is shifting from livestock to game, that he managed the farm initially using camps with resting seasons and changing from summer to winter grazing. Now he's shifting to game he using water points to control movement (open and close). Summer spread is good as pans fill up and game spread out. Monitor the veldt condition by making use of indicator plants and checking on the increaser / decreaser ratios. Also general veldt condition and variables due to rainfall.
Disease	Area good for grazing	The area is a good area for grazing as there is an	The new protection zone is there to protect the Hainaveld against disease.
	as we never get FMD – other areas do.	absence of Tsetse fly now.	

Livestock / Game	Cattle are able to browse and are in good condition. Cattle for selling, meat and milk. Some provide supplements during winter and dry season.	Livestock know their way from the homestead to the lake and they do not need to be herded to and from the lake. Cattle for selling, meat and milk. Some provide supplements during winter and dry season.	Are able to breed with specific breeds and have breeding seasons. Provide supplements during winter and dry season. Count twice a year, blocking or total farm count by using quadrants. Areal counts with aero plane. There is a big demand for game meat. Maun Lodge serves Game meat – ‗at the MSP a lot of people were eating it'. Diverse range of game on the game farms, including: Eland, Kudu, Wildebeest, Hartebeest, Zebra, Oryx, Impala, Springbuck, Giraffe, Ostrich, duiker, steenbuck, warthog. Predators such as lions are seen as an asset on the game farms that are for photographic tourism.
Organisation		The Lake Ngami Conservation Trust is for improved management of the lake area. The Nhabe Farmers' Association	Hainaveld farmers' Association coordinates with the Joint Ngamiland Farmers' Association and other Associations within other parts of Botswana, e.g. Ghanzi Beef Producers Association.
Infrastructure and inputs			Fenced farms, some with paddocks (one farmer has 6 paddocks with electric fencing) Some farms have their own kraals, crush, tractors and debushing machinery. One particular game farm as a 22 strand game fence, offset solar power electric fencing 3 strands outside for elephants.

Key Constraints and Challenges

	NG2	**Lake Ngami**	**Hainaveld**
Water	Drinking water is poor for human consumption. Sometimes drink from the pans due to constraints. Struggle to harvest water from roofs as they are thatched. Handwells are shallow so during the dry season take time to fill up. Watering cattle takes a long time.	Cattle travel a long distance to the lake but that is the only option because their borehole has sunk Water in their borehole is salty but cattle can drink. Cattle sometimes get stuck in the clay mud in the lake and die. A lot of people are drowning in the lake. The reflow of the lake and the fence has caused no pastures now – the lake and the fence (protection zone) has limited us. Most cases (70-90%) of the borehole users is that the cattle use the lake. We don't know how the others stop their cattle going to the lake.	Parts of the Hainaveld has poor water for drinking – too salty Most boreholes are equipped with diesel engines, which need maintenance and fuel. Boreholes break (or storage are damaged by elephants) and as they don't have a means to sell cattle they are not able to fix the boreholes. Farmers rely on neighbours for watering their cattle if boreholes break or if the quality or quantity is poor, which puts pressure on the grazing lands.

Fence	The fences do not seem to pose too much of a challenge to the communal farmers however, the game farm in the area struggles with elephants damaging the fences frequently. They have a constant budget monthly budget for maintaining the fence. After 10 years of game farming in the area and applying for compensation, they have received their first acknowledgement that they will get compensated for the fence damage.	The Hainaveld protection zone fence has taken away our grazing area. Managing the drought was better before the fence was put in. We never used to go to the lake before the fence was put in – now we have to go there. Put up protection zone (south of Kareng) – elephants break the fence and livestock end up there and livestock killed by DVS. Before the 1996 fence (Setata) – during the rains, the cattle would drink the other side (from natural pans) of the fence and graze that side too – to allow this area (Makakung) to regenerate and come back to it in the dry season.	The fencing situation is a challenge in the Hainaveld for both the livestock and game farms. Primarily due to the damage from elephants that are moving through the area. Some farmers reported that elephants do not like electric fencing but this is only practiced by a few privileged few. Similarly due to not being able to sell cattle, farmers struggle to buy materials and pay labour to fix the fences.
Climate Change	Lack of rain, shortage of rain, when raining grass roots shallow but trees tap roots into the deep water.	Frequent droughts due to low rainfall ―More than 20 years ago, there was plenty of rain, crops, plenty of milk and if you went to visit people you‘d get food – the rains have changed now. We have drought after drought‖	
Disease	Punished even though we don‘t have FMD. Lumpy skin disease is blamed on elephants spreading. Hard to treat. Pasturella disease.	There are however some diseases which affect cattle for drinking in the lake (worms) Cattle diseases such as measles from human waste We can‘t sell with FMD. The livestock price is low as the animals mingle with wild animals and they are susceptible to disease.	The Hainaveld is still feeling the effects of FMD. The last out break stopped all sales and therefore BMC lost their main market for the Hainaveld farmers (in Zimbabwe). The FMD is restricting the game ranches too, because even if the export ban was lifted, the game from the Hainaveld would not be valued as there is still FMD.

Veldt	The poisonous plant, Mogau, occurs throughout the area and is a major problem. Mogau (evergreen): invader species that cattle eat and die when they drink water. They control by denying water. Allow cattle to drink water first thing in the morning and then they go out to graze – then don‗t allow to drink water until the next morning.	Cattle from the West are causing overgrazing as they pass through this cattle post on their way to the lake. Cattle have to travel long distance to access pastures Sometimes their livestock even stay overnight at grazing areas because it is far from the kraals/homestead. There is overstocking, overgrazing, and livestock died – we don‘t have livestock now.	Problem with a specific grass that is ‗spreading like wildfire‘. It is very spikey and gets in cattle‘s eyes and throats. It is not good for the cattle. Some farmers are overgrazed due to overstocking and not being able to sell, lack of paddocks and poor management. No one looks at carrying capacity as no one gets advise from anywhere. The bush encroachment is bad in some areas of the Hainaveld, which limits grass growing and also limits access for trucks etc.
Land Use Conflict	None mentioned – see Human-Wildlife Conflict section	Conflicts between communities and landboard over land use. Conflicts between communities of Sehithwa and fishermen who come for fishing here. Scarcity of land – there is not enough land for all. Keeping a lot of cattle will finish the grass – that‘s why we have a drought. Can‘t fish now as the lake is closed. A lot of land has been taken from farmers since 1996 (wildlife, agric and mines). Land management systems in this area are not properly carried out. Worried about more exploration activities and pressure on land.	The key land use conflict in the Hainaveld is between the mining exploration, operation and the farming activities. KCM reported to carrying out exploration activities on 98 of the farms in the Hainaveld, of which 15 currently have mining operations or have planned mining operations on them. The future of farming may be threatened by the pending expansion of KCM and other mines within the area. See Human-wildlife conflict section too.
Management of cattle / game		Cattle do not always come back when the lake is dry. They stay around until owners follow them There is theft in the lake- some thieves have made kraals in the lake and when cows give birth, those thieves will separate the calves from their mothers Residents do not have control of where their livestock graze throughout the year. The youth are not interested in farming so the elderly are managing cattle.	Many of the Hainaveld livestock farms are overstocked and overgrazed. This is exacerbated by some water points not working or poor water available which forces farmers to rely on neighbours to water their cattle. This puts greater pressure on the grazing resources. Not enough Game ranches in the country to absorb the excess game.

Fires	There are frequent fires in the area which results in lack of grazing and the Mogau is more abundant after the fires. The fire breaks are too narrow and not maintained. The fires come from Nxamasere and Gumare on the eastern side and the Namibian border on the western side.	There was no mention of fires. The firebreak (that goes to Namibia, south of Kareng) is maintained annually but was not maintained last year.	There was mention by one farmer that when there are veld fires, the fences collapse and therefore they can‘t maintain them. From conversations with DAP it is estimated that only 26 livestock farms maintain their firebreaks. The status of the game farm‘s firebreaks is unknown. However, it was reported that 89 farms have no firebreaks and 41 are unknown. This is a significant challenge for preventing the spread of fires within the Hainaveld.
Human - Wildlife Conflict	Wild dogs and Cheetah: hassle the cattle, donkeys and goats. Last time seen on Sunday. Killed calf and one donkey. Others have problems with lions coming from Namibia – they aren‘t controlled and they cross back to Namibia. Elephants: _most painful‘ as they damage boreholes and pumps, and jojo tanks. Compensation for loss is too low.	Increase in the number of elephants Lions very rare. Wilddogs, cheetah, hyenas, lions and jackal too. The elephants are all over and destroy tanks, engines, crops and are very disruptive. Porcupines eat crops. There are no advantages to having the wildlife around as we can‘t kill them. The compensation is too low. Sometimes only 20% of people are compensated, due to there not being enough evidence. Or other wildlife don‘t attract compensation like the fish eagles that eat their goat kids.	There are a lot of elephants reported to be in the Hainaveld area, that damage water points and fences. This was reported by both the livestock and game ranchers. In addition, there were reports of lion, being a big problem. One farmer (working at DVS) reported losing 5 cattle and more than 20 goats to the lions within the month of June.
Support	Pasteurella blood disease, more in NG2, no vaccine available, die more during dry season from this. Advice from DVS to vaccinate every 3 months (March, July, Nov) and in the past bought from LAC but not stocked now. Last time he needed it, he ordered from Johannesburg. Lack of support from government: LAC seems to be failing. Heard government sub-contracting disease control out. No access to vaccines, and lick etc.	Absentee herders The challenge is that we don‘t have kraals so don‘t know how many we‘ll be able to round up. This could be due to poor management but if we can‘t sell then we can‘t pay the herders, maintain kraals, pay for diesel to provide water to bring the cattle back etc.	There is no training for farmers. It is a challenge to find good labour for game farms Game farms are not supported by DWNP. Policies and regulations within Botswana are not supporting the game farming industry (e.g. hunting ban, ban on export, slaughter regulations). For the game ranching there is an _endless list of permits and permissions needed for everything‘.
	No veterinary office in Nxaunxau only in Gumare which is 120km away.		

Market	We have never had an outbreak of FMD – but when there is an outbreak elsewhere, we can‘t sell. Very big challenge is the distance of 120km to Gumare – and there is no vet office in Nxaunxau. But the biggest problem is the lack sale of cattle – we only sell once in a while and when we do sell prices so low. BMC decides when and how many we can sell. If can‘t sell to BMC then we _throw them away‘ to the butcheries in Gumare or Maun. Transport is expensive. Livestock are often damaged during transportation and then we are penalised for it. Collection of money from BMC is a challenge as we have to travel to Maun to pick up the cheque. Transparency needs to be improved with BMC so that we know the weights before they get to Maun.	Lack of market for their livestock Cattle sale is not regular because of frequent outbreaks of FMD- it sometimes takes up to six months without selling. Farmers end up selling their cattle to the butcheries which offer them very low prices. The low prices are worsened by the P350.00 charged by the Ngamiland abattoir when their livestock have to be checked before slaughter. Even after slaughter at the butchery, takes long to get paid. Farmers in the communal areas are moving into the Hainaveld area as they feel they will be better off with fencing.	The main constraint reported is lack of finance and if farmers are not able to sell then they are not able to do the following: • Buy fuel to visit the farm and to take food for herd boys • Pay herd boys • Buy diesel for pumping water • Buy material to fix fences and parts for fixing pumps • Clear firebreaks • Buy supplements • Buy vaccines The biggest constraints for game farmers in the Hainaveld is the ban on exporting game, ban on hunting, being a red zone and not being able to slaughter on the farms. This is restricting the market for game farmers in several areas. All of these are restricting the market, income and finances for managing the game farms. A lot of farmers are leaving farming as main income stream as there is no income. It is more of a constraint now in that there is no income at all. The price disparity due to the FMD area is discouraging. The cattle industry is failing in the Hainaveld, local farmers are selling their farms and outsiders are buying them and converting to game farms. They are not selling because they want to – but because they have to.

Community Aspirations

	NG2	**Lake Ngami**	**Hainaveld**

Water	Pipe water to the west to allow grazing to that area as the water is too salty.	Government should drill boreholes for them and move them to less degraded areas Government must drill boreholes for individual farmers Government should provide us with water as the pipeline goes past our houses. The pipeline provides Bothothogo and Bodibeng. Lot of land to the west – lots of pastures – water is very salty though – government could pipe water for us so we can settle there.	
Disease		We need to train people to use cat holes to control measles.	There is a future for game farming and cattle farming in the Hainaveld as long as we‘re declared as green zone.
Fences		Must erect a fence to control cattle movement- the unfenced area between Makalamabedi and Kuke is too wide. We acknowledge the fence to the south of Kareng and we appreciate it. But the fence is not maintained so we suggest that people should be employed to maintain the fence. Fence by Makakung should be removed to allow cattle to be grazed to the west. Lake Ngami should be gated off as all the cattle from Sehithwa move up to the Semboyo area to graze. Need to have fenced farms to be able to manage their livestock properly.	Farmers need assistance with maintaining their fences The farmers would like the protection zone to be secure so that it can become a green zone.
Veldt management		People want to decrease livestock because rangeland is too small/there is no space for grazing. We want to avoid overgrazing. NG4 and NG5 – they are too big – so government should drill for water so people can settle there. • The government should pump water to the west where there is good grazing. • Improving management will help control FMD without the fences.	People need to off take cattle to enable farms to regenerate. Farmers need resources to be able to put fences into control the grazing.
Fires	Need equipment and training for fighting fires. Firebreaks need to be widened and maintained frequently.		Farmers need resources to be able to maintain their fire breaks

Human-Wildlife Conflict	Need to separate livestock and wildlife and have two separate land uses. If they put up a fence they can be separated – and we can sell to the EU like Ghanzi.	Government must deal with elephant- translocate them. We should be subsidised by the wildlife money like in Namibia, so we can benefit too and see the benefits of wildlife.	The numbers of elephants should be controlled through culling programme. This will help will reducing damage to fences and other infrastructure. Predators need to be controlled too Compensation system and rates need to be reviewed to making living with wildlife more bearable.
Support and Capacity building	Farmers still have to trek cattle to the crush for loading in Nxaunxau. Would like more handling facilities. Our area doesn't vaccinate for FMD but we would like pasturella vaccine. Government should help with water facilities for use to drink good water. Government should help with transporting cattle to market.	vaccination to prevent diseases suggesting that the Trust must work hand in hand to help chase away illegal fishermen Fast track the Trust process so they start implementing their mandate	Game ranching needs to be recognized and supported by DWNP. There is a future in game farming as long as we are declared a Green zone and if the Export ban on game is lifted, as well as receiving the support of government for Game ranching. Labour and equipment needed for removal of intruder plants, set up e.g. charcoal teams. All farmers consulted in the Hainaveld are open to training and capacity building support. We need to nurture associations to help grow and develop breeds, and AI etc.
Land Use conflict		Allow for fields and cattleposts to coexist Reduce the size of fields allocated We need to bring key stakeholders together to discuss conflicting policies that affect land management and use. There should be a gazetted area for livestock. Lake Ngami is very fertile – maybe government should allocate plots for arable farms – community by community then leave the rest for tourism.	Farmers need to know what the plan is for long term development of the farming block. However, this is constrained as the policies are conflicting as the area is allocated as farming land, but exploration is allowed.

Markets	BMC must weigh cattle at the crush before taking them so we know much money to money to expect We would like to be able to sell when we want to and the number we would like to sell, so we can pay herders Would like own quotas rather than shared with the whole community.	As the farmer's committee – it is recommended to allow other buyers to come in instead of BMC. We need the cattle price to be raised. We would like to be able to sell when we want to and the number we would like to sell, so we can pay herders Would like to old quarantine system so we can sell even during the FMD periods. Most people in the Lake Ngami area would like to sell so they can decrease the cattle number in their area. Would like own quotas rather than shared with the whole community. BMC should include the slaughter rate.	The capacity of the BMC abattoir needs to be increased to make it worthwhile for farmers to continue farming. BMC need to find alternative markets for the Hainaveld again. A commodity based trade system is favoured that will enable a freer market in Ngamiland. This would reduce the need for the fences.

8 RANGELAND REHABILITATION

Rangelands are geographical regions dominated by grass and grass-like species with or without scattered woody plants. Rangelands are extremely important to society for the goods as well as the ecological services they provide. Rangelands are distinguished from pasture lands because they grow primarily native vegetation, rather than plants established by humans. Rangelands are also managed principally with practices such as managed livestock grazing and potentially prescribed fire rather than more intensive agricultural practices of seeding, irrigation, and the use of fertilisers.

Over the last century ‗bush encroachment' which may be defined as the suppression of palatable grasses and herbs by encroaching woody species often unpalatable to domestic livestock (Kauffman et al, 1997) has affected millions of hectares of semi-arid rangeland and reduced its carrying capacity for livestock. Changes in natural vegetation dominated by the grass layer, leading to dominance of woody cover and increase in unpalatable forbs are considered as a threat to range conditions, with restoration attempting to return an ecosystem to its historic trajectory.

In the rangelands, the most common objective is to encourage palatable, productive perennials, as they are good for animal performance and to maintain a healthy environment. de Queiroz (1993) suggested that the reference point for rangeland degradation when measured in terms of beef that it can sustain, is the potential natural community that provides the highest grazing value for beef cattle production. This indicates that one major aspect of rangeland degradation is reduction in the capacity of the ecosystem to support livestock production and productivity.

In this respect rangeland rehabilitation has often reflected two prior judgments:-
(i) that removing livestock would reverse the damage that excessive grazing had occasioned and
(ii) that the cornerstone of reform would be exclusive grazing leases, which would enable investment in improvements and reward long-term stewardship while maintaining public ownership (Curtin et al, 2002).

As the latter authors point out these two judgments rested, in turn, on a set of assumptions that went more or less unchallenged in range science for much of the last century:-

(1) that rangelands would never find a ―higher‖ use than livestock production;
(2) that spatial and temporal variability in forage production was of secondary importance, as much as it could be abstracted away in carrying capacity calculations and/or mitigated by improvements;
(3) that the intensity of livestock grazing was the principal independent variable determining vegetation response on rangelands; and
(4) that livestock exclusion would cause vegetation to revert to its earlier composition and density.

The exact origins of these assumptions are obscure, but it is clear that they were imported to desert grasslands from elsewhere and are in fact misplaced (Curtin et al, 2005).

Fenoteselem (2005) also pointed out that the reference point of rangeland degradation with respect to ecosystem processes is the ability of ecosystem to cycle nutrients, process energy and to conserve the soil. Rangeland is considered degraded when pastures are getting unattractive to ungulates and support only low numbers. Thus, degradation in general manifests a decline in productivity and affects the capacity of rangeland to sustain grazing animals.

On the one hand extensive areas of Botswana's rangelands are still open to be utilised by free ranging wild ungulates and an on the other an increasing proportion of the savannah is being dedicated to fenced game ranching. Rangeland management and rehabilitation plans must therefore consider free ranging ungulates and open communal farming systems in order to fully capture all of the pertinent issues that currently affect range users.

8.1 Wildlife Connectivity

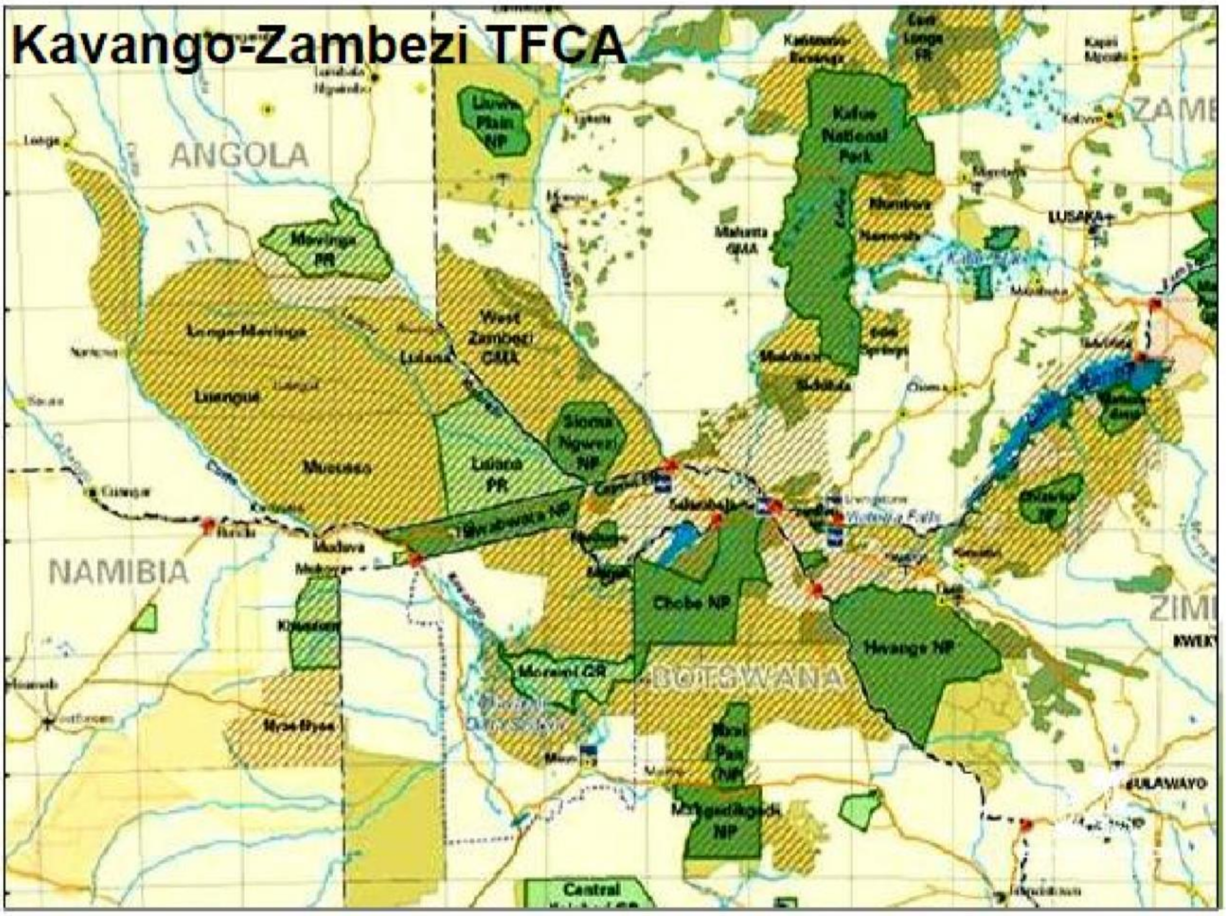
Across much of Africa, a rapidly expanding human population has eliminated and fragmented wilderness regions through, primarily, an expanding intensification of agriculture and associated settlements. The majority of the continents protected areas were established before there was a good understanding of ecosystem dynamics and many of these systems are therefore unable to serve as year-round functional systems within which animals can prosper year-round. This had led to either the dramatic reduction in wildlife population size or the movement of animals outside of protected area in search or seasonal resource requirements, leaving them at risk of persecution.

To fully appreciate the importance of ecosystem connectivity it is important to understand the ―metapopulation concept‖; the idea that the persistence of a species regionally depends on the colonization and extinction of subpopulations. Populations survive and maintain resilience in the face of ecological adversity and environmental change by being able to disperse between different ecological zones. While one sub-population may become extinct through such adversity, the population is recolonised by an adjacent sub-population, while dispersal between sub-populations as an on-going phenomenon creates genetic resilience to ecological change. Under these conditions, local populations could fluctuate in numbers; while the sum total of numbers across the region will remain relatively stable (Pulliam, 1988). The underlying principle is that dispersal and the ability to move between different ecosystems and eco-regions is crucial for species survival. The northern conservation zone and associated international protected areas are one of the few remaining functional wild systems where such sink and source populations continue to persist.

Understanding the movement and regulatory factors of movement of large wildlife herbivores between ecosystems is a complex phenomenon. Whilst data is still lacking for many species, in northern Botswana it is likely that the spatio-temporal rainfall patterns create a shifting mosaic of higher quality resources and therefore preferential habitats that stimulate the movement of wildlife across the different regions of the country. This means that in most cases wildlife density across most of Botswana's ecoregions is low, with temporary high concentrations of migratory and nomadic animals that are concentrated in areas of seasonally available high quality resources. Thus, the very nature of Botswana's semi-arid environment and predominantly poor soil quality instigates a mixture of nomadism and migratory behaviour in response to the climatic variables with migrations and nomadic movement evident in most parts of the country.

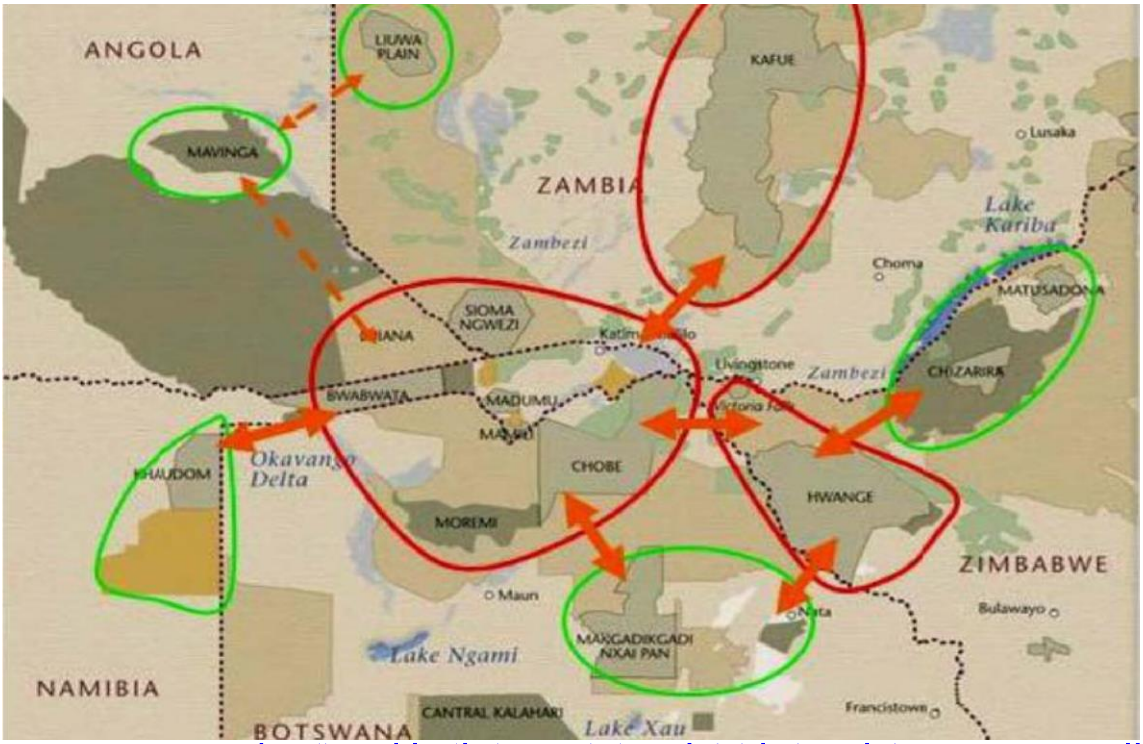
8.1.1 Connection with KAZA-TFCA

The Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA) is a planned conservation area spanning five countries – Angola, Botswana, Namibia, Zambia and Zimbabwe. The memorandum of understanding between the countries was signed in 2006. The MOU was recently signed into a treaty on the 18th August 2011. The conservation area/park aims at linking many of the existing protected areas in the various countries thus protecting wildlife movement routes and increasing the tourism potential for these areas. The spatial representation of the KAZA-TFCA varies greatly according to the source consulted.



https://www.cbd.int/doc/meetings/pa/ewsipals-01/other/ewsipals-01-presentation-27-en.pdf

Figure 75 KAZA - TFCA



https://www.cbd.int/doc/meetings/pa/ewsipals-01/other/ewsipals-01-presentation-27-en.pdf

Figure 76 Wildlife Connectivity in the KAZA - TFCA

When correctly portrayed the isolation of Khaudom National Park and Nyae Nyae Conservancy in Namibia, together with that of western Ngamiland (west of the Buffalo Fence), from the KAZA TFCA is striking. Khaudom National Park burns on a regular basis and its integrity is greatly undermined by its isolation. Within the current drive on the part of DVS for an ever increasing FMD free (green) zone in Ngamiland there is clearly no possibility of increasing regional connectivity with the KAZA TFCA despite the considerable ecological and (potential) socio-economic benefits of doing so. Indeed, the ‗mismatch' between Namibia's ‗red line' fence and Botswana's equivalent fence (the Kuke Fence), is serving to accentuate disease control risks, frustrate regional wildlife movements and connectivity and create 100,000s hectares of ‗empty' savannah.

8.1.2 Connection with ODRS

A number of reports have emphasised the loss of resilience that has resulted from the effective isolation of the Okavango Delta from the surrounding region and the need for increased connectivity to effectively conserve its key wildlife populations (Perkins and Ringrose, 1996; Scott Wilson, 2000; ODMP, 2006; PlanTech, 2012; Ecosurv, 2012; SAIEA, 2014). Ecosurv (2012) used the combined wildlife survey data (total wildlife biomass for years 1994-9 wet season and years 2003-7 during the dry season) to identify a number of zones, as well as wet and dry season distribution to infer connectivity between these ranges. As they point out the results indicate the importance of the Okavango Delta, the Panhandle and the Kwando/Linyanti as critical dry season refuge areas with the southern Gcwihaba WMA playing a role for species that are less surface water dependent.

Wet season dispersion of wildlife occurs mainly into the area between the Panhandle and the Kwando River and east of the delta into WMAs and Chobe and Nxai Pan National Parks. A second dispersal of wildlife occurs out of the Okavango Delta (near the northern end of the Southern Buffalo Fence) into western and south-western Ngamiland thus linking the Gcwihaba WMA to the ODRS (See Below) (Ecosurv, 2012). Using key Stakeholder consultations and the results of the thresholds study (SAIEA, 2012) Ecosurv (2012) pointed out that there is little remaining resilience in the ecosystem. The ungulate populations to the east of the Panhandle, to the west of the delta and towards (and in) Gcwihaba WMA are in imminent danger of collapse (Ecosurv, 2012).

In their Strategic Environmental Assessment of the Okavango Delta Ecosurv (2012) emphasise that if wildlife migration corridors between the ODRS and western Ngamiland are to be maintained, then the almost continuous linear strip of development (settlement, arable agriculture and livestock farming) along the main road from Maun to Shakawe is having a significant impact on ecosystem functioning, by creating a barrier to wildlife movement. This also increases interactions between humans and wildlife, particularly in the area between Guma Lagoon and Etsha 6. Ecosurv (2012) emphasise that if the situation continues in an uncontrolled manner (no planning and/or enforcement), the cumulative effects will only get worse and the impacts on wildlife may move to the point where irreversible changes occur. This would cause a crash in animal populations in the Core area and would lead to significant escalation in HWC.

It seems as if this point has almost been reached today (See Figure 77 Below). Ecosurv‘s (2012) recommended land use options were:-

- Delineation of wildlife corridors (width, location);
- Consolidation of villages (densification) to take advantage of existing infrastructure and services;
- Revitalisation of CBNRM policy;
- Prohibit the development of agriculture (arable and livestock) in the wildlife corridors.

FMD concerns aside (Knight-Jones and Rushton, 2016), wildlife moving out of the Okavango Delta into western Ngamiland does not negatively affect livestock keeping. Indeed differences between herbivore species based on digestive strategy, feeding apparatus, water-dependence, detoxification capacity and behavioural mechanisms all contribute to resource partitioning (Sitters et al, 2009). For instance, Burchell‘s zebra and wildebeest, two wild grazers similar in body weight to cattle, differ in feeding apparatus, water dependency, detoxification capacity and behavioural mechanisms if compared to each other or to cattle (Sitters et al, 2009). These differences decrease the potential of resource competition between wild grazers and cattle and serve to emphasise the fact that cattle distribution need not negatively affect wildlife distributions in non protected wildlife areas (Sitters et al, 2009).

There is therefore a strong case to be made for open cattleposts in western Ngamiland through which wild ungulate populations can move freely through and around. Active herding could also be introduced to use the available grass resources more effectively and enable adaptation to seasonal and temporal shifts in forage availability. Research from pastoralist systems throughout Africa have shown that herd mobility is a key component under conditions of resource variability and if impeded, will likely magnify vulnerability to drought and undermine sustainability (Wario et al, 2016). Fencing clearly compromises this mobility in both sectors and while it may offer leaseholders greater security of tenure, the loss of mobility and the chances of maintaining viable fences given Northern Botswana's growing elephant population, means that the fenced ranch option, for livestock or game, has little going for it.

Figure 77 Livestock biomass Ngamiland

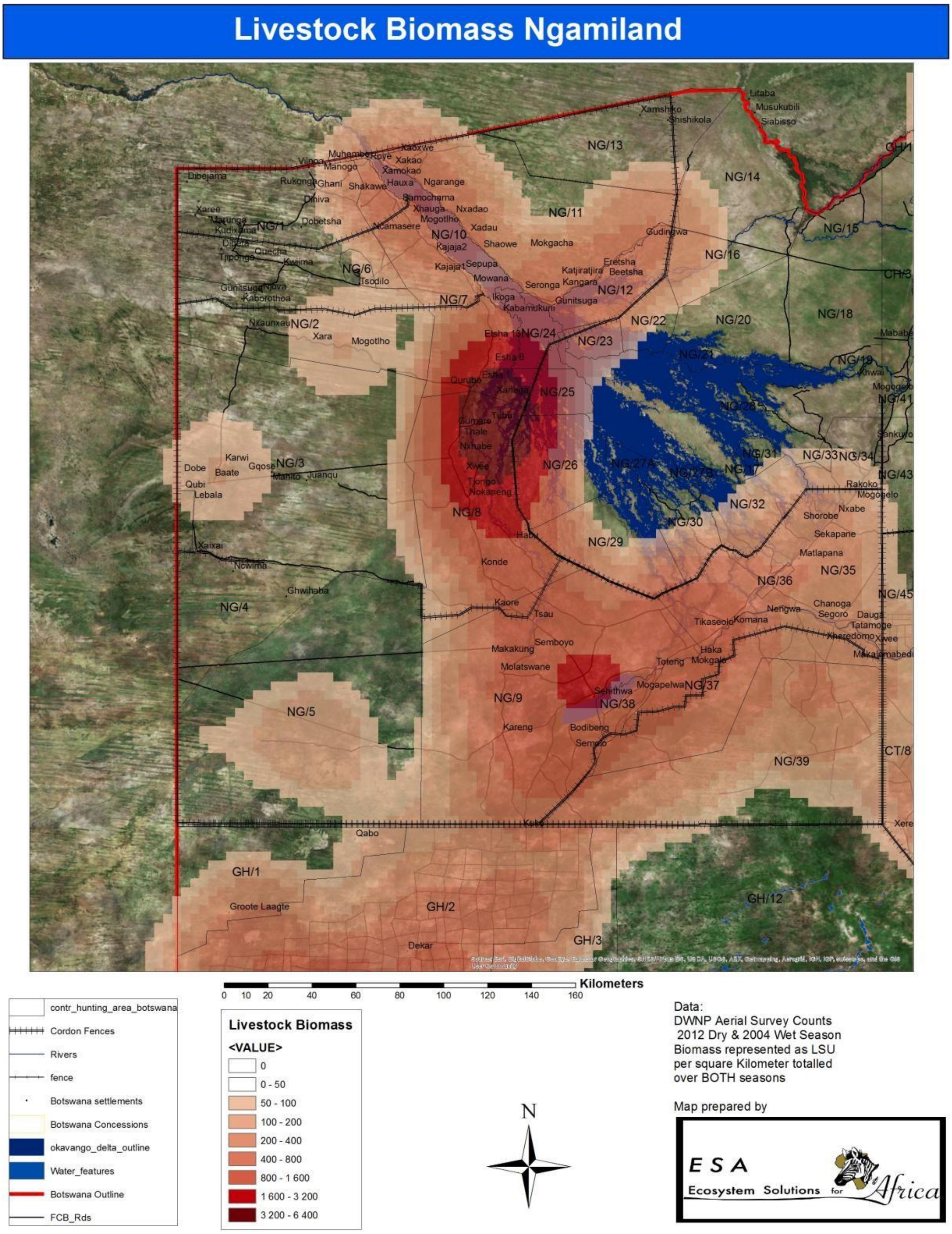
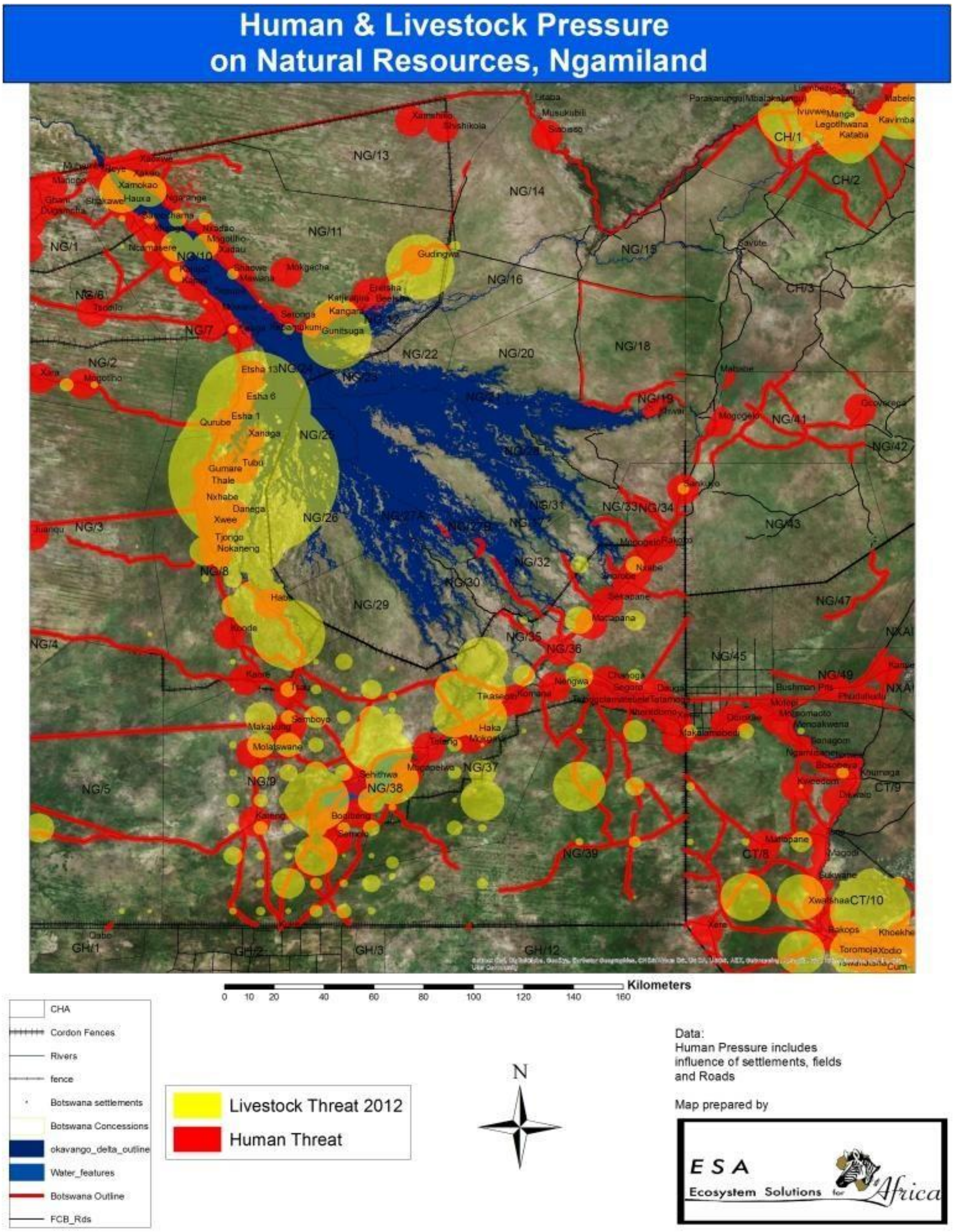


Figure 78 Human and livestock pressure



Ecosurv (2012) identified the following sector developments at the district level that were necessary in order to achieve the sustainable land management scenario:-

- Revise animal disease management in Ngamiland to allow minimal fencing, rehabilitation of wildlife movements and (possibly) process based rather than area based, animal disease management.
- Rationalise and strengthen CBNRM - Focus on critical CBNRM areas where there are high HWC and ecological/conservation issues. These areas need to be identified and given active support and funding to develop CBNRM models. In these areas reruns from CBNRM are often low and incentives such as reduced contributions to the Environmental Fund and reduced taxes would be important;
- Re-establish professional hunting of elephant as a land use to support CBNRM (in high HWC areas) and in low value non-consumptive tourism areas;
- determining the appropriate local scale at which people can work together, plan and prioritize together, and undertake / implement actions together (this could be key corridors or high biodiversity areas outside of the WMAs, or a concession area plus the immediately adjacent rural community);
- bringing the potential partners together (Wildlife Dept., community, private sector concessionaire, and relevant NGOs working in the area) to:
- Create a vision for the area with some key objectives;
- Identify the key issues that need to be addressed (e.g. how to work together, how to communicate effectively, how to jointly control illegal activities, how to jointly manage fires, how to address land-use issues such as settlement patterns, wildlife corridors, etc., how to jointly monitor relevant trends, how to optimize and share benefits, etc., etc.; and
- Develop an action plan for implementation; and moving into joint implementation with regular reviews and improvements to the approach.
- On the ground implementation of different CBNRM models and spread successful models to other areas.
- Elephant - Re-establish professional hunting of elephant as a land use to support CBNRM (in high HWC areas) and in low value non-consumptive tourism areas; o Prepare a strategy on artificial water point (AWP). Focus on reduction of AWPs and zoning important wet season ranges to be free of artificial water supply for wildlife. Prevent uniform distribution of elephant across the wet and dry season ranges;
    - o Open movement routes for elephant to emigrate. This would include removal of border fences in some areas and realignment of the Northern Buffalo Fence to the west of NG13;
    - o Develop CBNRM in key elephant movement corridors (eastern edge of the Panhandle); o Implement appropriate sections of the Elephant Management Plan.
- Research and Monitoring o Obtain a functional understanding of ecosystem processes in the upper basin, the buffer effect or ecosystem services of the upstream wetlands systems in relation to discharge, maintaining water quality, sediment supply or deposition;
    - o Applied research into each of the main hydrological thresholds:

They are options that must also be placed within the context of an absolute shortage of groundwater due to low yielding saline aquifers in western Ngamiland as well as an abundance of the poisonous plant (Mogau) (*Dichapetalum cymosum*).

Conclusion

The increasing isolation of protected areas due to expanding human development and activities is increasingly regarded as a key driver of wildlife population declines and local extinctions (Jones et al, 2012; Kiffner et al, 2016). Ecological connectivity is important for a number of reasons including the maintenance of mobility in response to the green grass that follows spatially and temporally highly variable rainfall and fire events, as well as movements across nutrient gradients. Kiffner et al (2016) point out how the corridors between Lake Manyara and Tarangire National Parks and the northern route toward Lake Natron are considered ‗critically' and ‗extremely' threatened, respectively, as they pass through two multiple use that have distinctly different policies for natural resource utilisation. There is a parallel here with the challenge in Ngamiland which is the fact that ribbon development along the Panhandle and Okavango Delta fringes for pastoral/arable/residential means is jeopardising wildlife access to a large otherwise unutilised tract of savannah in western Ngamiland. Consequently, effective blocking of the corridor(s) would lead to severe ecological and economic consequences.

Kiffner et al (2016) emphasise that balancing the needs of people and wildlife conservation requires more focused conservation planning that attempts to safeguard functional connectivity by:-

(i) clear delineation of wildlife corridors in areas with weak conservation status using modern spatial techniques and

(ii) effective law enforcement (anti-poaching, no land-use changes, restricted livestock densities) alongside income generation schemes that allow local people to directly benefit from wildlife presence in communal lands.

The location of the corridors is known, although they are not delineated on the ground or in land use plans. The corridors should therefore be integrated into LUCIS and every effort made to not only safeguard their functionality, but also improve it by moving inappropriate land allocations to areas outside of the corridors. Strategic use of ‗hour glass shape' fencing could also be used guide large herbivores into the corridors rather than into ‗conflict'areas with people and domestic stock. It is clear however that unless explicitly delineated, recognised, implemented and respected the wildlife corridors will be little more than a concept. Local people with the required skills can be used to help implement the corridors by acting as Community Trackers or Rangers using for example spoor counts and observations to monitor their functionality and help overcome potential ‗bottlenecks' that could close them. Keeping the landscape open, reducing livestock densities, increasing anti-poaching efforts and the benefits of living with wildlife are all essential to the maintenance of a free ranging wild animal system between the ODRS and western Ngamiland.

‗Open' game ranches within and around the proposed wildlife corridors could also be used to effectively channel large herbivores (and predators) between the Okavango Panhandle and fringes of the Okavango Delta into western Ngamiland. The Buffalo fence would then act to direct wildlife into low conflict zones rather than act as an impenetrable barrier. The issue of wildlife corridors is inherently linked to much larger Policy decisions that need to recognise that:-

(i) fencing and vaccination for FMD control in Ngamiland is simply not working.

(ii) fencing for FMD control is set to become even more problematic as the elephant population continues to increase and radiate out of Northern Botswana.

(iii) A move to Commodity based trade (CBT) as recognised by the Phakalane Declaration of SADC (2012) which endorses CBT - as long as the animal is itself not infected with FMD there is nothing wrong with beef from an FMD areas as long as it is deboned, lymph nodes removed and pH Levels controlled. It is an approach that is recognized by the OIE, but not by the EU.

(iv) Multi-species production systems that embrace livestock and free ranging wildlife populations on open unfenced rangeland are better suited to the Kalahari System and will enable greater adaptability and resilience to climate change, than the current drive for geographic disease control and intensive production on fenced ranches. The uncertainty surrounding the vulnerability of species to climate change should also be emphasised (Butt et al, 2016).

It is increasingly clear that Policies that were set in the 1970s are no longer serving the cattle industry well. Indeed, the sector is failing on a number of fronts, with BMC showing ever increasing dependence on government bailouts, the lucrative EU market appearing increasingly elusive and the cattle sector simply failing to address crippling unemployment and poverty in the rural areas. It seems likely that as the key factors of climate change, increasing elephant numbers and increasing challenges with geographic disease control play out in the future, the challenges faced by the livestock sector will become even harder to surpass.

8.2 Fire impact

Fire has tremendous influence on vegetation pattern in savannahs and is the major determinant of savannah vegetation structure and floristic composition (Scholes and Walker, 1993). Flammability varies among plant communities, and fuel breaks due to roads and topography affect fire spread across the landscape. Weather, in particular wind speeds and direction can change rapidly. Fires in southern African savannahs typically occur late in the dry season (August–November), prior to the first seasonal rains.

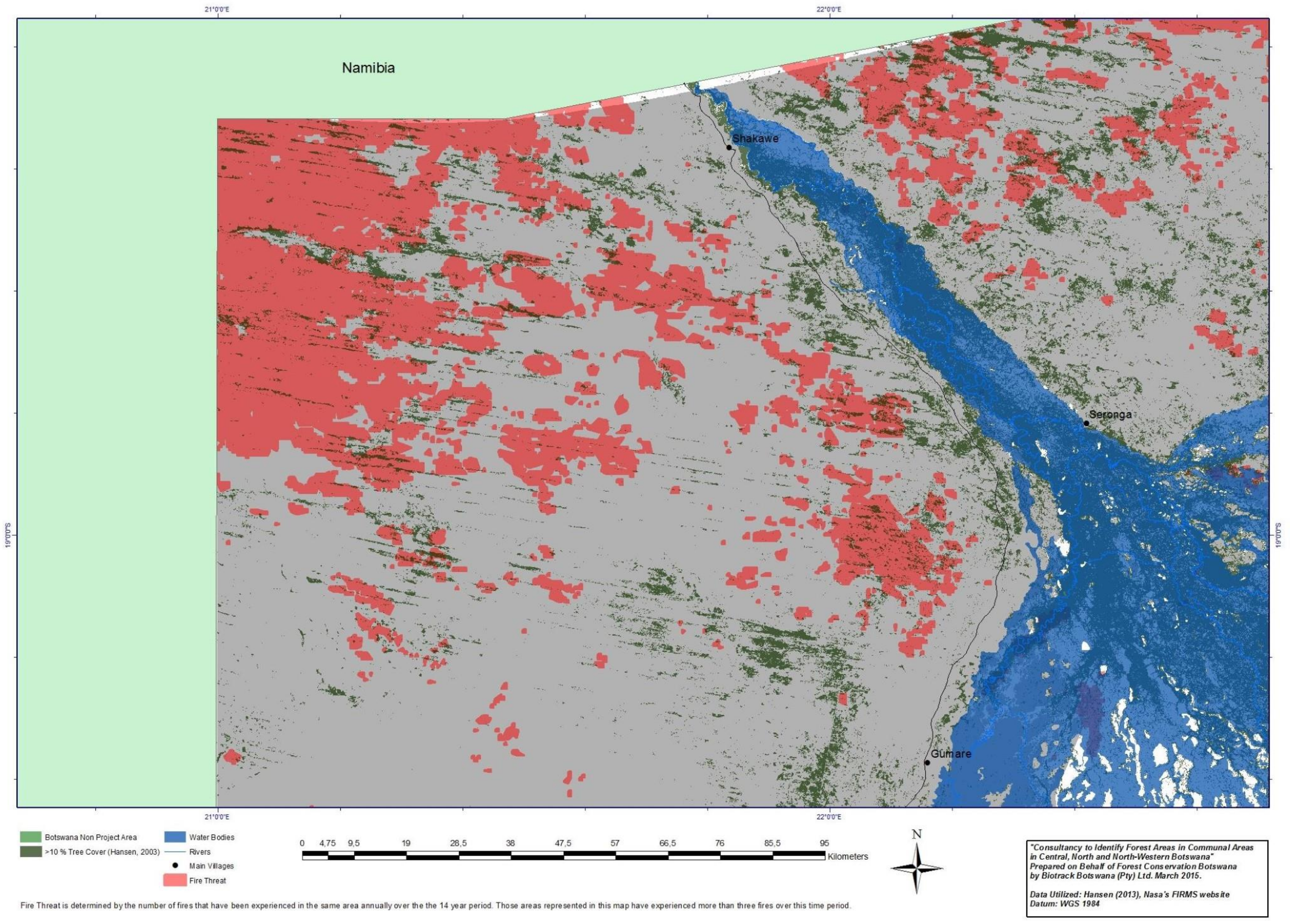
Fire especially acts to limit tree cover via a demographic bottleneck, limiting the recruitment of tree saplings to adults. Therefore, escaping the fire and/or seedling browsing trap is fundamental in determining the relative abundance of tree species and population dynamics in savannah communities. As such it is important to consider the way in which fire works with factors such as herbivory (browsing and grazing pressure) as managing ecosystems characterised by multiple stable states is complex and dynamic, over both space and time.

Large portions of Ngamiland burn every year with severe and extensive veld fires believed to have led to the loss of extensive forest resources across Northern Botswana over the last fifty years (Biotrack Botswana, 2015).

Figure 79 Fire Threat in NW Botswana

(See Below)

Fire Threat in NW Botswana 2001 - 2014



Draft Final Report

Fire records from Chobe District indicated that the wild fires are almost exclusively started by people (NFS, 1992). People can be prosecuted and fined for negligence in starting fires in Botswana, such that most fire reports describe an unknown origin. The causes vary widely, but known and suspected sources of ignition include; campfires, discarded cigarettes, vehicle fires, hunters, safari expeditions, wildlife poachers, field burning, intentionally set fires by villagers and also fires that cross from neighbouring countries (e.g. Namibia) (NFS, 1992). People can be prosecuted and fined for negligence in starting fires as veld fires are banned under the 1978 Herbage Preservation Act.

The transboundary nature of the fires should also be emphasised and is illustrated below.

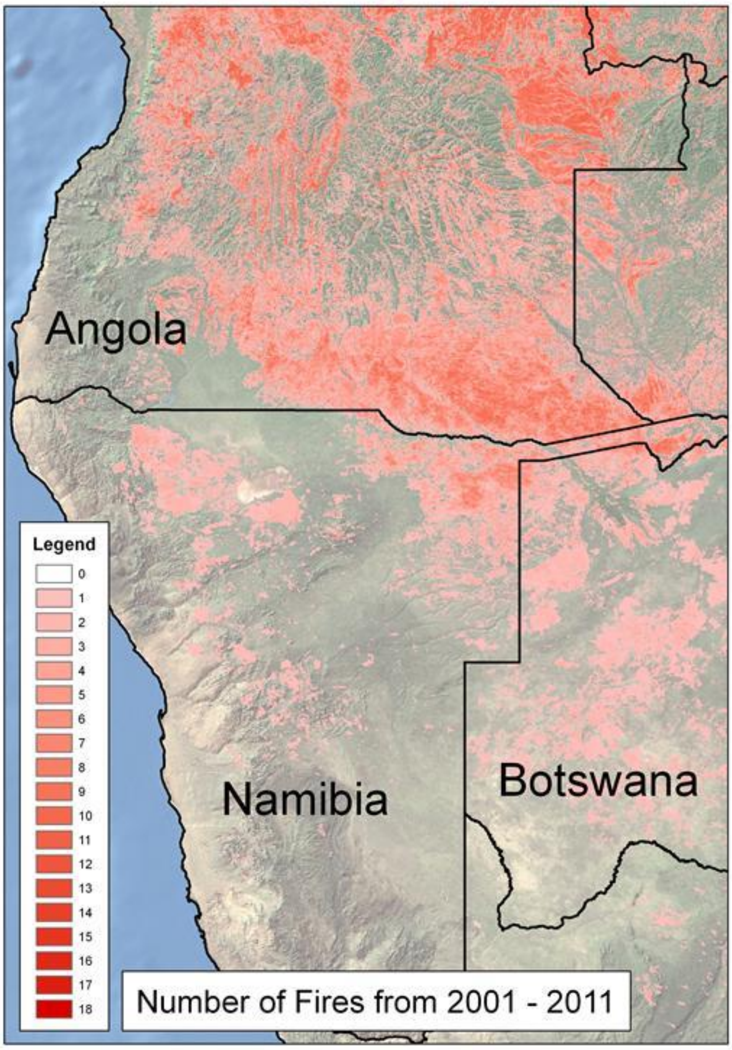


Figure 80 Number of Fires in the Okavango Basin from 2001 - 2011

(From SAREP, 2012)

Around the Okavango Delta and across the Northern Conservation Zone hunting concessionaires have long been blamed for starting fires in order to draw in animals, and buffaloes in particular, that are attracted to the green grass, or rapid post-fire regrowth. Such fires then ran out of control into the photographic concessions. In this regard it will be interesting to see if the hunting ban in Botswana leads to a decline in the extent of fires. It should be emphasised that high quality mukusi forests located within easy reach of visiting tourists are valuable not only to biodiversity, but also the tourism industry. Most fires are therefore human-induced with the EIA for the Contagious Bovine Pleuro Pneumonia (CBPP) fences in Ngamiland (Scott Wilson, 2000) showing that the access the new veterinary fences created resulted in fires breaking out along them, presumably as they had opened up the area to vehicles and people.

Long term research in the Gwaai River of Zimbabwe has indicated that fire is detrimental to the establishment, growth and health of *Baikea plurijuga* (mukusi) (NFS, 1992). By contrast, *Pterocarpus angolensis* (mukwa), which is a fringe species of the *Baikiaea plurijuga* woodland is more fire tolerant. NFS (1992) identified the high incidence of fires in Northern Botswana as the principal cause of the successional change or ‗savannisation' process that was taking place throughout the forest reserves: a gradual opening up of the canopy and reduction of total tree cover (at least in the short term), accompanied by an increase in fire and elephant resistant shrubs (*Dichrostachys glomerata*, *Baphia obovata, Combretum spp.*, *Bauhinia macrantha*). Probably due to a larger proportion of rootstocks accumulated over many years, which is typical of miombo woodlands, NFS (1992) did not find the fire regime causing an increase in the relative coverage of grasses at the expense of shrubs (see also Mmolotsi *et al*, 2012). NFS (1992) also pointed out that while the successional set-back occurring was unlikely to have any negative effects on biodiversity, it was producing habitat that was less desirable for sable.

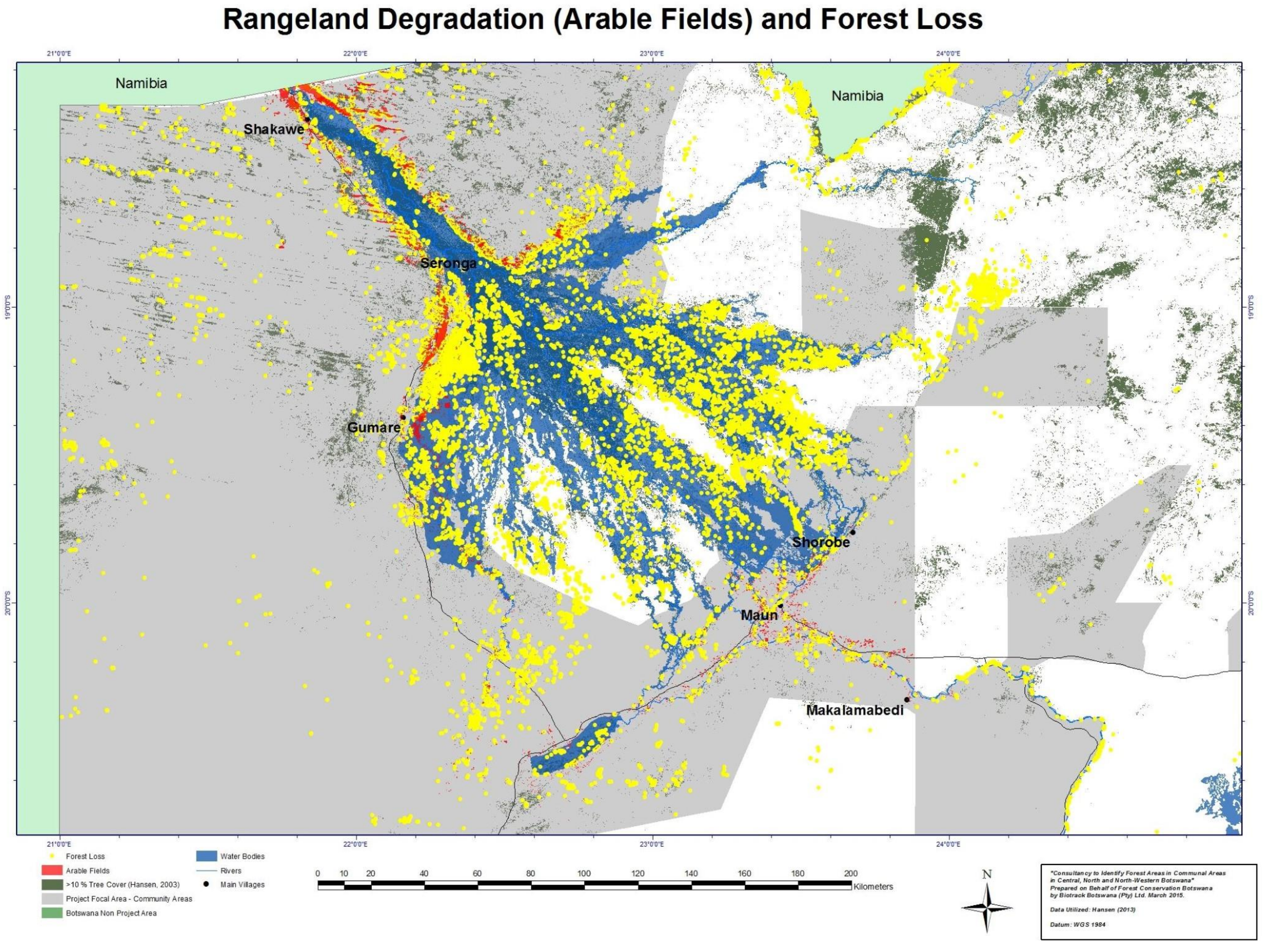
The trans-boundary nature of the fires should be emphasised with the Caprivi Strip and Khaudom National Park in Namibia subject to frequent and intense wildfires, with the KAZATFCA providing the essential structure within which collaborative fire management can take place.

Figure 81 below uses global forest loss data from Hansen et al (2013) to show the extent of forest loss across Northern Botswana in the period 2000-2014. Hansen et al (2013) considered a ‗forest' to refer to trees at least 5m in height, which is the same as that of the 2011 Forest Policy in Botswana. In the figure below the yellow dots or pixels show forest that has been lost over the period 2000-2014, with the red dots showing where the pixels overlap with arable fields. The green dots show the remaining forest cover. The tendency for the Okavango Delta fringes to burn extensively is striking, with many fires also affecting areas of open rangeland in western Ngamiland.

Figure 81 Rangeland degradation (Arable fields) and Forest Loss

(See Below)

Draft Final Report


Rangeland Degradation (Arable Fields) and Forest Loss
21°0'0"E
22°0'0"E
23°0'0"E
24°0'0"E
19°0'0"S
20°0'0"S
Namibia
Namibia
Shakawe
Seronga
Gumare
Shorobe
Maun
Makalamabedi
Forest Loss
Arable Fields
>10 % Tree Cover (Hansen, 2003)
Project Focal Area - Community Areas
Botswana Non Project Area
Water Bodies
Rivers
Main Villages
0 10 20 40 60 80 100 120 140 160 180 200
Kilometers
N
"Consultancy to Identify Forest Areas in Communal Areas in Central, North and North-Western Botswana"
Prepared on Behalf of Forest Conservation Botswana by Biotrack Botswana (Pty) Ltd. March 2015.
Data Utilized: Hansen (2013)
Datum: WGS 1984

8.2.1 Firebreaks

The main method used in Botswana for preventing and controlling wildfires is the construction of strategic fire breaks approximately 30 metres wide. This is done using graders and other mechanical equipment. After inspecting and assessing the existing fire breaks in and around the Ramsar Site, as well as other fire breaks in Botswana during a fire study tour in December 2005, the following conclusions were drawn:

- Many of the firebreaks were planned not taking local circumstances and weather into consideration. For instance, some fire breaks were constructed parallel to the prevailing easterly winds and would therefore not prevent a wildfire from spreading in a westerly direction. Aerial surveys conducted during April 2006 also showed that existing strategic fire break systems have not been maintained and unless attended to immediately would not be effective in controlling the spread of wildfires.

- Greater use could be made of natural barriers in the landscape as firebreaks and with limited use of strategic burning potential buffer zones could be created with minimal impact on the sensitive environment in many areas of the Ramsar Site. (From Trollope et al, 2006; p.40)

8.2.2 Pre-emptive Burns

In the Okavango Delta Management Plan Trollope et al (2006) make a number of key recommendations concerning the use of pre-emptive burns. The details below are taken from his report for the ODMP as they remain as relevant today, as they did then. They apply to NG/2 and the unoccupied Farms in the Hainaveld, the only areas where there is sufficient herbaceous biomass to support a veld fire. In essence semi-arid rangeland managers need to flexibly respond to environmental (i.e. rainfall) and ecological (i.e. seedling emergence) conditions instead of applying a fixed burning schedule (Lohmann et al, 2014).

- **Type of fire**

It is recommended that fires burn with the wind either as surface head fires in grassland or a combination of surface head fires and crown fires in tree and shrub vegetation be used in controlled burning. This is because surface head fires cause least damage to the grass sward and crown fires can cause maximum damage to woody vegetation when fire is used to control bush encroachment (Trollope, 1999). High fire frequencies should be avoided though, as especially hot and frequent fires will lead to nutrient losses from the soil and negative impacts on perennial grass growth (Lohmann et al, 2014).

- **Fire intensity**

Research on fire behaviour in the Eastern Cape Province and Kruger National Park in South Africa has shown that fire can be classified into the following categories according to fire intensity (Trollope, 1983).

Fire Intensity (kJ/s/m	Description
< 500	Very cool
501 – 1 000	Cool
1 001 – 2 000	Moderately hot
2 001 – 3 000	Hot
>3000	Extremely hot

Table 27 Categories of fire intensity

When burning to remove moribund and/or unacceptable grass material a cool fire of <1 000 kJ/s/m is recommended. This can be achieved by burning when the air temperature is <20°C and the relative humidity >50%. When burning to control undesirable plants like encroaching bush, a hot fire of >2 000 kJ/s/m is necessary. This can be achieved when the grass fuel load is >4 000 kg/ha, the air temperature is >25°C and the relative humidity <30%. This will cause a significant topkill of stems and branches of bush species up to a height of 3m. In all cases the wind speed should not exceed 20 km/h.

- **Season of burning**

Research in southern Africa has clearly indicated that the least damage is caused to the grass sward if controlled burning is applied when the grass is dormant. Trollope et al (2006) made the following recommendations in the ODMP:-

Habitat/Objective	Timing
Burkea, Acacia or Mopane Woodlands	Where plant growth is dependent only on rainfall then these areas should be burnt at the end of the dormant winter season in approximately October
Remove moribund and/or unpalatable grass material	Applied after the first spring rains of >13mm to ensure adequate moisture for regrowth to take place in the grass sward. Burning after rain will also ensure that the fire intensity and danger are low, reducing the potential for the fire to escape and become a wildfire
Control the encroachment of undesirable plants like bush encroachment	A high intensity fire is required and it is recommended that this be applied before the first spring rains in August/September when it is extremely hot and dry.
Seasonal swamps	The ideal burning window in this vegetation unit for removing moribund and/or unpalatable grass material is to burn during the period May to July, before the flood waters start rising. This will ensure that the burnt areas are subsequently flooded and the grass sward will recover rapidly when the flood waters recede after July.

(Table based on information from Trollope et al (2006)

Table 28 Recommended timing of controlled fires in the ODRS

- **Frequency of burning**

When burning to remove moribund and/or unacceptable grass material the frequency of burning will depend upon the accumulation rate of excess grass litter (Trollope, 1999). Field experience indicates that this should not exceed 4,000 kg/ha and therefore the frequency of burning should be based on the rate at which this phytomass of grass material accumulates. This approach has the advantage that the frequency of burning is related to the stocking rate of grazers and to the amount of moisture the area receives. Therefore in the dryland areas like the Burkea Woodlands, the required frequency of burning based on the accumulation of excessive grass fuel >4,000 kg/ha loads, will be significantly lower than in the Seasonal Swamps that receive markedly greater levels of moisture from the annual flood waters in the Delta. Frequent burning can cause soil crusting and as a result reduce the rate of infiltration of rainwater into soil in turn affecting the recruitment and resprouting of plants (Mills and Fey, 2004) and leading to greater inter-tuft distances of perennial grasses.

Post-fire range management

Grazing after burning in the Ramsar Site will be difficult to control because in both the areas used for domestic livestock and wildlife there is open access to grazing after a fire. In order to prevent overgrazing it is important to ensure that the burnt area exceeds the short term forage requirements of the grazing animals that are attracted to the highly palatable and nutritious regrowth that develops after a burn i.e. burn relatively large areas at any one time (Trollope, 1990). Another strategy that has been successfully used in southern Africa is to apply a series of patch burns at regular intervals throughout the duration of the burning window during the dormant season. This has the effect of attracting the grazing animals to the newly burnt areas after the different fires thereby spreading the impact of grazing over the entire burnt area and avoiding the detrimental impacts of heavy continuous grazing after the burns (Brockett et al, 2001).

Key Recommendations for Fire

Government oriented fire suppression approaches to fire hazards (bans, firebreaks and fire trucks) raises questions of sustainability in the long run and are also clearly failing as a fire management approach. Land use fire needs include a requirement to burn for supporting livelihoods as in controlling bush encroachment, weeds, pests and diseases, harvesting veld products, managing wildlife movements, stimulating growth of fresh pasture and managing fire risks in adjacent protected areas. Clear potential linkages between CBNRM and range rehabilitation exist, with tangible benefits to rural livelihoods. Education, awareness and training can be linked to community based fire management through a controlled approach of pre-emptive burns and fragmentation of the spatial extent and continuity of fuel loads. Dube (2013) emphasised the need for a land use driven fire management approach that has the benefit of integrating indigenous knowledge with contemporary information on fire leading to more innovative approaches, via the development of a framework for Community Based Fire Management (CBFiM).

The main objective of fire management is to reduce the frequency and extent of veld fires in western Ngamiland. Fire frequencies should drop to Trollope et al‘s (2006) recommendation to a rate of one in 3-5 years and cool burns should be promoted. It is recommended that this is achieved through the:-

- Establishment of Community Based Fire Management Teams – to maintain firebreaks and undertake pre-emptive burns.
- Pre-emptive burns in the early dry season to fragment fuel loads across extensive rangeland areas.
- Targeted ‗hot fires‘ in extensive areas of bush encroachment in order to rehabilitate these areas.

FIRE DANGER STAGES	FDI	FIRE DANGER	FIRE INTENSITY kJ/s/m	CONTROLLED BURNING	FIRE SUPPRESSION
BLUE	0-20	LOW	<500 (Flame lengths 0 – 1m)	Too cold, humid or wet for controlled burning	Fires are not likely to start, or may spread very slowly, or may go out unaided. There is little flaming combustion & intensity is low under all conditions. Control is readily achieved & limited or no mopping up is required.
GREEN	21-45	MODERATE	500-1000 (Flame lengths 1 – 1,2m)	Suitable for controlled burning: • to remove moribund and/or unpalatable grass material; • to construct burnt firebreaks.	Although controlled burning operations can be conducted without creating a fire hazard, care must be taken when burning on exposed, dry slopes. Keep a constant watch for unexpected changes in wind speed and direction. Light mopping up operations are required .
YELLOW	46-60	DANGEROUS	1001-2000 (Flame lengths 1,2 – 1,8m)	Suitable for controlled burning: • to remove moribund and/or unpalatable grass material up to a maximum FDI of 55.	Controlled burning not recommended above FDI = 55 for removing moribund grass. Mature fine fuels will burn readily; spread moderate in forests, fast in open areas. Fires burn on the surface with moderate flames. Control is not difficult but direct and indirect attack with fire truck and labour should be used. Light to moderate mopping-up operations necessary.
ORANGE	61-75	VERY DANGEROUS	2000-3000 (Flame lengths 1,8 – 2,4m)	Suitable for controlled burning: • to create and/or maintain an optimum balance between herbaceous and woody vegetation e.g. combat bush encroachment.	Great care must be taken during controlled burning. Ignition occurs readily. Grass fires spread at ± 7km/hour. Fires may be very intense with local crowning and short to medium range spotting. Control very difficult requiring indirect attack methods with major assistance necessary. Check for any sign of smoke anywhere. Any fire that occurs, should be attacked with maximum force and aircraft if possible. Mopping-up operations may require an extended effort.
RED	76-100	EXTREMELY DANGEROUS	>3000 (Flame lengths >2,4m)	Too dangerous and unsuitable for controlled burning.	Rate of spread extremely high. Fires extremely intense plus extensive crowning, fire whorls and long range spotting. Dangerous heat effect on people within 10m of fire, remove all personnel from field. Control may not be possible by frontal attack during the day and fire fighters should limit their efforts to containing lateral spread until weather changes. Damage potential total and mopping up operations may be very extensive and difficult. Full ground and aerial assistance necessary throughout.

Table 29 Fire Danger Rating System for Controlled Burning and Fire Suppression In African Grassland and Savannah Ecosystems (From Trollope et al, 2006; p.45).

8.3 Alien and Invasive Species

Non-native species are arriving with ever increasing frequency, in some cases causing tremendous environmental and ecological damage and creating new challenges for policy makers (Liu and Piper, 2016). In invasive species management, prevention is the ―first line of defence‖ and the most cost-effective approach (Liu and Piper, 2016). There are an increasing number of invasive plants that are of concern in Ngamiland (see ODMP, 2006.), many of which are waterborne and are of direct concern in the ODRS. This section focuses on two, *Cenchrus biflorus* and *Xanthium strumarium*, that affect extensive areas of western Ngamiland.

According to Rejmanek and Pitcairn (2002), early detection and intervention can be the most effective way to control the spread of invasive species. In reality and for certain species, complete eradication is impossible once invasion reaches critical levels. Figure 82 below shows the estimated relationship between the probability of successfully eradicating invasive species, average number of work hours needed, and the infestation area. As expected, the larger the infestation area, the less likely eradication is to succeed. Almost immediately after the initial invasion, the probability of success drops dramatically from around 90% to about 45%. The amount of effort needed for eradication is below 10,000 h when the degree of infestation is relatively low, but goes up dramatically when the intensity of the infestation increases.

Source: Rejmanek,M., Pitcairn,M.J. (2002) from Liu and Piper (2016) p.140

Figure 82 Eradication success of invasive species in relation to control effort

Responsibility for solving invasive species control has conventionally been assigned to government. However, the large continuing costs arising from invasive species demonstrate the limitations of government-centred approaches to governance in this area and have led to growing demands for landholders and community organistaions to take a leading role (Marshall et al, 2016). Achieving mutual trust among landholders is often challenged considerably by the temptation that each faces to ‗free ride' on others' control efforts. The problem of collective action in these circumstances thus involves establishing sufficient mutual trust to motivate an effective aggregate level of reciprocal control effort (Marshall et al, 2016). In the absence of this trust, individuals will expectthe outcomes of controlling an invasive species on their own properties to be diminished at best, or futile at worst, due to reinfestation from uncontrolled populations on neighbouring lands.

8.3.1 Cenchrus biflorus

Although a widely used forage plant in arid areas, *Cenchrus biflorus* is viewed by many scientists as an invasive weed that has a serious negative impact on agriculture and biodiversity in arid and semi-arid environments. It has risen from insignificance as a forage and famine cereal crop to its recent status as one of the most economically destructive weeds in many regions of the world. Numerous features like high nutritional value, prolific seed production, tolerance to high temperature and prolonged drought conditions contributed greatly towards its success as a potential forage species in arid environments. But, evidence from agriculturalists shows that it is a destructive invader which disrupts cultural practices and reduces natural biodiversity. Unfortunately, limited knowledge is available about its ecology and management in natural habitats and agro-ecosystems.

Cenchrus biflorus was reported to be spreading rapidly throughout the Hainaveld Farms and was seen around Lake Ngami.

8.3.2 *Xanthium strumarium* (Cocklebur)

Xanthium strumarium (common cocklebur) is a species of annual plants belonging to the Asteraceae family, it was introduced to southern Africa from South America. Bromilow (2001) points out that it is a common, poisonous and serious arable weed, that is competitive and difficult to control as the bur, with its hooked projections, gets easily entangled in the hair of mammals. Once dispersed and deposited on the ground, typically one of the seeds germinates and the plants grows out of the bur. Bromilow (2001) points out that pre-emergence herbicides work well, as does shallow cultivation during the seedling stage. However, once high seed levels are in the soil, the infestation is difficult to control. It seems likely that Lake Ngami has already reached this stage as the infestation has been present since flooding commenced in 2009.

8.3.3 Control of Invasive and Exotic Species

As emphasised above early detection and control is the key to dealing with the threat posed to by invasive and exotic species. Wakie *et al* (2016) point out that efforts to control *Prosopis* species around the world, particularly by mechanical and chemical means, have proven expensive and ineffective. As a result strategies that have sought to minimize costs and maximize economic benefits are being sought in several developing countries. For instance, a strategy of managed utilization, controlling through utilization and eradication by utilization, has been advocated in Ethiopia, Nigeria, and Kenya. These utilization schemes (e.g. fuelwood or charcoal production) are promoted in developing countries because they create new income opportunities for the affected communities, while positively contributing towards the control and management of the invasive species. Biological and mechanical controlling approaches, which incur higher costs, are the least preferred options in most developing countries (Wakie *et al*, 2016). As the example of *Prosopis* shows the key to controlling exotic and invasive species is to link control activities to some form of utilisation, or where this is not possible at least link it to income creation in the affected communities. For example reporting the presence of an invasive species such as *Cenchrus biflorus* to DFRR could be linked to a Control Unit within DFRR or the Community that is tasked with removing the individuals before they flower and seed (e.g. by fire). The principles would be the same for all invasive and exotic species but the method of eradication would be tailor-made to the life cycle of the species and the point at which it is most vulnerable,

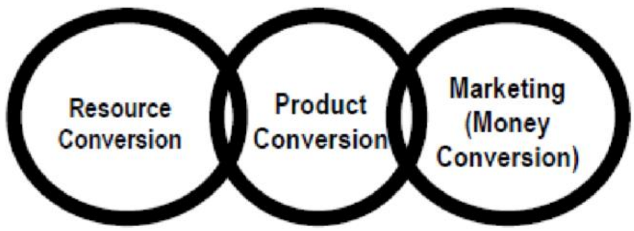
It should also be emphasised that the best defence to invasive and exotic species are ‗healthy' and well managed ecosystems and that the current susceptibility of Ngamiland District to the spread of invasive and exotic species is in fact an indicator that land management is far from sustainable. Indeed, for as long as large tracts of rangeland remain so heavily stocked with little or no prospect of livestock sales, the situation regarding invasive and exotic species in key parts of Ngamiland can be expected to get much worse.

9 RANCH REHABILITATION

A ‗ranch' is defined very loosely within the context of this report in order to encompass both ‗open cattleposts' and the more ‗classical' ranch set-up which is perimeter fenced and possibly includes internal paddocks. The definition of a ranch here is also extended to game ranches.

The recommendations made in this chapter are not intended as a ‗one size fits all' approach to livestock keeping in Ngamiland. Instead the chapter presents a number of ways in which management can improve the existing situation across the entire ‗chain of production', enabling the livestock owner to choose aspects that can be improved based on what is possible and within the management reach and circle of influence of the farmer. This chapter targets the Hainaveld Farms, open cattleposts in NG2 and around Lake Ngami and also game ranches, particularly those along the southernmost tier of ranches next to the Kuke Fence. Many of the Hainaveld ranches have been, or are likely to be in the future, impacted, by the expansion of Copper/Silver mining in the area.

All farmers (communal and commercial) manage a chain of production and the chain consists of the following:-



1. Resource conversion: Is about healthy and productive ecosystem processes:
    a. Water cycle – cycling of rainwater through living plants
    b. Mineral cycle – cycling of nutrients
    c. Energy flow – harvesting of sunlight
    d. Community dynamics - diversity of life in and above soil surface level. In essence it is about the quantity and quality of forage grown which can be managed by the farmer.

2. Product conversion: conversion of plant material into meat and milk.
    a. Keeping livestock safe
    b. Keeping livestock healthy
    c. Keeping livestock productive

In essence it is about the kilograms of meat produced per hectare per year which can be managed by the farmer.

3. Money conversion/Marketing: conversion of meat/milk into money
    a. Transport to markets
    b. Access to markets when animals are ready.
    c. Paid on time.
    d. Grading of the carcass.
    e. Price of the product

In essence it is about getting the best price possible. Farmers can control some aspects of this link, but in general farmers are price takers and will have to take the price they are offered. Management practices should strive to continuously improve each aspect of the above production chain, which is in line with the overall objectives of the Sustainable Land Management (SLM) project.

9.1 Management approaches

The Hainaveld leasehold farms vary in size and are often 4,900 ha rather than the more usual 6,400ha. However, some have been amalgamated making for management units between 10,000 – 15,000ha. Open cattleposts are in general spaced a minimum of 8kms apart, although this distance is often much greater in NG2 and complicated around Lake Ngami by the high density of kraals. Management details will clearly vary with the size of the grazing area available, with this report detailing a variety of approaches that can be used to improve upon the current situation in terms of range management, animal production and sales/offtake.

The management approaches recommended below and have relied heavily upon HM principles in relation to the four ecosystem processes, water cycle, mineral cycle, energy flow and biodiversity. A key theme throughout is to restore and improve essential ecosystem processes and reduce overgrazing and overresting through planned grazing and the use of the ecological tools of grazing and animal impact (high intensity grazing - HIG). This can be achieved by increasing herd mobility in a number of ways by using:-

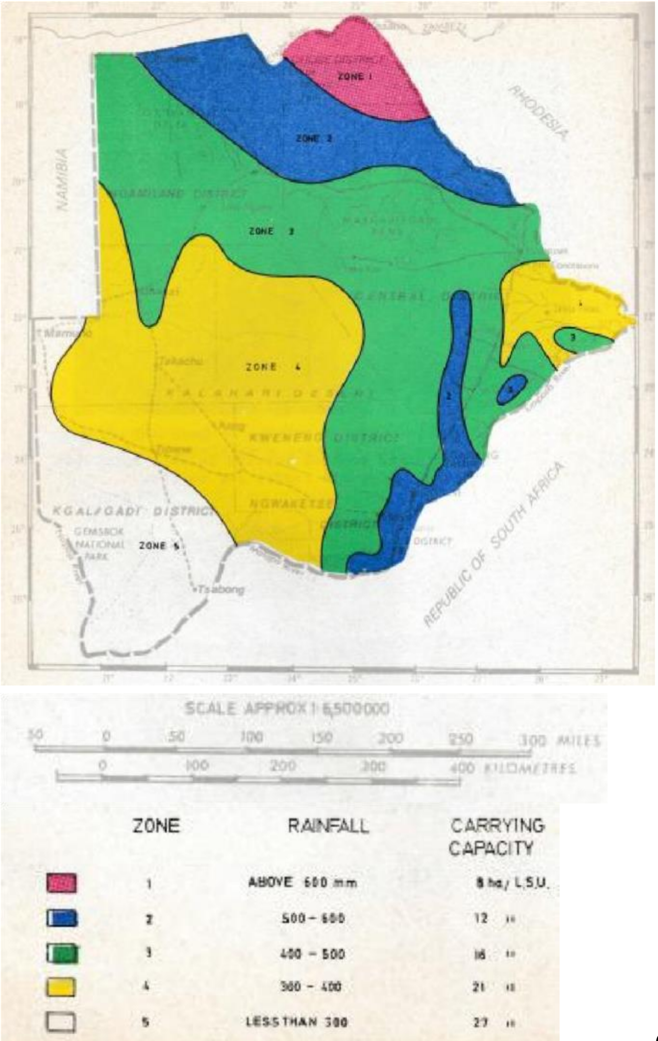
A. HIG
  (i) Methods
    - Waterpoints
    - More Paddocks
    - Increased herding
    - Mobile kraals
    - Mineral supplements/licks
    - Electric fencing
  (ii) Fire
    - Patchy burns

B. Bush thinning ○ Herding/Kraal location ○ Bush clearing – manual and mechanical
    ○ Goats ○
    Fire

C. Alien and Invasive Species ○ *Cenchrus biflorus* and other species

9.2 Current paradigms and perspectives

The recommended potential carrying capacity of the Hainaveld Farms on the basis of the work by Field (1975) is 16ha/LSU (that is for areas having an average annual rainfall of 450mm/yr), which equates to 306 LSU for a 4,600ha ranch, or 400LSU for a 6,400ha ranch.



(From Field, 1975)

Figure 83 Potential carrying capacity

The current perspective is that as long as farmers ―obey‖ the carrying capacity of their land and are stocked below this number, the land will not degrade further and overgrazing will not take place. This is very often the case, but not always for the reasons given. Andre Voisin, the French scientist who developed _Rational‘ Grazing, helped us to understand the importance of recovery period to ensure that plants are not overgrazed. Plants are therefore overgrazed when animals stay for too long in one area or come back too soon after being grazed. So, when we have too many animals, it may happen that we bring them back to the same area too quickly. It is important to understand that overgrazing is not so much a function of the number of animals, but rather the length of time they spend grazing a patch of rangeland. On this basis it is possible to plan grazing effectively.

The cattleposts and ranches in NG2 and the Hainaveld appear to be characterised by absentee owners. When visiting ranches or cattleposts in the day one is quite likely to find nobody around except for cattle hanging expectantly around the waterpoint, and quite possibly calves still in the kraal. The owners themselves may be encountered at weekends, or more especially, end of the month weekends, but outside of that they will probably be operating their own businesses in Maun or from other settlement centres. Ranch or cattlepost residents/workers may, or may not be around and the best time to catch them appears to be early in the morning or late afternoon. At these times they are at their busiest, watering and kraaling livestock in the late afternoon, and letting them out to graze in the morning.

As Abel et al (1987) pointed out it is a system that is designed to avoid working in the heat of the Kalahari and is based upon the minimum expenditure of energy. Coupled with the instilling of the kraal – waterpoint axis into cattle as their _home range‘, and the overall permanence of kraals, it raises considerable scepticism as to the role that active herding can play in the system. Currently herding activities are very limited.

9.3 Resource Conversion

Many of the Hainaveld Farms are in fact similar to cattleposts in the way in which they are operated. On the basis of observations made during the field survey in May/June the following were noted:-

- Water cycle: Evidence of capped soils. Lack of litter and decomposing plant material. Pedestalling and soil movement visible. The water cycle is not effective and moisture loss will especially happen through evaporation. Can be improved with management practices.
- Mineral cycle: Lack of litter and low evidence of animal activity and dung. Possible leaching of minerals in the sandy soils. Feeding the soil with litter and dung therefore very limited.
- Energy flow: Lack of broad leave grass plants and wide spacing of plants near the water point mean that harvesting of sunlight will limited.
- Community dynamics: Lack of seedlings and young plants. Fair diversity of plants. Near borehole mostly weeds and bare soils therefore we can assume that most of the perennial grass plants were overgrazed and died. The further away from the borehole, the more grass plants were seen. Very few overrested plants.

9.4 Product Conversion

Observations made in the field identified the following:-

- Safety: Relatively good based on the current strategy of kraaling animals at night. Safety during the day also good. Predator activity is a problem especially for farmers near the south and along the Kuke Fence.
- Health: The Hainaveld is a healthy livestock rearing area. The general animal condition was good probably due to the occurrence of some grass and a diversity of edible bushes in the area.

- Productivity: Numerous young unproductive female animals were observed together with evidence of later maturing females (3 to 4 year old females not pregnant or without a calf at foot). Stunted calves occur due to kraaling practices by keeping them away from their mothers for daily milking as well as using the calf to ―herd‖ back cows at the end of the day. Due to these practices intercalve periods may also by longer than necessary. We assume that as browsing will increase during the latter parts of the dry season, this may result in possible higher pH levels due to higher protein intake which may result in lower fertility. Bulls run with the herd throughout the year. There is a tendency to breed with larger frame bulls which is driven by the 180 kg carcass incentive (see below). General Animal Husbandry should be a priority.
- Genetics: We see more and more that farmers are selecting for bigger animals since they receive more money for a bigger animal. As we have picked up in conversations with farmers, the 180kg marketing benchmark in Botswana drives their decisions to select for these bigger animals. Bigger animals may not be as well adapted as local breeds to sicknesses and lack of forage during certain periods of the year or in droughts.

9.5 Money conversion/marketing

The following were observed:-

- Lack of access to markets as well as bad timing due to the ineffectiveness of the BMC quota system. This causes huge financial losses when farmers can‘t market their animals on the right time of the year and at the right age.
- Little understanding of the pricing/grading structure and a lack of information.
- Payments not on time or problematic. Low prices compared to the green zone prices Transport of animals problematic.
- Local markets are thin, both because people have limited purchasing power, and because of difficulties in accessing larger markets elsewhere.
- Low individual volumes of (perishable) produce for sale.

The current situation in Ngamiland concerning sales and offtake is nonsensical and is a major barrier to SLM, improved animal production and livelihoods. The entire chain of production needs attention in Ngamiland. Resource conversion has been shown to be weak through the dominance of overgrazing and overresting, while product conversion and marketing conversion are undoubtedly the most problematic of all. Weak or non-existent markets have led to far too many old and unproductive animals remaining on the veld, contributing significantly to range degradation by just wandering around without any real production related purpose. It is a Tragedy of TGLP and its explicit goal of commercial beef production that there should be no real product or marketing point to livestock keeping in Ngamiland, except for a few subsistence related sales, milk from the kraal and the _prestige‘ that goes with owning large herds of cattle. It is an area that simply has to change drastically if SLM is to be realised.

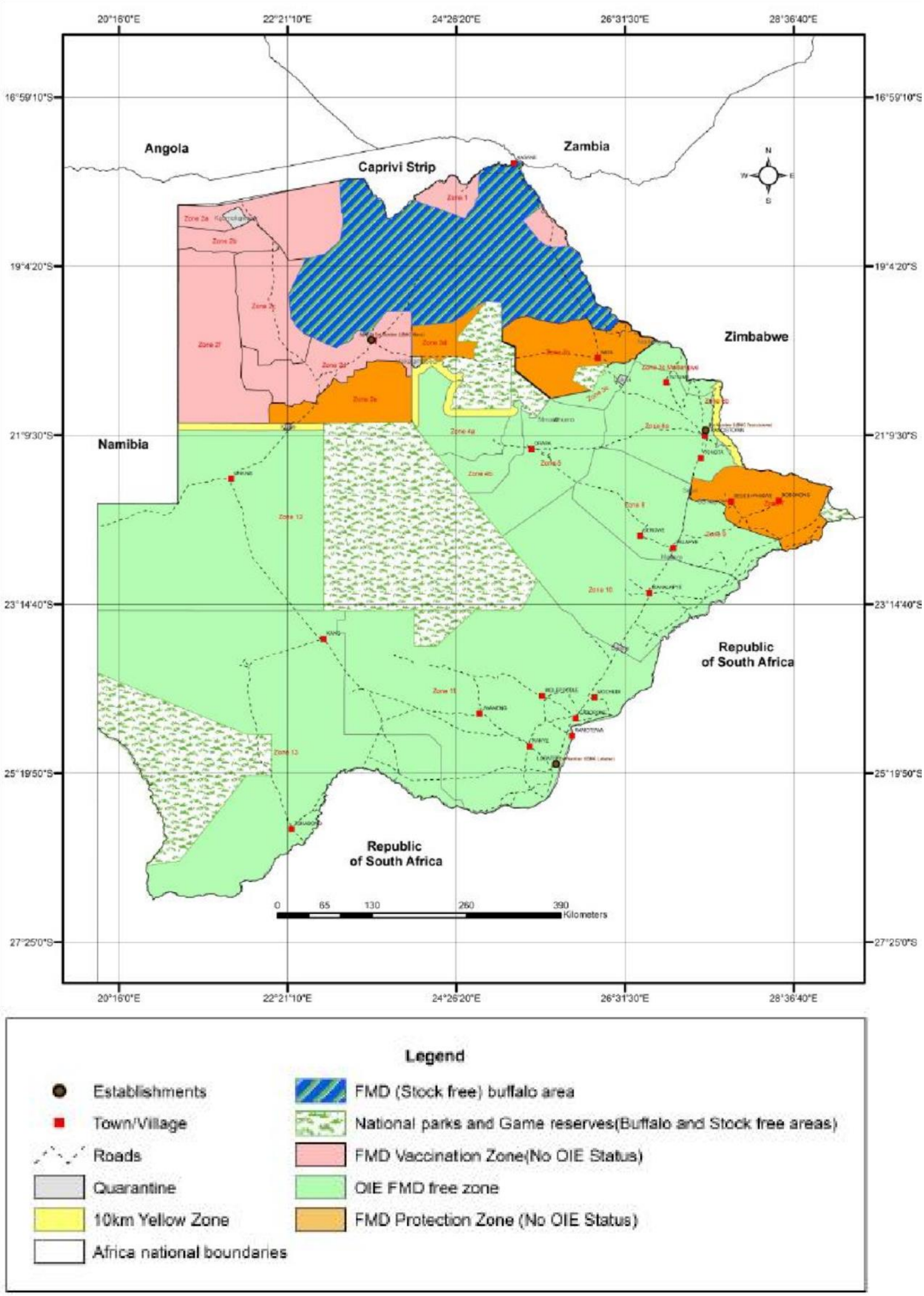


Figure 84 Botswana Disease Control and Protection Zones

(From EU, 2016; p.3)

9.6 Resource conversion improvement

The aim is to improve the ecosystem processes. Improved ecosystem processes will ensure a more productive and resilient environment and will allow the farmers to grow as much as possible plant material that can be utilized by livestock and wildlife. Improvement of the ecosystem processes include:

a. Water cycle (effective rainfall) – break soil capping, soils covered by litter and living plants, shrubs and trees. This will enable higher levels of infiltration, lower levels of run-off and lower levels of evaporation. More water will therefore remain in the soil for longer and be available to plants to grow. Farmers will be able to grow more plant material on the same hectares.
b. Mineral cycle - feeding the soil with dung, urine and litter will feed soil microbes and plants. This will enable farmers to grow more plant material on the same hectares.
c. Energy flow – stacking of a variety of plants, shrubs, trees three dimensionally and having more plants will ensure that farmers can improve and increase the harvesting of sunlight. This will enable farmers to grow more plant material on the same hectares.
d. Community dynamics - diversity of life in and above soil surface level (plants, invertebrates, wildlife etc.). By having effective recovery periods for grazed plants, farmers will be able to keep plants healthy and productive by stopping overgrazing and overresting of plants. This will enable farmers to grow more plant material on the same hectares.

9.6.1 Continuous grazing

Continuous grazing is a system by which one or more groups of animals remain in one undivided grazing area for more than one year. It equates to the ‗cattlepost system' (Abel et al, 1987) where animals have free access to all areas and are not controlled in terms of their movement and choice of grazing.

Animals left too long in a pasture will regraze preferred species and tend to leave weeds and less desirable plants alone. Eventually food reserves in the pasture's high-quality forages become depleted and regrowth will be little or nothing. Weeds and low-quality forage take over under continuous grazing, and productivity plunges to about one-third of that from a pasture under the Voisin or ‗rational' management system (See Below). Voisin also believed that a pasture did not reach its full productive potential until it was at least 100 years old and that even very old, overgrazed, permanent pastures could be improved drastically with better management within three years.

Van Oudtshoorn (2015) details the following advantages and disadvantages of continuous grazing:-

Advantages

- Relatively low cost of supporting infrastructure and drinking water system – compared to that of rational grazing systems.

- Low management input in terms of planning, labour, movement of animals and record keeping.
- Low disturbance of animals (if animals do not overnight in a kraal).
- At correct stocking rates, high performance per animal (animals can select palatable species over a large area).

Disadvantages

- Difficult to control area-selective grazing, which might lead to overgrazing of some parts and underutilisation of others.
- Difficult to control species-selective grazing, which might lead to overgrazing and a decrease of palatable grasses, particularly when overstocked.
- Fodder banks cannot be saved for the dry season or for periods of drought.
- No rest period can be applied to maintain vigour and ensure seed production of good forage plants.
- Animals are often not seen for extended periods, leading to sick or weak animals not being noticed in time.
- Footpaths to preferred areas may lead to erosion.

Herders can also be used to keep animals in one dense group and to move them throughout the grazing area in a planned herding routine.

9.6.2 Rotational grazing

There are any number of rotational grazing systems that involve the division of large grazing areas into smaller ones, and the rotation of livestock through them. Rotational grazing is centuries old. While it served reasonably well in the more humid environments it generally leads to decreased production over time.

The benefits of multi-paddock grazing for maintaining productivity and profitability and for adaptive management responses to changing conditions have been evident to ranchers for many years in many countries (Tainton, 1999; Teague et al, 2013). However, recent reviews of published rangeland grazing studies suggest that multi-paddock rotational grazing improves neither vegetation nor animal production relative to single-paddock continuous stocking (Briske et al, 2008). Fynn (2015) emphasises that rotational resting (deferred resting) in which some paddocks are grazed and others rested over the entire growing season (e.g., Kirkman and Moore 1995) is a superior approach to grazing management.
Van Oudtshoorn (2015) details the following advantages and disadvantages of continuous grazing:-

Advantages

- Species composition can be improved by simulating (grazing) palatable grasses only and by allowing them to rest,
- Forage camps can be rationed for dry periods,
- Degree of defoliation can be controlled by moving animals at the appropriate time, thereby ensuring the viability of good grazing grass species,
- Animals are regularly inspected when they are moved from camp to camp, thereby ensuring that sick animals are noticed in time,

- Excess growth can be cut for hay or used for standing hay during the dry season,
- High production per animal is achieved,

Disadvantages
- Moderate to high cost of fencing, maintenance and provision of water,
- Moderate level of planning and management skills required,
- Increased labour to move stock and supplementary feeding,

9.6.3 Holistic Planned Grazing

Allan Savory developed planned grazing where the needs of plants, livestock, wildlife and people are factored in and where the ecological tools of grazing and animal impact are utilised to heal the land. Holistic Planned Grazing is a planning process for dealing simply with the great complexity livestock managers face daily in integrating livestock production with other forms of production such as cropping, while working to ensure continued land regeneration, animal health and welfare, and profitability.

Holistic Resource Management, or Holistic Management, as developed by Allan Savory in 1965 has been much misunderstood in the literature and incorrectly by some regarded to be the same as intensive rotational (IRG), as well as being known by a variety of other terms such the Savory Method, short duration grazing (SDG) and rotational grazing. Opinions over the validity of HM with regards to supporting the sustainable use of rangelands have long been polarised. In general many farmers swear by it, whilst many researchers are highly critical (Briske et al, 2014) and point to the failure of many formal range assessment measures to back up the farmers claims (Teague et al, 2013). It is a debate that is rumbling on in the literature, but has proven valuable as it has focussed in on those areas where there is good agreement with HM practices, as well as those where opinion is divided.

The key principles of Holistic Planned Grazing are as follows:-

1. Run as few herds as possible – one is best. One herd provides the best graze-to-plant recovery ratio (shorter grazing periods and longer recovery periods). Each additional herd results in less growing time provided to plants, and thus reduces productivity of both plants and livestock. When the animals are concentrated into one large herd, most places on the grazing unit will only have livestock on them 10% or less of the time.

2. Plan plant recovery times before you plan grazing times. The emphasis is on the planning of recovery periods, rather than grazing periods. Managers reserve certain areas for the animals at crucial times, such as calving, and then indicate on the chart where the animals would have to come from to get there, and so on, backwards.

3. Maximum density for minimum time. Animals that remain bunched in a single herd are more effective at chipping the soil surface with their hooves and trampling down plant material to cover the soil so that air and water enter, and new plants can grow. Scattered animals have less impact on the soil surface with their hooves and will create less litter to cover the soil surface. If animals – bunched or scattered – are left in any one place too long, or if returned to it too soon, they will overgraze plants and compact and pulverize soils.

4. Overgrazing is linked to the time animals are present, rather than how many animals there are. Overgrazing commonly occurs at three different times:

- When plants are exposed to the animals for too many days and the animals are around to re-graze the plants as they try to regrow;
- When animals move away but return too soon and graze the plants again while the plants are still using stored energy to reform leaf; or,
- Immediately following dormancy when plants are growing new leaf from stored energy.

5. Base stocking rates on the volume of forage available and how long it must last. Stocking rate used to be defined as the correct number of animals to carry to avoid overgrazing. Even though we now know that overgrazing of plants is not related to animal numbers but to the time the animals are present, stocking rate is still a useful concept. We now align it with carrying capacity – the number of animals the land can carry based on the forage available over the non-growing season plus a month or more of drought reserve. And this is on many land bases adjusted to also cater for the wildlife needs on the same land. Stocking rate for the growing season will be figured based on estimated ADH that will be grown, season weather predictions, and historical production (See below for ADH).

6. Drought reserves are planned as time reserves not areas of land. In the past, areas of land were left un-grazed as a reserve or insurance against dry years. However, this was a risky practice. It reduced livestock production in average or better years because there was less forage available to graze and in seasonally humid environments the un-grazed area was prone to fire. To keep animal production high in every year and spread the ―drought reserve‖ over most of the land to reduce the risk of wildfires, we now reserve days of grazing spread across most, or all, of the land.

7. Plan on a grazing chart. Because managers need to plan months ahead, cover drought reserves, livestock and wildlife needs, and other land uses and to do this all on the basis of plant recovery periods, it cannot be done well – or remembered – without the chart. The grazing chart provides a clear picture of where livestock need to be and when, and this determines how managers plan their moves backwards or forwards. The chart is also essential for monitoring and adjusting, or controlling, the plan.

8. Create one plan for the growing season before main growth starts. The aim of this plan is to grow the maximum amount of forage possible during the growing season so that animals have enough to eat throughout the year and plants are not overgrazed.

9. Create one plan for the non-growing season once grasses stop growing. The aim of this plan is to prepare the soil and plants for the coming growing season and to ration out the remaining forage over the months ahead – right through to a month or more after main growth is expected to start. This additional ―month or more‖ becomes the drought reserve to be used if the next growing season starts late.

10. Monitor the plan. No plan ever goes exactly to plan. What you expect to happen rarely does, and thus planning is always a process of planning, monitoring, controlling or adjusting, and re-planning if necessary.

11. Holistic Planned Grazing is a process not a recipe. No two years are the same, the land changes each year and so does the weather. The people involved also change, as does the economy within they operate. So just following a recipe and grazing in the same place at the same time year after year simply does not work.

9.6.4 Rotational, Rational and Holistic Planned Grazing – How They Differ

Andre Voisin, who first discovered the link between overgrazing and time and the paramount importance of recovery time over grazing periods, developed rational (meaning well-thoughtout) grazing in response to this discovery. He also spoke out vehemently on the dangers of rotational grazing.

Table 30 Comparison of rotational, rational and Holistic Planned Grazing

	Rotational Grazing	**Rational Grazing**	**Holistic Planned Grazing**
Grazing periods are based on:	Number of grazing divisions and desired rest period.	Recovery periods needed during fast and slow growth.	Recovery periods needed during fast and slow growth
Grazing adjustments based on:	Height of grazed plants in grazing division.	Daily growth rate of plants.	Daily growth rate of plants, livestock performance, and/or wildlife needs
Stocking rate is based on:	Estimated dry matter intake and/or rainfall received.	Animal days per acre/hectare (ADA/ADH)	ADA/ADH available for the nongrowing season, plus a ―time reserve‖ for drought, and effectiveness of water cycle
Animal nutritional needs addressed by:	Estimated dry matter intake and daily monitoring of animals.	ADA/ADH estimates and daily monitoring of animals	ADA/ADH estimates, daily monitoring of animals, and allocating the best grazing divisions for critical times, then planning backward from those critical periods.
Use of herd effect for land restoration	Not planned	Not planned	Incorporated into plan that is essential in brittle environments.
Wildlife and other users/uses	Not planned	Not planned	Incorporated into plan so livestock can be used to enhance.
Drought planned by:	Reserving grazing areas.	Reserving time (days of grazing) spread over all grazing divisions	Reserving time in all grazing divisions, and ADA/ADH estimates at end of growing season in a closed plan.
Performance in brittle environments	Breaks down in brittle environments.	Breaks down in brittle environments.	Does not break down in any environment.
Fire prevention	Not planned	Not planned	Routinely planned.
Management decisions based on	Multiple goals involving either forage, animals, or finances at any one time.	Multiple goals involving either forage, animals, or finances at any one time.	A Holistic Context that addresses social, environmental, and economic factors simultaneously.

Adapted from http://savory.global/assets/docs/evidence-papers/The_Science_and_Methodolgy_of_Holistic_Planned_Grazing.pdf

A Farm manager using a continuous or some form of rotational grazing is most likely to switch to a rational system when there does not seem to be any other viable alternatives. Successful managers of any sort of enterprise rarely switch from something that is working to something that may or may not work; they switch when they believe that what they have been doing is no longer working. Thus the shift to a rational system most often occurs when a rancher sees his or her operation on a downward trajectory (real or perceived) or unlikely to survive (or to provide a desired level of economic and non-economic benefits) without radical intervention. Demonstration ranches or Farms can clearly help in this respect by showing Farmers the difference ‗Rational Grazing' can make.

An inflexible and rigid approach to grazing management will not help restore degraded rangelands. Indeed, it might well make the situation worse. The current situation whereby animals wander around the range and graze continuously, and selectively, has led to severe overgrazing around the kraals and waterpoints and underutilisation, or over resting, further away. More than two thirds of the grazing area of ranches may be underutilised.

The advantages of **high stock density** are:-
More plants grazed more evenly.
- More even distribution of grazing, urine and dung
- Quicker moves for animals to fresh un-fouled ground, better nutrition
- Tighter plant communities through increased animal impact
- More even litter laying for soil cover
- Animal performance improves
- More effective rainfall
- Quicker land improvement (greater diversity of plants, etc.)

Animal impact means that the stock density of livestock are stepped up to levels where their behavior change and they start to break up capped soils and trample down plant material that can form litter and cover bare soil. This result of changed behavior is critical in improving the ecosystem processes, especially the water cycle and mineral cycle but also to heal overrested plants by trampling down the oxidized plant material. The ecological tool of animal impact was introduced by Allan Savory and can be employed by using small fenced paddocks or camps or by using full time herders.

This method aims at mimicking nature and the way large animal herds were used to move over large areas as packs, which flattened the grass and covered the soil surface with mulch and dung, thus allowing biological decay before the next growing season and the grassland to rest during long durations (Chaplot et al, 2016). The surficial tillage by animal hooves, which loosens the soil and increases water infiltration in soils is also hypothesised to stimulate seed germination and plant growth (Fynn, 2008, 2015). Significantly, grassland recovery and C sequestration into soils does not simply result from the exclusion of grazers by fencing, with grass height and biomass increasing at non-grazed sites, but not grass basal cover and soil surface coverage (Chaplot et al, 2016). As the latter authors emphasise, grazers, rather than being a cause of grassland degradation, may be a means for improved grassland functioning, provided proper management is applied (Allred et al, 2012).

The primary objective is to introduce severe and intense grazing and trampling effects into overrested rangeland and ensure sufficiently long recovery periods for perennial grasses to recover vigour. Farmers can use the following ecological tools in order to achieve this and improve the above mentioned ecosystem processes:-

o Waterpoints o Paddocks
o Increased herding o Mobile kraals o Mineral supplements/licks
o Electric fencing

9.6.5 Waterpoints

McGowan International and Coopers Lybrand (1988) emphasised the low priority attached to water reticulation on the Hainaveld Farms and the reluctance to drill more than one borehole. They found that the watering facilities for most ranches include borehole, borehole equipment, reservoirs, troughs and reticulation were poorly maintained and that there was little reserve for the inevitable breakdowns. In the majority of cases a single reservoir of 45,000 litres when completely full provides only 2.5 days water for 400 livestock units at an estimated consumption rate of 45 litres/day/livestock unit. The groundwater situation has also not improved over time on the Hainaveld farms and as such it is not seen as a particularly viable or enlightened solution to recommend a renewed phase of borehole drilling and water reticulation on the Farms.

Some individual owners have clearly invested a lot of money in water development, despite the high risks involved, but any broad recommendation to improve water provision on the Ranches seems destined to be a costly failure as it was for the Ncojane ranches and other Livestock Development Projects. Solutions to improved range and animal management must therefore be found on the basis of a single waterpoint, although it should be emphasised that additional waterpoints would definitely be an advantage within a HM framework as when placed strategically waterpoints can be used to move animals around.

The fact that a number of ranches remain without water today serves to emphasise the extent to which suitable groundwater supplies are a constraint to livestock production in the Hainaveld. Piping of water to areas with no or very limited water for people and livestock can open up those areas for livestock farming, although it is also expensive

9.6.6 Paddocks

Paddocking, although regarded as essential for basic grazing and herd management by the DAP, has not been carried out on all ranches. In 1987 McGowan and Associates reported that 65% of the Ranches studied (n=40) had internal paddocks. It is difficult to generalise however, as on some Ranches perimeter fences are down and they operate more or less as open cattleposts, while on others paddocks have been given a high priority. Where the ranch is perimeter fenced with two or more paddocks there is clearly an opportunity to practice some form of rotational grazing.

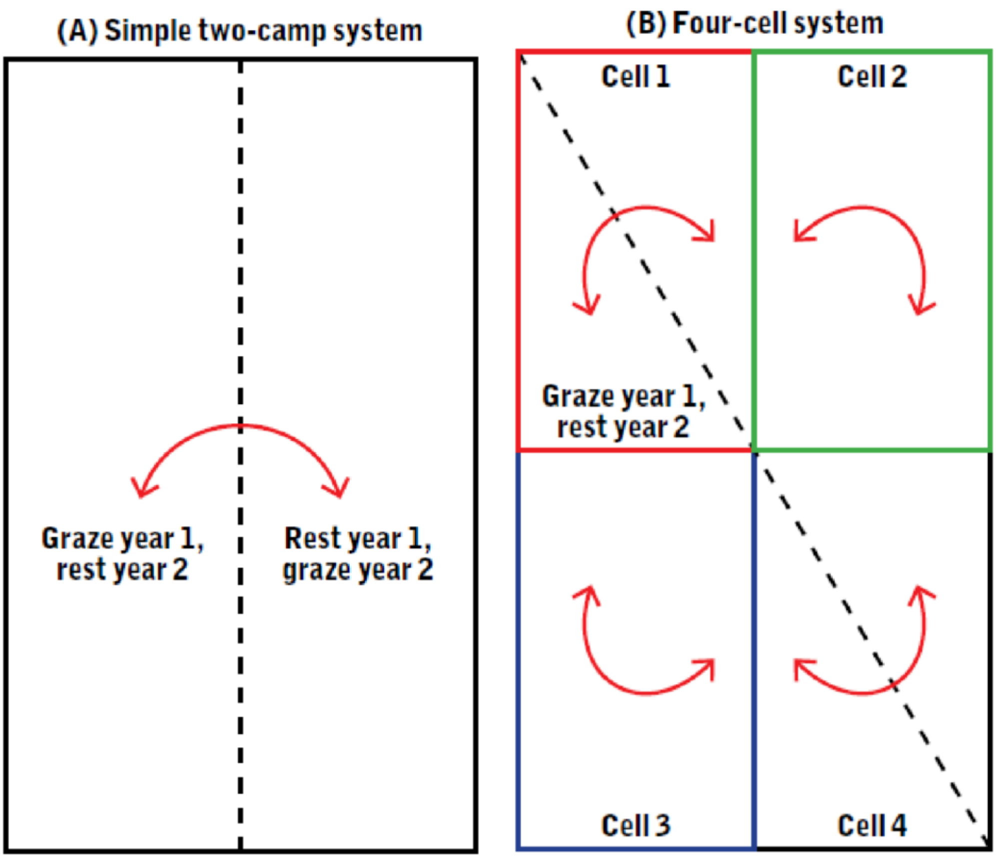
Holistic Management emphasises that recovery and grazing periods are interlinked and one cannot change without the other changing. As the number of paddocks increases, grazing periods become shorter, steadily and increasingly minimizing overgrazing. Using multiple paddocks per herd enables a manager to effectively increase the surface area utilized by grazing animals; subdividing a grazing unit into smaller paddocks facilitates placing livestock in parts of the landscape that they may have previously neglected or under-utilized, enabling the ecological tools of grazing and animal impact. This creates a de facto increase in available forage that livestock actually seek, encounter and consume compared to that prior to subdivision (Teague et al, 2004).

Fences are costly to put in and maintain. A new factor complicating fence maintenance is the tendency for elephants to move through the Hainaveld farms and damage fences on the way. Game fences seem to fare particularly badly, but even cattle fences can sustain considerable damage with grazing plans and animal movements disrupted as a result.

For a 4,900ha and 6,400 ha ranch, where the emphasis is on profit maximisation, some ‗typical' management scenarios are presented below for different paddocking arrangements. It is important to emphasise that there are almost as many varieties of grazing systems as there are farms.

- **Two paddocks of equal size**

Grazing half the Ranch one year, while resting the other half of the Ranch for a full year, is already practiced to good effect on some Farms in Ghanzi District (See for example Fynn, 2015). It is regarded by some as a much better option for range management as it allows the perennial grasses to fully recover, so overcoming the alleged failure of more intensive movement or rotational cycles (Fynn, 2015). Provided the fences can be properly maintained it is also of course a relatively simple option. For an average rainfall year the recommended stocking rate for such a management strategy would be:-



(From Fynn, 2015; p.59) (From Fynn, 2015; p.59)

Figure 85 Types of Rest and Recovery Systems

- **Three or More paddocks**

HM stresses that animal performance improves with more paddocks, because animals can move more quickly onto fresh grazing, and because the animals graze more evenly, which results in better forage quality (fewer old and stale plants). Within a planned grazing approach, paddocks enable higher stock densities to be achieved and the problems of overrest to be more effectively addressed.

Block A Graze year 1, Rest year 2	Block B Rest year 1, Graze year 2
Currently Grazed	Growing season rest
2 weeks in, 6 weeks out	Growing season rest
2 weeks in, 6 weeks out	Growing season rest
2 weeks in, 6 weeks out	Growing season rest

(From van Oudtshoorn, 2015; p154)

Figure 86 Block design system

HM makes the following points with regards to movements between paddocks:-

- Plan your grazing to ensure an even plane of nutrition through moves to fresh grazing as fast as recovery periods will permit.
- Do not hold animals back to clean up forage they do not want to eat unless you are running a class of animal whose performance doesn‗t matter, or when you‗re using your stock to clean up old material in the non-growing season.
- Supplement what the forage lacks until forage quality improves sufficiently, but avoid the trap of selecting for animals that are dependent on supplementation.
- Ensure that concentrated animals are provided adequate watering facilities.
- Handle animals calmly.

Allow animals to move themselves between paddocks rather than driving them.

- Plan paddock moves to adjacent paddocks during calving, lambing, kidding.
- Plan grazing ‗backwards‘ over breeding, calving, lambing or kidding to ensure paddock moves are over minimal distances and least stressful. (Instead of beginning in a certain paddock and planning your moves **into** future paddocks from there, when planning ‗backwards‘ you are assessing which paddock you must come **from** in order to move into a certain paddock at a particular time.).
- Plan grazing backwards to ensure a rising plane of nutrition as breeding begins.
- From two months prior to calving, until the end of the bulling period, make sure the animals are on a high plane of nutrition.
- If grass is getting away from you in the growing season, leave a paddock or two out. These paddocks can be used in the nongrowing season or when animal performance is not critical.

9.6.7 Increased herding

HM points out that an attractive alternative to fencing that can be used to similarly concentrate animals over the rangeland is herding. High intensity grazing by herding is achieved through high stock densities that are used to break soil surfaces, ―planting‖ seeds by hoove action to ensure seed germination or cycle annually dying plant material biologically and rapidly. HM explicitly states that herding is more effective than fencing when herders are trained to look for any areas of bare soil and make sure the surface is broken up and litter and dung are laid down with a short period of soil compaction. In addition they are trained to keep an eye out for any areas of existing grass where the seasonally dying above ground parts are starting to shift from rapid biological decay to gradual chemical/physical breakdown (oxidation and weathering) (HRM, 2012). Where such areas exist that would result in the grass community shifting to bare soil and brush encroachment the herders again concentrate the animals while out grazing as a herd, laying down litter and clearing old grass away from growth points in the coming season so sunlight can reach them (HRM, 2012). The moribund oxidizing material prematurely kills the plants – the main reason people burned (HRM, 2012).

Increased herding is of course ideally suited to unfenced cattleposts and/or unfenced ranches. The challenges with such an approach is undoubtedly overcoming the current situation whereby ‗the borehole is the herder‘ with cattlepost and ranch herding management tending to be based upon the ‗minimum expenditure of effort‘, with salaries or remuneration that reflect it. As such it will require a major shift in thinking by ranch owners and herders alike.

9.6.8 Mobile kraals

The HRM Demonstration Site in Zimbabwe is at Dimbangombe near Victoria Falls where the full range of African wildlife and predators can be found. Every night the livestock are kept in portable lion-proof kraals, that provide a visual barrier to predators that are consequently reluctant to enter. Such kraals also provide extremely high animal impact and as a result can be used on one site for no more than 7 nights to heal any seriously eroding gullies or extremely compacted bare soil (HRM, 2012). They can also be used in conjunction with croplands to improve soil fertility on fields before planting. Placing the kraals in areas of dense thorn bush can also be used as a strategy to breakdown thorn bushes and open up bush encroached veld.

Such an innovative approach has however been met with some scepticism on the Farms and the few Farmers spoken to directly during this Project who suggested that it would not work in Ngamiland. Indeed, kraals in Botswana tend to be permanent with the instilling of the kraal-waterpoint axis into the home range of cattle and essential part of the ‗borehole is the herder' approach. Culturally kraals are more or less permanent affairs, with burials sometimes occurring within them, and their construction varying greatly from little more than cut thorn bushes, through to solid structures out of Acacia or other hardwood tree stumps and branches to treated gum poles. The idea that herders would be in anyway willing to be out at night guarding stock in such mobile kraals from predators such as lions was also viewed with some disbelief by Ranch owners.

Mobile Kraals can be used very effectively to heal badly degraded areas while still keeping animals safe at night. Since farmers and their animals are used to kraaling this may be a very effective way to address serious land degradation. The initial cost of the materials will have to be addressed.

9.6.9 Mineral supplements/licks

McGowan and Associates (1987) pointed out that around half the ranches report feeding supplements and their on-ranch observations suggested that limited supplementation was carried out on a large number of ranches, particularly during the drier winter months. Cattle were in fair condition and death rates lower on ranches where supplements were given (McGowan and Associates, 1987). The latter report emphasised that changes in the system of pricing and distributing bonemeal and other phosphate supplements were both urgent and important. HRM stress that an attractant, such as a few bales of old hay, or coarse salt (to animals denied salt blocks), that causes animals to bunch closely and mill around for a short time on a chosen site to create the desired herd effect to speed land restoration.

It follows that relatively simple techniques can be used to distribute grazing pressure more evenly across the Ranch, even when there are no paddocks, so as to provide areas with some periods of rest and recovery, rather than simply continuous grazing.

9.6.10 Electric fencing

Electric fencing can be used to make more and smaller camps/paddocks, to improve grazing planning and to increase stock density of livestock. However this is expensive and farmers will need training to use it effectively. Using electric fencing in thick bush savannah would also clearly pose challenges as will elephants periodically moving through the area.

9.6.11 Forage and drought reserves

A reserve in area—a paddock or two set aside, just in case—causes you to lose production over the entire property and also on animal performance because you have fewer paddocks to graze. A time reserve, because it leaves all paddocks in the grazing plan, enables you to grow more forage and keep animal performance higher because you can move more quickly.

Holding Forage Reserves in **time**:

- Increases the production on every plant grazed in every paddock, because the grazingto-recovery ratio of every paddock is increased.
- Budgets animal days for reserve for as long as required
- Decreases the risk of losing reserve to fire, as the reserve is spread over the whole cell
- Improves animal performance through the whole season because animals move more frequently when there are more paddocks included in a cell. This means less fouling and more even flow of quality feed into the rumen
- If a drought is experienced, it brings animals through in better condition
- Closed (non-growing season) planning done early, if the current season was poor, results in greatly reduced need to sell off animals, and thus fewer animals sold, at earlier sale and higher prices (before others panic)

Holding Forage Reserves in **area**:

- Forage may lose nutritional value in paddocks held as reserve
- Overrested grassland in reserve paddocks may shift to forbs and woody species in both brittle and non-brittle environments
- Lowers animal performance in all paddocks through entire growing season because there are fewer paddocks to graze and speed of moves decreases
- Lowers production of all plants bitten in all paddocks grazed because the grazing-torecovery ratio decreases

9.6.12 HIG and Communal Areas

Sandford (1980) was one of the first to point out that the expression ―communal areas‖ is actually misleading. Apart from the fact that the Chief‟s representative would sometimes allocate grazing rights Sandford (1980) also stresses that, within the ―grazing‖ area which any individual is permitted in theory to use there are,

" Areas which are <u>de facto</u> private during the dry season, because only the borehole owner can get water for his livestock, are open to others during periods of rain when their cattle practice a wide range of freedom of access. At open water pans, at District Council boreholes and at some dams access is truly open to all members of the community all through the year. There is then a shading off into different kinds of "syndicated" boreholes, owners of which may or may not agree that the livestock of non-members should water for a fee, and then into purely individually-owned boreholes (within the area now zoned communal) where the owner of the

borehole will not permit the watering of any cattle except his own can drink at open water pools. But some owners of boreholes go so far as to claim that they have also been allocated exclusive right to the grazing around those boreholes and that no-one else may use it at any time without their permission" (p36).

In theory while it is useful to distinguish between communal areas, open cattleposts (where the ‗borehole is the herder' – Jerve, 1982) and fenced commercial ranches (perimeter fenced, internally paddocked with water reticulation), in reality there is a blending of the three categories. Thus for example, ‗*de facto*' private cattleposts occur within communal areas and become the personal fief of influential people whether they be indigenous or endogenous to the area (See for example Wilson, 2007). It is a situation that is complicated further by the existence of ‗dual grazing rights' whereby the large herd owners graze their herds on the ‗commons' before retreating to their own ‗private' pastures on their ranch or cattlepost.

The Northern Protection Fence has prevented livestock from the Hainaveld Farms being grazed on the Communal land around Lake Ngami, although with the Lake containing water any respite from ‗dual grazing rights' is likely to have been shortlived. There are a number of boreholes within the Commons that are effectively private, and of course numerous kraals that totally encircle the Lake itself. The current situation around Lake Ngami may be best characterized as a ―rush for the spoils‖ (Campbell et al, 2006) rather than any kind of optimum stocking strategy. Indeed, the over-stocking around Lake Ngami cannot be resolved within the existing property rights framework which serves to hamper attempts by individuals or groups to better manage their rangelands. If this framework can be changed to one in which a respected Entity such as a Community Trust that represents the interests of all the surrounding Villages can agree rules on access and stocking rates, then a move towards sustainable land management could be made. It seems likely though that there is too much inequity, too many herd owners, too many interested parties and the too prevalent perception that the costs of grazing control far outweigh the benefits, to ever achieve this. As Sandford (1980) put it

―*There are conditions under which control and limitation of livestock numbers can be brought about on communally-managed land. The most important of these conditions are: that the community, and its land, are of sufficiently small size that everyone can see that the resources are finite and can also see that everyone else in the community is being constrained by the same rules that bind him; that members of the community are sufficiently equal to each other in wealth that the limitation affects each more or less equally; that some individual, not a committee, is responsible for ensuring that members of the community obey the rules; that alternative ways than accumulating stock are available for the more successful to acquire status; that if the environment is a very unstable one the major adjustments to livestock numbers can be made by adjusting a communally-owned herd rather than the herds of individuals. If all or most of these conditions are fulfilled there is some prospect of controlling livestock numbers. Where the conditions are not fulfilled the record of attempts to regulate numbers is one of dismal failure* (Sandford, 1980; p.38-39).‖

HIG is therefore unlikely to be viable in communal areas as any reserve grazing will simply be ‗poached'. Experience in The HRM Demonstration Site in Zimbabwe at Dimbangombe near shown that HIG can work in a communal setting, even without fencing. However, as Sweet (1986a) put it following the failure of the communal grazing cell experience in Botswana, *„Group action to overcome a problem perceived by outsiders can only be expected if that* *problem is also recognised and considered important by the community………The issue of grazing control and stock limitation can probably only be successfully tackled when the problems more readily perceived by the communities have been addressed and overcome.*‘

9.6.13 Fire

Fires are viewed unfavourably by many land users (Joubert et al, 2012), since they are difficult to manage, have inherent risks and immediate costs, while the benefits are realised only in the longer term. When fires are applied a rangeland manager faces opportunity costs since grass biomass is not used as fodder for cattle, but to fuel fires instead. Consequently, an opportunistic use of grass biomass resources in years of above average rainfall is often more appealing (Behnke and Scoones, 1993). Fires can be used to clear bush encroached areas and increase grass cover.

In practice, a mode of fire management that requires the burning of a whole farm at in the same time is hardly feasible. After burning at the end of the dry season, the vegetation needs to be rested for several weeks to ensure that grasses can re-grow and recover (Tainton, 1999). As a consequence, rangeland managers would have to face a temporal lack of fodder for livestock. Joubert et al (2012) found that a fire event in the second season after germination was as effective in reducing tree seedlings as a fire event in the first season. This allows a farmer to only burn 50% of the land after a shrub recruitment event while burning the other half in the subsequent year. In addition, cattle can feed on the other half of the farm, while the burnt area is rested for some weeks. The green flush that follows fires, or rapid post fire regrowth, is highly attractive to domestic and wild ungulates alike and needs to be managed to prevent overgrazing. Much of the Hainaveld is affected by ecosystem changes summed up by the below model in which fire suppression and livestock keeping has led to widespread bush encroachment.

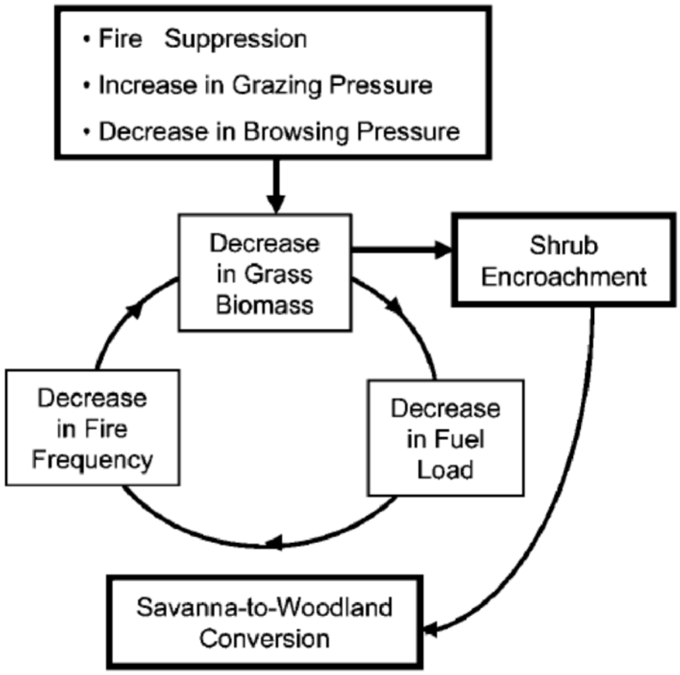


Figure 87 Schematic representation of the positive feedbacks in vegetation disturbance dynamics

From D'Odorico *et al* (2006) p.80

Many ecologists have proposed strategic fire management to reduce shrub encroachment emphasising that it can lead to high increases in long-term average livestock stocking rates in semi-arid savannah rangelands because:-

(i) the risk of a collapse of the perennial grass matrix is largely reduced, since under grazing pressure grasses suffer strongly from competition by juvenile trees
(ii) grass growth is furthermore promoted by the fire-induced removal of accumulated moribund grass biomass, which otherwise constrains grass growth.

Timing in the application of fire management is critical. High fire frequencies should be avoided, as especially hot and frequent fires will lead to nutrient losses from the soil and negative impacts on perennial grass growth (Joubert et al, 2012). The use of fire to control bush thickening or bush encroachment is discussed more fully in the Rangeland Management Report.

9.6.14 Bush Control Measures

The persistence of the bush encroached layer is such that it does not typically respond positively, in terms of woody cover, density and species composition to single or a mixed array of treatments.

Various groups of bush control have been proposed and can be grouped under mechanical, chemical and biological methods. Clearing can be effective, but like chemical techniques is labour intensive and uneconomic to implement (APRU, 1980). Consequently, hopes for control depend upon the judicious use of fire (Sweet, 1982; Sweet and Tacheba, 1984), often in conjunction with increased browsing pressure from goats, to control the post-burn woody regrowth (Sweet and Mphinyane, 1986). Effective control demands consideration of a number of interacting factors including drought and stocking rates, under-canopy fuel loads, atmospheric conditions at the time of the burn and the degree of mixed cattle and goat production ultimately sought (Sweet and Mphinyane, 1986).

It follows that management must be opportunistic, with timing all important as *Acacia sp.* in Botswana can exceed the readily controllable height of 2 metres in 7-10 years with good rainfall (Sweet and Tacheba, 1984). It follows that drought cycles alone, irrespective of the effects of stocking rate and the piosphere effect, could theoretically preclude adequate fuel accumulation for ten years at a time (Sweet and Tacheba, 1984). Given that destocking may be infeasible in all but experimental trials there is clearly a high risk that fuel accumulation will be insufficient to support an intense fire, for lengthy periods of time (Westoby et al, 1989).

Moreover, while increases in the stocking levels of goats can reduce woody growth by as much as a third in paddocked trials (Carl Bro, 1982), goats may not be the panacea to bush encroachment they are often made to appear (McGowan and Associates, 1979; McGowan and Coopers Lybrand, 1988). Adverse changes in herbaceous composition can result if goat stocking levels are too high, and the problematic encroachers such as *Acacia sp.* and *Dichrostachys cinerea* are not amongst the most palatable woody species (APRU, 1980; Sweet and Mphinyane, 1986). Palatable species are therefore likely to receive disproportionate levels of browsing pressure and to be replaced by the more resistant encroachers over time.

The use of bush harvesting for charcoal and/or animal feed production to control bush thickening or bush encroachment is also an option. Some Farmers already harvest droppers and fencing posts from trees and bushes on their Farms, although not on a commercial scale. Acacia bushes are often cut to make bush kraals for goats and occasionally cattle.

9.6.14.1 Bush thinning

Widespread unselective clearance of woody biomass can prove to be detrimental to the herbaceous layer in both wildlife and livestock areas, with the ‗selective thinning' approach recommended (Hagos and Smit, 2005). The latter authors point out that rather than the total clearance often employed by commercial farmers a more appropriate approach would be the selective thinning of *A. mellifera* trees, thus reducing the grass–tree competition, while retaining some of the beneficial effects of the trees in terms of soil enrichment.

Hagos and Smit (2005) also propose clearance of a proportion of tree equivalents in line with the average annual rainfall of the area, via an approach that is detailed further below. For example, as a rule of thumb, the number of tree equivalents per hectare should not exceed twice the long-term average rainfall (mm). A tree equivalent (TE) is defined as a tree (shrub) of 1.5 m height. Thus, a 3-m shrub would represent 2 TE, a 4.5 m shrub 3 TE, etc.
(Smit 2001).

Example:
On your farm with an average rainfall of 450 mm you have the following composition:
100 trees over 5 m in height per hectare
2,000 shrubs/bushes averaging 3 m in height per
hectare 2,000 shrubs below 2 m in height per hectare
This will give you the following:
100 trees @ (6 m/1.5 =) 4 TE 400 TE per hectare
2,000 shrubs @ (3 m/1.5 =) 2 TE 4,000 TE per hectare
2,000 shrubs @ (1.5 m/1.5 =) 1 TE 2,000 TE per hectare
Total 6,400 TE per hectare

As an additional guideline it is recommended that thinning should take place at the following intensity:-

Using the above example for a 450 mm rainfall area, thinning would result in the following densities:-
90% of 100 trees left = 90 trees @ 4 TE 360 TE
10% of 2,000 large shrubs/bushes left = 200 shrubs @ 2 TE 400 TE
10% of 2,000 small shrubs left = 200 shrubs @ 1 TE 200 TE

Total 960 TE
(NB the above example has been taken from MEWT, 2002)

Where certain desired species need to remain, they can be marked to ensure that they are not treated. Such an approach will ensure that not all trees are killed. The use of tree equivalents and annual rainfall data can therefore act as a guide to ensure that the bush thinning operation does not result in detrimental impacts to the broader savannah ecosystem functioning. The recovery and resultant changes to the affected areas in terms of vegetation species composition, physiognomy and abundance should form part of a comprehensive post thinning monitoring programme.

Following the work of Hagos and Smit (2005) and the recommendations made by the Namibian MEWT (2002) tree equivalents could be used to guide the degree of thinning of encroacher species on the Hainaveld farms. It should also be emphasised that MEWT (2002) also recognises the following species as encroachers *Acacia erubescens* (Blue thorn), *A. fleckii* (Plate thorn) *A. luederitzii* (False umbrella thorn) *A. mellifera* (Black thorn) *Colophospermum mopane* (Mopane), *Dichrostachys cinerea* (Sickle bush), *Terminalia prunioides* (Purple-pod), *Terminalia sericea* (Silver terminalia), *Catophractes alexandri* (Trumpet thorn), *Prosopis spp.* (Mesquite) and *Rhigozum trichotomum* (Three thorn).

Selective thinning of *Acacia mellifera*, but could be extended to *Dichrostachys cinerea* (Sickle bush) and *Terminalia prunioides* (Purple-pod). For all three species selective thinning would be a positive impact on the veld. It is also important to emphasise that ‗traditional' charcoal projects target the big trees across a wide range of species, whereas bush thinning on the Hainaveld Farms would target high density bushes (thin branches) of an encroaching species (*Acacia mellifera*) that when thinned/harvested tends to resprout rapidly from the base. The latter fact is much lamented by livestock farmers but also results in a sustainable thinning/harvesting process.

The main challenge with bush thinning for charcoal or livestock feed production on the Hainaveld Farms. NG2 or around Lake Ngami is the initial cost outlay. A bush harvesting point could be established which serves as a central processing point or a mobile unit could be used. In either case the initial outlay costs are likely to be beyond the means of most Farmers and also too time consuming to be considered as a viable business proposition.

9.7 Product Conversion Improvement

The reluctance of the majority of farmers to invest in herding their livestock as in other parts of Africa does create many challenges with regards to peaceful co-existence with a healthy wildlife sector. Indeed, while the ‗minimal expenditure of effort' (Abel and Blaikie, 1987) makes sense within the current macro-economic framework, if the costs of failing to herd were felt more fully by the owners themselves, it is unlikely that straying, depredation, as well as fatal accidents on Botswana's roads, would be such a significant problem. Farmers can improve the following aspects of livestock management:-

9.7.1 Keeping livestock safe

Safety of livestock is related to predation and theft and is a prerequisite to good livestock farming. Farmers in the Hainaveld area complained about predation by especially lions. This will have to be addressed. It seems that theft is not a problem.

9.7.2 Keeping livestock healthy

This starts with basic animal husbandry. Vaccinations should be done timeously and regularly. Good herdsman should spot sick animals daily and treat them immediately. The most important factor to consider is the quantity and quality of nutrition the animals have access to. Poor nutrition means unhealthy animals. Most areas have a macro or micro mineral deficiency of some sort. Identifying these deficiencies and supplementing them will greatly improve animal health.

Milk is a very important commodity on the cattleposts and ranches but can conflict with calf well-being. Perkins (1991) estimated a minimum of 20l/day on the eastern Kalahari cattleposts and ranches in 1988 (n=73) (Perkins, 1996).

9.7.3 Keeping livestock productive

- **WATER**

All animals need healthy, cool and clean drinking water at all times. Animals should have access to water at all times of the day to be productive. Groundwater quality in the Hainaveld is typically poor due to low yielding and poor quality aquifers. Perched aquifers in and around the Kgwebe Hills yield fresher water, but nonetheless also in low quantities. Some farmers mentioned that the saline water meant that livestock did not need salt licks. HRM emphasises that the watering of animals must not be stressful for them in that there must be adequate water in the trough for them, allowing them to drink their fill before moving on.

Table 31 Daily water requirements for livestock

Beef cattle		**Sheep and goats**	
Live weight (Kg)	Water requirement (l/day)	Live weight (Kg)	Water requirement (l/day)
Growing heifers, steers and bulls		Weaners	
200	36	20 - 30	3. - 5.
250	57		
Finishing animals		Late pregnant ewes	
300	54	45 - 55	4. - 7.
450	78		
Lactating cows		Lactating ewes	

400	60	20 - 55	6. - 9.
Mature bulls		Adult wethers and dry ewes	
730	78	50-60	3. - 5.

(From van Oudtshoorn, 2015; p.141)

Table 32 Guidelines for the use of saline water for livestock

Salt concentration (ppm)	**Description**	**Use**
< 1000	Fresh water	Presents no burden to livestock
1,000 – 2,999	Slightly saline	Should not affect health or performance but may cause temporary mild diarrhea
3,000 – 4,999	Moderately saline	Generally satisfactory, but may cause diarrhea, especially at initial intake
5,000 – 6,999	Saline	Can be used with reasonable safety for adult ruminants but should be avoided for pregnant animals and baby calves
7,000 – 10,000	Very saline	Should be avoided if possible. Pregnant, stressed, lactating or young animals can be affected
> 10,000	Brine	Unsafe, should not be used under any circumstances

(From van Oudtshoorn, 2015; p.142)

- **NUTRITION**

The most important factor in a productive animal is nutrition. Farmers should strive to maximize the nutrition of each individual animal from birth to sale. Any form of nutritional stress during an animal‘s life will result in a drop in production whether it is growth rate or calving rate. A grazing plan can ensure animals move into the correct areas at the correct time to ensure maximum productivity.

- **STRESS**

Stress at any stage of an animal‘s life will result in a drop in production. Stress can come in the form of poor nutrition, poor weaning practices, animal handling and kraaling. Most stress to animals is management inflicted.

- **WELL ADAPTED AND FERTILE ANIMALS**

It is critical that farmers keep fertile and well adapted animals. Farmers should therefore measure the amount of kilograms they produce per year and not the size or income per animal. The following should be checked on a regular basis and are opportunities to improve productivity:

- Forage availability: As part of grazing planning, check the number of animals in the beginning of the dry season against forage availability (use STAC or square method). This is the time to destock before animals will start to loose condition and to ensure animal numbers are in balance with available grazing and browsing.
- Bulls:
    a. Make sure they are fertile?

b. Make sure you have enough bulls for the number of cows and heifers
c. Make sure they are well adapted to your area
d. Make sure they healthy and fit enough to service the cows

- Cows
  a. Make sure they are fertile and that they produce a calve on a regular basis.
  b. Make sure they calve easily, have enough milk for their young and are they good mothers
- Calves
  a. Allow calves maximum time with their mothers to suckle
  b. Allow calves to go out with their mothers as soon as possible
- Oxen
  a. Decide when to sell and sell when ready.
- Culling:
  a. Cull old and infertile animals on a yearly basis at the right time.
- Important production figures: (these are important and communities and farmers should strive to develop the capacity to measure the **production of live mass** on their farms/communities. Size of the animal and/or number of animals are often poor production indicators.

9.7.4 Properly managed livestock providing ecosystem restoration services

Healthy ecosystems are an essential prerequisite for healthy animals, with important decisions concerning herd composition and management needing to be made. The nature of these decisions will of course depend upon the desired outcome of the ranch venture, with the perspective of maximising economic gain through sustainable land management adopted throughout this report. This can be achieved with proper grazing planning that is done twice yearly, namely in the beginning of the growing season and the beginning of the dry season. By allowing areas to fully recover in the growing season before being grazed again will improve the veld and thus improve production. In the beginning of the dry season, forage availability will have to be analysed and animal numbers will have to be adapted accordingly to ensure that forage will last, including a possible drought period.

The following production systems are possible:
- Cow – calve operation where calves will be sold at an early age to feedlots. Not really possible in these areas in Botswana.
- Keeping roughly a third cows, third young animals/calves, third oxen of various ages. Selling oxen to abattoirs. This is the current system in these areas and very viable.
- Running only oxen. Buying in young oxen and grow them out.

9.8 Improvement of money conversion/marketing

The aim is the turn the meat into money and the following are important.

a. Transport to markets
b. Access to markets when animals are ready.
c. Paid on time.
d. Promotion of more abattoirs to promote a Free Market system

Management practices should strive to continuously improve each aspect of the above production chain, which is in line with the overall objectives of the Sustainable Land Management (SLM) project.

9.8.1 Reform of BMC

A number of recent studies have questioned both the role of the BMC and the value of remaining committed to the EU Beef Export Market. Indeed, the resounding conclusion seems to be that both BMC and the EU export market have outlived their usefulness and are now actually constraining the forward progression of the livestock industry in Botswana.

Just before independence, the Botswana Meat Commission (BMC) was established under the BMC Act in 1965, with the mandate to promote the development of the country‘s livestock industry in general and the interests of livestock producers in particular, and to market the country‘s beef and related products globally (MoA/FAO, 2012). Specifically, BMC was tasked with slaughtering and selling at the highest prices and the lowest costs possible, all livestock available to it (Hubbard and Morrison 1985). It was a mandate that worked well until 1983 when the BMC had to dip into its reserves to pay bonuses to farmers (MoA/FAO, 2012). As the latter report points it was in fact a structural problem caused by the seemingly conflicting goals of the BMC: offer high prices and a guaranteed market for all producers on the one hand (social role) and develop a competitive, tax and foreign exchange generating beef industry on the other hand (economic role) (MoA/FAO, 2012). Furthermore, the BMC Act‘s requirement for the processor to ―operate efficiently (world best practice)‖ creates an incentive to procure from the most competitive farmers only, rather than from all farmers (MoA/FAO, 2012).

TSG (2006) point out that Botswana‘s beef industry and cattle sector in in crisis. Diminishing throughput at the Botswana Meat Commission (BMC), has resulted in rising losses and dependence on government bailouts; low productivity both in cattle rearing and at the BMC; an inability to fill Botswana‘s export quota to the lucrative EU market; and the failure of the sector to provide a vigorous base for the rural economy and fulfil its potential role in employment creation and poverty alleviation. The TSG (2006) report makes a number of recommendations including:-

- raising domestic prices to regional export parity levels;
- promoting a shift in the cattle sector from a system based on oxen production to one based on weaner production,
- with consequent improvements in productivity and efficiency;
- removing trade restrictions on beef and cattle; and reforming and restructuring the BMC.

TSG (2006) also point out that the majority of households in Botswana (62%) do not own cattle, and hence are net purchasers of beef. TSG (2006), like other observers, emphasise the need for BMC to undergo restructuring and competition. In particular, there is a need for prices to move towards export parity (EPP) and for trade liberalisation to allow competing beef and beef product exporters, thus removing BMC‘s export monopoly. This would stimulate the growth of private sector abattoirs and processors, provide much-needed competition to BMC, and promote the seeking out of new export markets (TSG, 2006). The ban on beef imports also needs to be lifted in order to overcome the fact that BMC exports hindquarters to the EU, whereas the domestic and regional markets prefer forequarters. If forequarter imports could be sourced competitively for the domestic market, this would release cattle that could be sold to the BMC (TSG, 2006). Finally, full trade liberalisation would encompass lifting the de facto ban on live cattle imports, which could also help to alleviate domestic supply constraints – but only if pricing was regionally competitive (TSG, 2006). The latter report points out

…..‘*it is doubtful that a proper reform of BMC will be possible under continued public ownership, as crucial decisions (such as the reduction of excess capacity) become too politicised and either delayed or avoided altogether…….Without fundamental reform, at some point BMC"s losses will become unsustainable, even for government, and the company will collapse. While this outcome may seem disastrous, it may not be. Although in principle engaged in value-adding activities (processing raw materials – cattle – to produce finished products – beef), BMC is at present value-subtracting, as the value of what it produces is less than the value of the inputs it consumes. It can be argued that the Botswana economy as a whole, and farmers in particular, would be better off without BMC, as farmers could then sell their live cattle outside of the country for regional prices that are higher than what they receive from the BMC* (TSG, 2006; p.5-6).″

- **Weaner production**

It is debateable whether weaner production is the route that Botswana should follow as recommended by TSG (2006). Botswana has a worldwide reputation for the production of free range beef that ranks arguably as the best in the world and it would be unfortunate to taint this reputation with grain fed beef from feed lots along with the herd health and veterinary issues this involves. Weaner production is infrastructure intensive, as it requires fencing and separate penning of different elements of the herd; closer and better educated supervision; and abundant localised watering for calf and cow. TSG (2006) also point out that intensive weaner production and feedlots would:-

- require much higher reliance on imported inputs which may not remain readily accessible or affordable,
- put extra stress on the environment, and
- that weaner herds are less resistant to drought, as they constitute younger, more fragile, high-cost long-return units.

9.9 Example

- Farm is situated in the Ghanzi district of Botswana
- Started managing holistically in 1999
- Started with a breed cow herd of 600 cows
- Total head of 1200
- Stocking rate of 1MLU/15ha
- By 2012 we had grown to 5000 head
- A cow of 1750 breed cows

- Stocking rate of 1MLU/5ha
- In 2013 with the start of a 4 year drought we reduced numbers by about 1000 head
- We hired additional farms to carry a percentage of the animals that were selected to stay through the drought
- We now manage 50,000ha, with 6,000 head and 2,250 Breed Cows
- Our production system is simple and easy to manage
- Cows are bred between December and May
- Calving happens between October and February
- Weaning between 7 & 8 months from June to Augusto
- All females are kept for breeding
- Not pregnant or unproductive females are sold
- Oxen are run to between 18mth and 30mths before been sold
- We select our own bulls for breeding and purchase about 15% of the bull herd
- Further expansion is possible as available forage has greatly improved
- We can now restock the home farm while keeping the hired farms

What these facts prove is the great potential that all land has to produce more than expected. By following basic ecological and livestock principles, and a comprehensive grazing plan that is implemented well, farmers can improve productivity and profitability. Generally, successful cow-calf producers operating in drought-prone environments rely on two pervasive management practices:-
(1) appropriate stocking rate management and
(2) controlled, properly timed, calving and breeding seasons that coincide with expected availability of forage (Teague et al, 2009).

It is however essential that such guides do not simply point out the obvious but rather empower Ranch owners to more effectively manage the veld as a result of limited monitoring efforts. HRM provides a useful approach whereby the amount of forage is envisaged in terms of ‗stock days' and assessed via a simple walking technique known as STAC or the use of a square.

9.10 Animal Days per hectare

One animal or stock day per hectare (ADH or SDH) represents the amount of forage one animal consumes in one day. ADH/SDH can easily be converted to the actual square meters required to feed one animal for one day. This calculation helps to determine paddock size as well as carrying capacity/stocking rate. In the field HRM practitioners recommend four people standing at each corner of the area required to field one animal per day. It is an excellent visually striking way to view the veld and breakdown the component vegetation into a stock day. Experienced HRM practitioners also take into consideration the browse potential, something that clearly requires experience.

The stock day concept can be backed up by the so called STAC method of assessing the amount of forage on the rangeland.

9.11 STAC method

The STAC (Sole Toe Ankle Calf) Method, permits Farmers to quickly assess grass quantities by walking through their available grazing and measuring grass height and volume to obtain critical information on how long the feed will last. This enables Farmers to match their stocking rate to their carrying capacity and help plan for future management decisions.

9.11.1 How It Works

STAC stands for Sole, Toe, Ankle and Calf. These are the points of measurement of the top of the bulk of the grass sward (plant). In other words look through the grass to identify what height the bulk of the grass stops so that one measures bulk not stalks and wisps that stick out the top.

Having made the decision on bulk height, one then works out what feed is available. The formula for beef cattle is as shown in table 33 below, Sole is 30 SDA (stock days per hectare) Toe is 60 SDH, Ankle is 90 SDH, and Calf is 120 SDH. In the beef industry in South Africa HM works on a 2.5 percent of body mass intake as an average through the year. So at 11.25 kg dry matter intake the forage calculations used in semi-arid (brittle) environments with mixed to sweet grasses are as shown below.

STAC Adapted to Semi-arid (Brittle) Environments

First, do the steps as above, then work out what percentage of the grass sward is at the measurement. This is done by pacing ten paces and scoring each footfall according to available bulk feed as follows:

- Full (as per bulk height) scores a 1
- Half the feed available only (half covered with bulk height) would score 0.5
- If there is a bare patch with no feed available (no bulk present) you would score it a 0. (It is best to count only on the one foot each time rather than on each footfall, it is a lot easier.)

This will then tell you what percent of the sward is not full, from which it is possible to calculate what feed is available with this figure and the original bulk measurement.

For example, if you count 10 footfalls and find 3 are bare, 4 are only half, while the rest are full that would mean that 50% of the sward measures to your original bulk estimate ((4 x .5) = 2 + 3 = 5 or 50%). Say it was toe height; then 50% of 24 SDA or 60 SDH would equal 12 SDA or 30 SDH.

The rules for this method of forage assessment are no different to the rules one would use when doing squares or clippings for assessment. It is always done twice in a representative area, and always in more than one representative area in a paddock where there is variation.
On foot it is important to force yourself to put your next footfall where it should go, not where you may influence the score.

Measurement	**SDH**	**SDH @ 50%**
Sole	30	15
Toe	60	30
Ankle	90	45
Calf	120	60

Forage Calculations for 1 SAU based on 1,000 lb (450kg) beef cattle with 25 lb (11.25kg) Intake

Table 33 Forage calculations based on STAC method

10 LIVESTOCK AND WILDLIFE POTENTIAL

This chapter outlines the livestock and wildlife potential in the three focal Project areas before discussing the optimal land use management plans in the next chapter. There are some structural constraints, such as poor groundwater resources, the impact of elephants and the occurrence of mogau (*Dichapetalum cymosum*) that can be identified across all three areas. There are also ‗solutions' such as those through education, training and capacity building of Farmers that apply to all three areas and can be built upon through future implementation of SLM Projects in each area.

10.1 Key factors

The following factors are considered below for livestock keeping and wildlife utilisation in each Focal area. The wildlife option in NG2 in this scenario is for wildlife within an open unfenced system.

- Groundwater - Saline and low yielding aquifers that limit the exploitation of groundwater
- Mogau - The presence of Mogau (*Dichapetalum cymosum*) which is poisonous to domestic stock
- Overgrazing – around waterpoints
- Underutilised – under-utilised or what may be termed ‗over-rested', Refers to a situation where herbaceous biomass is not only fuelling severe and extensive veld fires but also leading to soil capping and excessive evaporation. Indeed, the nutrient and water cycles are impacted upon negatively by the lack of concentrated trampling by ungulates in such under-utilised areas. It is a condition that needs to be reversed.
- HEC - Increasing pressure from elephants, typically lone bulls or small groups of bull males that damage Jojo tanks and borehole infrastructure
- HEC – elephant damage to fences
- Depredation - Lions
- Depredation – Wild Dogs
- Fire – Veld fire potential
- Pasturella – propensity for disease outbreaks
- FMD - threat
- Marketing and sales – the whole complex of factors surrounding sales and offtake Poaching/Theft = illegal killing or taking of wildlife and domestic stock, respectively.
- Mobility – importance of ungulate movements

Table 34 below illustrates the way in which different factors influence the livestock or wildlife potential in each Focal area. The strength of the colour relates to the significance of the factor in influencing development in each sector.

Table 34 Livestock and Wildlife Potential for Development in relation to the Key Factors

Livestock Potential

Factor	NG2	Lake Ngami	Hainaveld
Groundwater			
Mogau			
Overgrazing			
Under grazing			
HEC - infrastructure			
HEC - fences			
Depredation - Lions			
Depredation – Wild Dogs			
Fire			
Pasturella			
FMD			
Marketing and sales			
Theft			
Mobility			

Wildlife potential

Factor	NG2 (Open)	Lake Ngami	Hainaveld
Groundwater			
Mogau			
Overgrazing			
Under grazing			
HEC - infrastructure			
HEC - fences			
Depredation - Lions			

Depredation – Wild Dogs			
Fire			
Pasturella			
FMD			
Marketing and sales			
Poaching			
Connectivity			

Rating

	High
	Medium
	Low
	None

10.2 NG2

Repeated reports have emphasised the potential role that wildlife could play in NG2 and how this could be used to improve livelihoods and improve wildlife conservation in Ngamiland and the broader KAZA-TFCA. Aerial surveys have shown that elephants and zebra can be found in NG2 and move from the Okavango Delta into western Ngamiland in the wet season and return when the surface pools dry up. Other plains game such as eland, kudu, gemsbok, wildebeest, hartebeest, impala, duiker and steenbok, should also occur in the area.

Botswana‗s elephant population is increasingly radiating out of the Okavango Delta and Northern Conservation Zone and as a result is causing unprecedented levels of humanelephant conflict. It is a movement that is difficult to stop, with the killing of elephants under problem animal control, exacting an unknown toll on the population and the potential benefits that may be received from it. HEC, like HWC, is also hardening attitudes towards wildlife in the rural areas as people see the wildlife resource as threatening their livelihood and competing for the same resource base, but offering no sustainable benefits to them.

The occurrence of Mogau throughout NG2 limits the expansion of the livestock sector, and while livestock can ‗learn‗ to avoid it, mortality is likely to be a continual problem, especially in poor rainfall years. On the other hand, the occurrence of Mogau presents an opportunity to wildlife conservation as it offers no such restrictions. Free ranging wildlife populations, through their mobility over large areas, are best adapted to the spatially and temporally highly variable occurrence of green grass that follows patchy rainfall and fire events. Such wildlife populations are also better adapted to the hotter and drier conditions predicted for the area under climate change scenarios, with mobility the key to their survival and the overall resilience of the ecosystem.

Issue	Result	Consequence

Lack of suitable groundwater	Low borehole density and opportunities for cattle-keeping	High untilised herbaceous biomass
Abundance of Mogau	Increased livestock mortality	
Lack of wildlife connectivity with Okavango Delta	Low population of zebras	
Lack of benefits from wildlife	Poaching/Poisoning of predators	
Predators	Livestock mortality/poisoning of predators	Disruption to ecosystem functioning
Lack of herding/mobility of cattle	Concentrated grazing around the borehole	Overgrazing and Overresting
Lack of markets	Build up of animals	Overgrazing
Presence of elephants	HEC – damage to infrastructure	Shooting of elephants

Although not visible on the DWNP (2012) Aerial Survey data elephants move throughout NG2, travelling in particular from Ikoga to Khaudom National Park (McCulloch, pers comm). One lone bull elephant was seen in NG2 during the field survey in June while dung and tracks suggested the presence of many others. Elephants can knock down game fences with impunity, often putting whole sections on the ground and while they appear to often step over cattle fences, they can also damage them extensively.

Reactive HEC-mitigation measures such as chili fences, watchtowers, lights, noise-generation and bees, are all ineffective at deterring elephants at a large scale due to the labour and technical skills required (Evans and Adams, 2016). The attempt of government wildlife officers, to address conflict is hampered by limited resources, especially in such a remote and inaccessible area as NG2. In eastern Africa such realities have led to the use of electrified fencing with Evan and Adams (2016) citing a Kenya Wildlife Service estimate that a total of 1,245 km of electrified fencing currently stands in Kenya with an additional 1000 km under the process of construction. As Evans and Adams (2016) state _*electrified fences are an attempt to create hard boundaries that control human-elephant interactions and designate separate spaces for elephants and for farmers. Despite their stated technical and ecological purpose, elephant fences are inherently political* (p215).‘

10.3 Lake Ngami

The Lake Ngami Management Plan (Ecosurv, 2013) clearly articulates Lake Ngami‘s development potential from a tourism and fisheries perspective and highlights the opportunities and constraints faced by the livestock and arable sectors. Lake Ngami offers a diverse array of development options that should be seen from an integrated and holistic management, rather than sectoral, perspective. Livestock, tourism, arable agriculture and fisheries all have considerable potential to contribute in a meaningful way to local livelihoods and the economy of the region.

The current uncontrolled situation concerning range management is unsustainable and can only be improved upon. The formation of a Community Trust for Lake Ngami represents a potentially very positive development and by working with farmers and Farmer Associations can provide the essential platform through which community mobilisation for effective range management can be effected.

The return of inflows and surface water to Lake Ngami after three decades of the lake-bed resembling little more than a dustbowl presents considerable opportunities for livestock development, as it has removed the primary constraint of availability of surface water, that livestock owners normally face on Botswana‘s rangelands. The erection of a veterinary cordon fence (the Northern Protection Fence) between Makalamabedi and Kuke has also helped reduce the problem of dual grazing rights and has helped to clearly define the southern and eastern boundaries of the Lake Ngami Communal area. An extremely complex social dimension to livestock ownership exists around Lake Ngami in which multiple and diverse livestock owners depend on the same grazing resource and water supply. It is a social structure to livestock ownership that will make any form of grazing control and management extremely difficult to implement and enforce.

Apart from the wildlife populations found in and immediately around the Lake there are limited options for any meaningful linkages to the broader wildlife systems. Ecosurv (2013) highlight the linkages with Lake Ngami by wildlife movements from the west to the Gcwihaba WMA and from there to the broader Okavango Delta. Wildlife can also move along the Kunyere River between Lake Ngami and the southernmost Okavango Delta. Linkage to the south and east are however severed and have been for some time.

The poaching of wildlife, HWC, the poisoning of predators and overall negative perception regarding the presence of wild ungulates in the area, due to the lack of any tangible benefits from them, must be regarded as the most concerning of all the factors.

Table 35 Key Issues at Lake Ngami

Issue	Result	Consequence
Presence of surface water in the Lake	Livestock can drink from the Lake	High grazing pressure all around the Lake
Presence of alien and invasive species	Increased occurrence of *Cenchrus biflorus* and other invasives (Cocklebur)	Damaging to biodiversity and livestock health
Lack of connectivity with Okavango Delta and surrounding rangeland	Low populations of wildlife in area	Lack of wildlife in area and tourism related opportunities
Predators	Livestock mortality/poisoning of predators	Disruption to ecosystem functioning/Restriction of tourism activities
Lack of benefits from wildlife	Poaching/Poisoning of predators	Disruption to ecosystem functioning/ Restriction of tourism activities
Lack of herding/mobility of cattle	Concentrated grazing around the borehole	Overgrazing
Lack of markets	Build up of animals	Overgrazing
Presence of elephants	HEC – damage to infrastructure	Shooting of elephants
Proliferation of kraals	Very high kraal densities	Overgrazing

In communal lands there are institutional weaknesses due to lack of secure property rights, which hamper attempts by individuals or groups to better manage their rangelands.

10.4 Hainaveld Farms

The Hainaveld Farms constitute a diverse array of livestock, and also game, management practices. A number of constraints surrounding herd management and productivity were identified during the Field visit in June and these will be captured in the Final Scoping Report, but include the tendency to keep young calves kraaled all day to ensure the cows return at dusk as well the practice of keeping oxen well past their prime sell by date.

Although it is possible to generalise, it is also important not to lose sight of the diversity that exists in the Hainaveld Farm Block and become over-prescriptive in the identification of potential management solutions. The northern and central tier of Hainaveld Farms are close to Maun, Makalamabedi, Sehitwa and Toteng, while the southernmost tier lie along the northern boundary of the Central Kalahari Game Reserve and the Kuke Fence. The southernmost (2-3 ranches) tier of Hainaveld Farms, along the northernmost boundary of the Central Kalahari Game Reserve, in particular, have switched away from domestic stock to game ranching. Many appear to have amalgamated several Farms and now manage them as a continuous unit, with one such 10 bed, 15,000 Farm on the easternmost portion of the northern CKGR on the market for six million US dollars (http://botswanaproperty.org/africa/botswana/ghanzi-district/property/15-000ha-game-farm-for-salein-botswana-hainaveld).
Elephant movements through the area have reached unprecedented levels and are causing significant HEC, while predators such as lions, wild dogs and hyenas also feature prominently in HWC. The _elephant problem‘ in many ways calls for a fresh look at the area from a land use planning and zoning perspective as the current situation appears to be wholly unsustainable and detrimental to both the livestock and game sectors.

Table 36 Key Issues on the Hainaveld Farms

Issue	Result	Consequence
Lack of suitable groundwater	Low borehole density and opportunities for cattle-keeping	High untilised herbaceous biomass
Presence of alien and invasive species	Increased occurrence of *Cenchrus biflorus*	Damaging to biodiversity and livestock health
Lack of connectivity with Okavango Delta and surrounding rangeland	Low populations of wildlife in area	Lack of wildlife in area and tourism related opportunities
Predators	Livestock mortality/poisoning of predators	Disruption to ecosystem functioning/Restriction of tourism activities
Lack of benefits from wildlife	Poaching/Poisoning of predators	Disruption to ecosystem functioning/ Restriction of tourism activities
Lack of herding /mobility of cattle	Concentrated grazing around the borehole	Overgrazing
Lack of markets	Build up of animals	Overgrazing

Presence of elephants	HEC – damage to infrastructure	Shooting of elephants
Proliferation of kraals	Very high kraal densities	Overgrazing

10.5 Scenarios

A number of scenarios were and subjected to a SWOT analysis and the results will be used to optimise the production of land use plans for each area. The scenarios are as shown below.

NG2	**Scenarios**
1.	Multi Species Production Systems – Unfenced cattleposts and Unfenced _game ranches‘
2.	Fenced Commercial ranches and fenced cattleposts
3,	Status quo
Lake Ngami	
1.	Lake Ngami with water
2.	Lake Ngami without water
3.	Integrated management
Hainaveld	
1.	Commercial ranches and Game ranches
2.	Cattlepost system and Game ranches
3.	Status quo

Table 37 Scenarios for each Focal area for consideration in the production of optimal land use management plans

10.5.1 SWOT Analysis

The following factors were considered in the SWOT analysis:-

- Ground water
- Mogau
- Climate change
- Fire
- Depredation
- HEC
- CBNRM
- CBT
- Tourism
- Invasive species
- Livestock

The results of the SWOT analysis reveal:-

- Unfenced cattleposts and unfenced ranches with wildlife connectivity to the Okavango Delta is the best option in NG2
- Integrated management is the best option at Lake Ngami.
- The cattlepost system and fenced game ranches is marginally the best option in the Hainaveld.

The scoring system is relative but shows how once the rangeland becomes fenced up into ranches options, and the differential between various options, becomes very slight. Indeed, the results for NG2 show clearly the comparative advantage of keeping wildlife free ranging on extensive areas of unfenced rangeland. In many respects it is a comparative advantage that Namibia and South Africa had early last Century and lost through fencing up its rangelands into livestock and game ranches. As the subsidies for livestock have been withdrawn over the decades and the demand for wilderness and wildlife viewing has increased, Namibia and South Africa have sought to re-open their rangelands and reconnect ecosystems. Fencing up NG2 into game or cattle ranches would therefore be a retrogressive move, with the stand out option, reconnecting NG2 to the Okavango Delta and allowing wildlife populations to move between the two ecosystems.

Table 38 Multi-Criteria Analysis for the Three Focal Areas

(See Below)

Focal Area	**Scenarios**	Factor - Scoring is based on the ability of the scenario to deal with the factor in a positive way (i.e. high score = positive ability to cope, low score = poor ability to cope											
NG2		**Ground water**	**Mogau**	**Climate change**	**Fire**	**Depred ation**	**HEC**	**CBN RM**	**CBT**	**Tourism**	**Inva sive species**	**Livest ock**	**Total**
With link to ODRS	Unfenced cattleposts and Unfenced _game ranches‘	9	9	8	8	8	8	9	8	8	8	7	90
Without link to ODRS	as above	5	7	5	5	7	6	3	6	3	7	6	60
2	Fenced Commercial ranches and fenced cattleposts	2	5	2	2	4	5	1	6	2	5	5	39
3,	Status quo	3	5	2	3	4	3	2	5	3	6	4	40
Lake Ngami		**Ground water**	**Mogau**	**Climate change**	**Fire**	**Depred ation**	**HEC**	**CBN RM**	**CBT**	**Tourism**	**Inva sive species**	**Livest ock**	**Total**
1	Lake Ngami with water	9	8	6	5	6	7	8	6	8	4	7	74
2	Lake Ngami without water	3	8	3	7	5	5	5	6	3	5	5	55
3	Integrated management	8	8	8	8	7	7	9	6	9	6	9	85

Haina veld		Ground water	Mogau	Climate change	Fire	Depred ation	HEC	CBN RM	CBT	Tourism	Inva sive species	Livest ock	Total
1	Commercial ranches and Game ranches	2	3	3	4	4	5	1	5	7	6	6	46
2	Cattlepost system and Game ranches	2	3	5	5	4	6	1	5	7	6	6	50
3	Status quo	2	3	4	5	4	5	1	5	7	6	6	48
Total		45	59	46	52	53	57	40	58	57	59	61	

The SWOT analysis reveals that for Lake Ngami an integrated management approach is key, whereby the sectoral development of tourism, fishing, horticulture, arable agriculture and livestock keeping all form part of the sustainable management of the area. Currently these sectors are entirely isolated from one another with different actors involved, and different people benefitting. As a result each sector is being exploited to the maximum, which is clearly unsustainable.

There is little difference between the various scenarios or options now available in the Hainaveld Ranch block. The traditional cattlepost system appears to have a marginal benefit over that of commercial ranches, primarily because of the more open rangeland system it works within. Options are however limited and the adaptability of the various scenarios to the constraints, and especially climate change, are poor. In this respect it is important to look at scoring across the three focal areas, as well as the scoring of the three scenarios within each one, as they serve to show how damaging fencing up open rangelands is in terms of ecosystem resilience and sustainability. As such it makes no sense to turn western Ngamiland into another Hainaveld Ranch block, albeit with less groundwater.

11 LAND USE MANAGEMENT PLANS

The land use management options proposed in this chapter build upon those of the past and attempt to establish a basis for an integrated and multi-sectoral approach to land use planning and management in Ngamiland that seeks to overcome the overly sectoral approach that has so dominated past plans.

11.1 Past Management Recommendations

The Scott Wilson (2000) EIA of the Veterinary fences in Ngamiland considered a number of layout options for the various fences in the District. Since then, the veterinary cordon fences have become an important component of land use planning and management and it is not within the remit of this Project to debate the layout options further. However, from a sustainable land management perspective it is important to consider land use planning options that are cross-sectoral and include a potential win:win option for both livestock and wildlife.

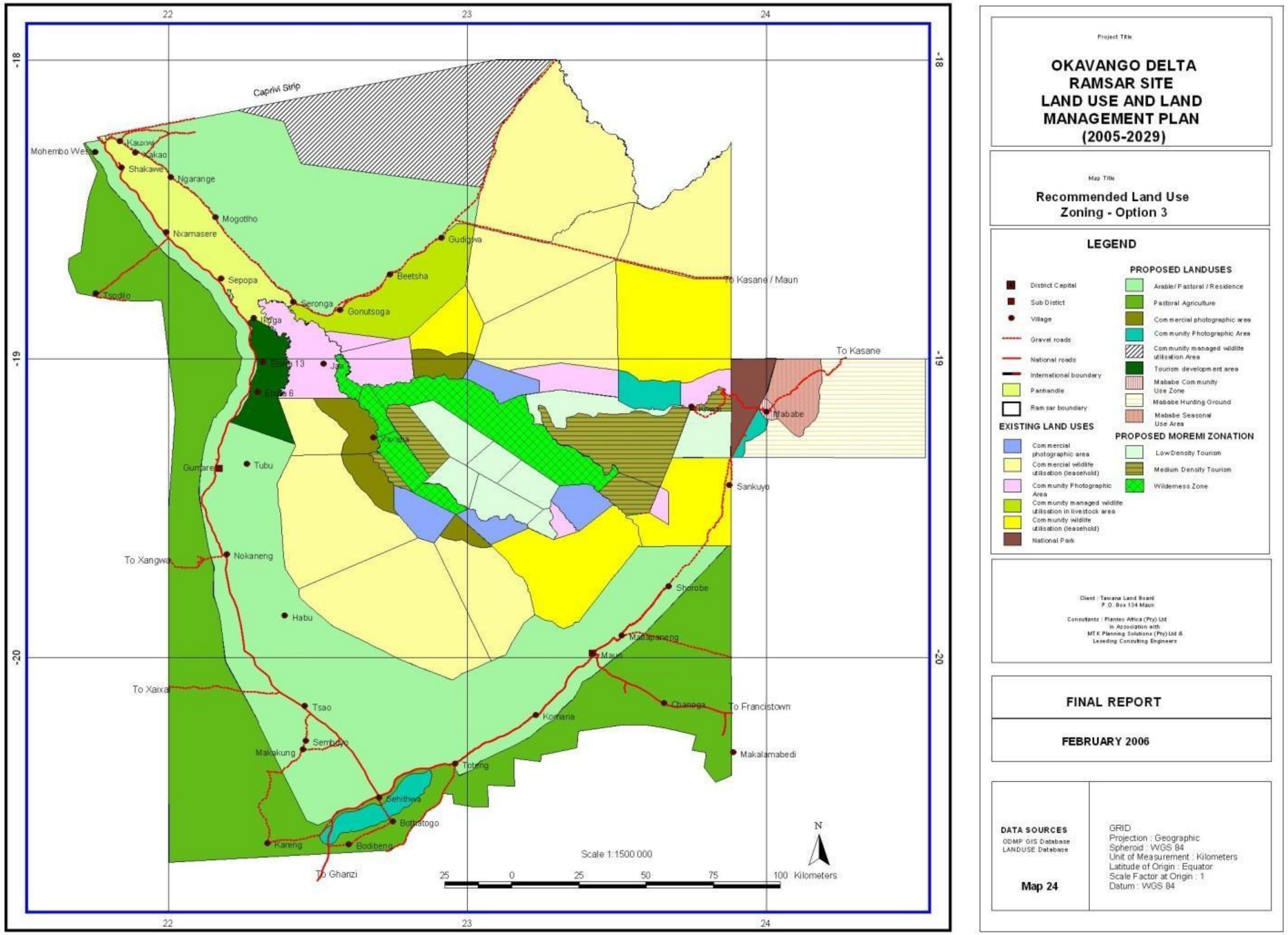
The ODMP review (Plantech, 2012) points out that as a component of the ODMP, with Tawana Land Board as the lead Institution, an Integrated Land Use and Land Management Plan was developed for the years 2005-2029. This Plan was developed around the key stakeholders‘ and communities‘ aspirations ***—to strengthen capacities for improved and better land use and land management practices, as well as wise and sustainable utilisation of the ODRS's land and other resources during the plan period***.‖

However, Plantec (2012) also emphasised that the Plan (See Figure 88) is largely unimplemented and, what is even more important, ***there appears to be no concerted efforts to overcome the key problems that have hampered (and continue to hamper) the Plan's implementation.*** Significantly, land use conflicts between wildlife, livestock, arable land, tourism, natural resources conversation and scattered settlement expansions, as well as between subsistence use (gathering of veld products, fishing and hunting wildlife) were not adequately addressed by the Plan, neither was the need for conservation and sustainable resource utilization (Plantec, 2012).

The Ngamiland Management Plan (Landflow, 2009) adapted the Ramsar Site Integrated Land Use Plan, to reflect the broad contrast that can be made between the need for clear zoning and land management strategies in the fragile Okavango Delta, as compared to the marginal dryland areas beyond the boundaries of the ODRS. The latter have a less sensitive natural system, fewer land use conflicts and the sparse distribution of natural resources meaning that the communities require large areas of land to maintain their livelihoods strategies through mixed land use practices.

In this option (See Figure 89), pastoral agriculture, arable agriculture and residential land uses outside Ramsar site are lumped as one big broad land use where applicable. In some areas, change of use is proposed in order to get the most value out of the land. Complete user displacement is avoided by introducing mixed use or adopting change of use through persuasion and/or first preference given to current land owner.

Figure 88 Okavango Delta Ramsar Site Land Use and Land Management Plan (2005 – 2029)



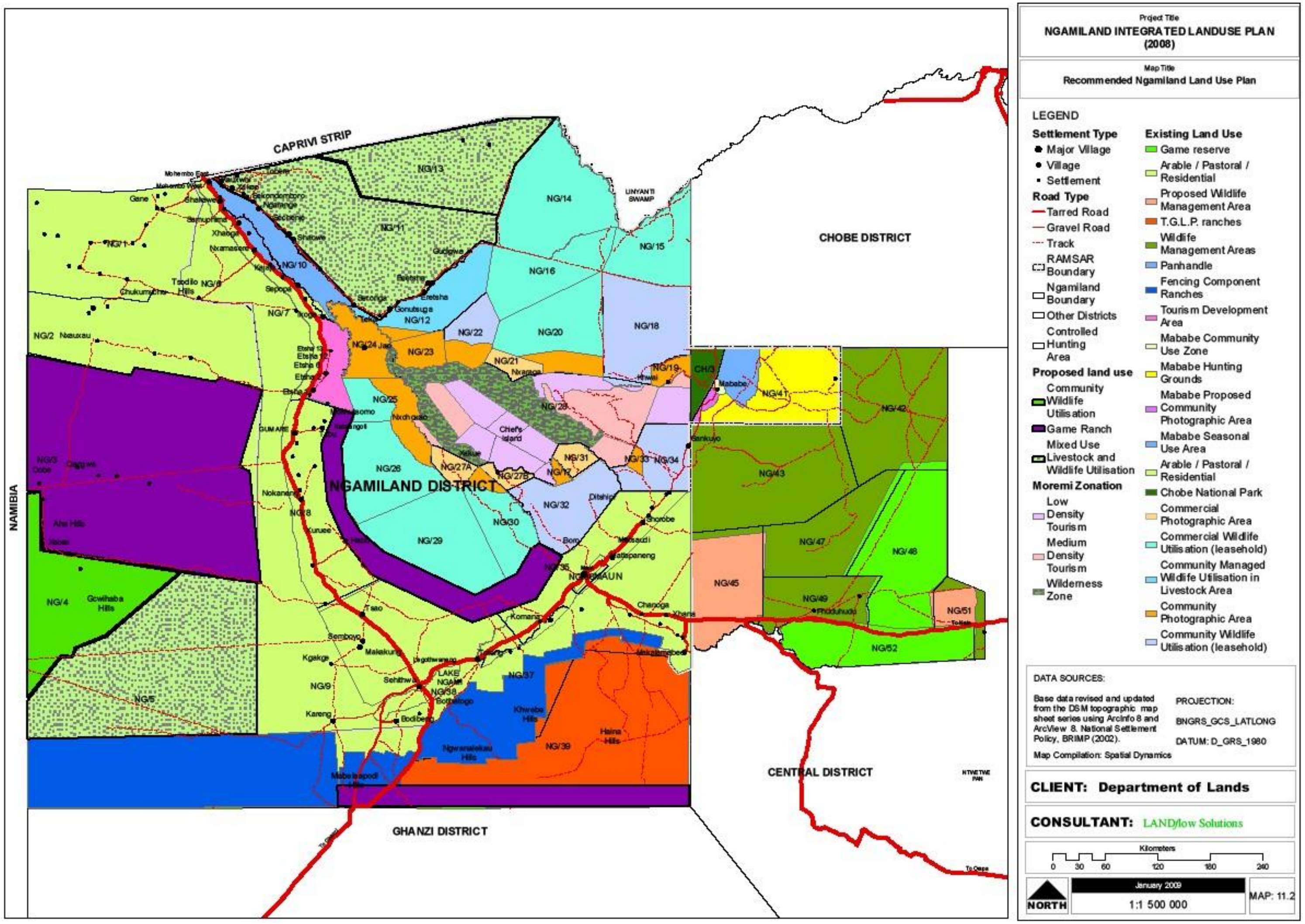


Figure 89 Ngamiland Integrated Land Use Plan (2008)

11.2 Past Management Recommendations

All land use management options developed here reject the idea of more fencing as a way to resolving land use and land management plans in western Ngamiland. Instead the options call for implementation of the existing policies and strategies that seek to address the key issues of diversification, poverty alleviation, CBNRM and multi-species production systems on open, unfenced rangeland.

Option 1 – incorporate everything north of Northern Protection Zone into KAZA –TFCA show Khaudom NP and Nyae Nyae in Namibia and red line fence.

This option fully embraces CBT and the KAZA-TFCA in Namibia by linking Khaudom National Park and the Nyae Nyae Conservancy in Namibia with Botswana. These links already exist due to elephant damages to fences and could be developed further by the provision of wildlife migratory corridors between the two countries.

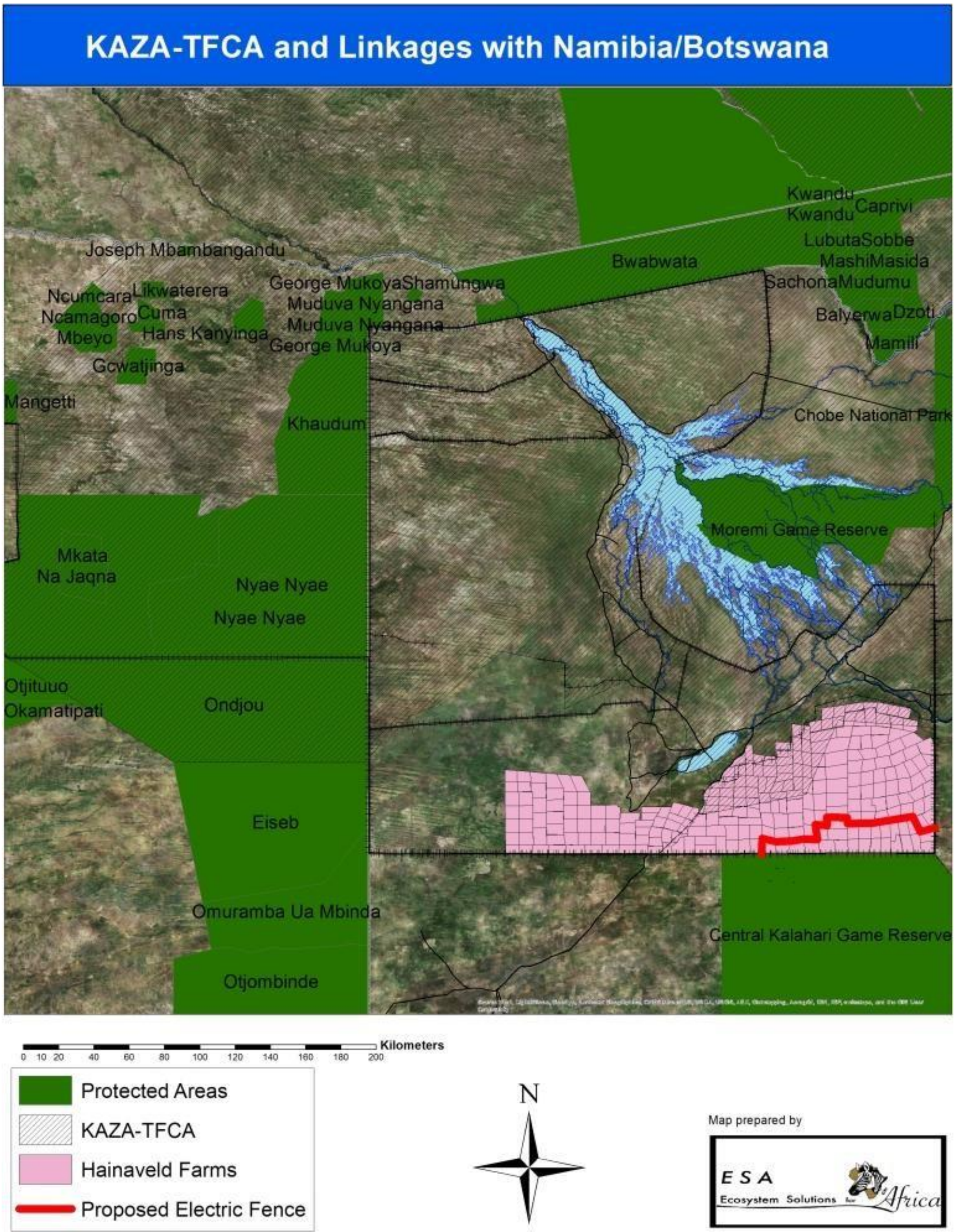


Figure 90 KAZA –TFCA Linkages with Botswana and Namibia

Option 2 – wildlife corridors linking with gap in buffalo fence into western Botswana – also linking a corridor from Ikoga to ODRS.

There are two key dimensions to wildlife populations in western Ngamiland:

(i) The movement of water dependent wildlife species from the ODRS to western Ngamiland, and also Lake Ngami.

(ii) The movement of water independent wildlife species throughout the area but particularly through NG1 – NG5.

Kiffner et al (2016) point out that balancing the needs of people and wildlife conservation requires more focused conservation planning that attempts to safeguard functional connectivity by:-

(i) clear delineation of wildlife corridors in areas with weak conservation status using modern spatial techniques and

(ii) effective law enforcement (anti-poaching, no land-use changes, restricted livestock densities) alongside income generation schemes that allow local people to directly benefit from wildlife presence in communal lands.

It is recommended that SLM develop a series of Projects to both delineate the corridors – by for example mapping them and integrating them into LUCIS, and develop CBNRM activities within them.

The Figure below shows the key wildlife movements in western Ngamiland, where corridors would be developed.

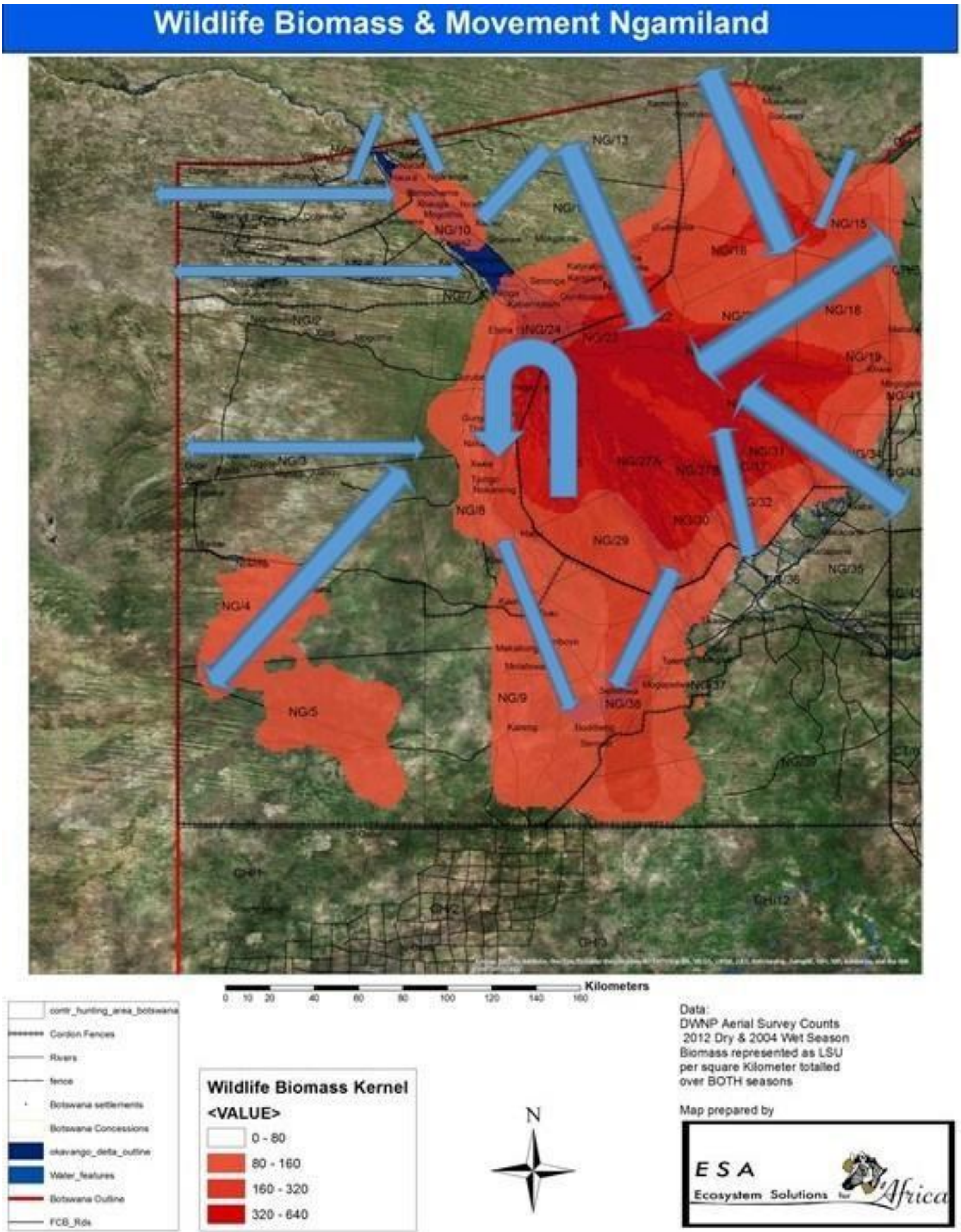


Figure 91 Wildlife Biomass and Movement in Ngamiland

Scott Wilson (2000; p.61) made the following points, ‗*The greatest development potential for wildlife lies in the south-west Ngamiland in NG/4 and Ng/5 linking use of Kalahari species that are not water dependent. Maintenance of wildlife diversity in this area is dependent upon freedom of movement for species such as eland, ostrich, giraffe and gemsbok.*'

Scott Wilson (2000;p.62) made the following points:-

Pt 7 „The triangle between Tsodilo Hills, the Panhandle and NG/24. This area needs to have its cultural and wildlife tourism potential developed as a unit, particularly with the potential for the Tsodilo area become a World Heritage Site."

Pt 8 „Ng/2 and the southern section of NG/1 have potential to be linked to wildlife developments either within Botswana or with those in Namibia to the west".

Pt 11 ‗*CBNRM potential of Grootlaagte and NG4 and 5 could be greatly enhanced by linking the two areas into an integrated unit."*

11.3 Lake Ngami

Options are more limited at Lake Ngami as the area of land available is much smaller and the pressure on the rangeland and other natural resources (such as fishing) at unprecedented levels. As emphasised in the Ranch Rehabilitation Report the current situation around Lake Ngami may be best characterized as a ―rush for the spoils‖ (Campbell et al, 2006) rather than any kind of optimum stocking strategy. Indeed, the over-stocking around Lake Ngami cannot be resolved within the existing property rights framework which serves to hamper attempts by individuals or groups to better manage their rangelands. If this framework can be changed to one in which a respected Entity such as a Community Trust that represents the interests of all the surrounding Villages can agree rules on access and stocking rates, and integrated and holistic management of all natural resources around the Lake in a balanced and fair way, then a move towards sustainable land management could be made.

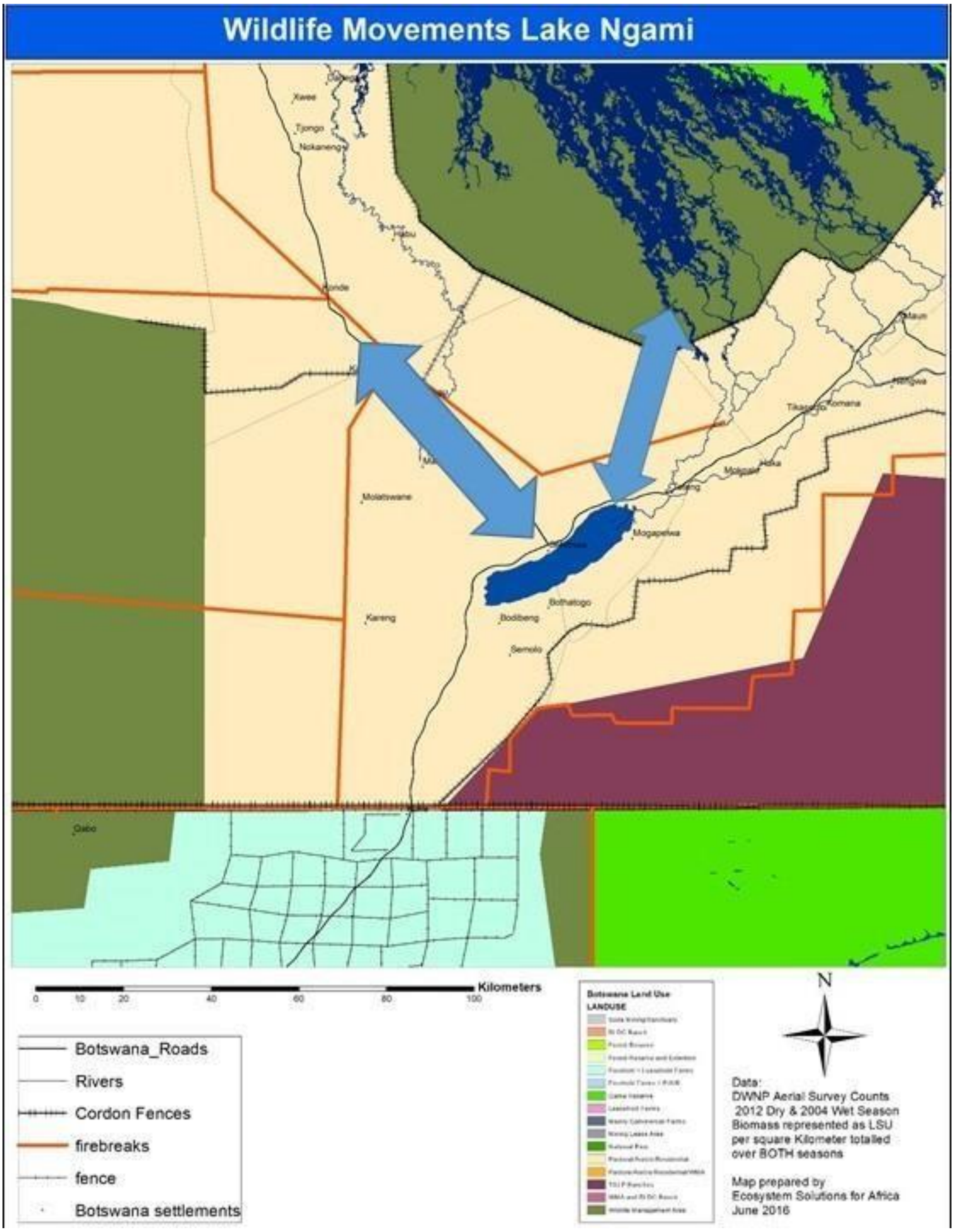


Figure 92 Wildlife Movements – Lake Ngami

11.4 Hainaveld Farms

Option 1 – Linkage with CKGR

Fencing the Hainaveld Game Farms into the CKGR and using them to help manage the Kalahari System as a whole (e.g. by pumping boreholes in a drought situation) was emphasised by Ecosurv (1997 and 2012) and fits well with DWNP Research Division‘s recommendations in their report entitled ―An Action Plan for the Management of Wildebeest Populations in the Kalahari‖ (Research Division, 1994) which recommends that about 15 extra boreholes should be drilled in CKGR. With a strengthened electrified fence running along the top of the Hainaveld Game Farms and then linking up with the Kuke fence it would strengthen FMD disease control and greatly assist with HWC (depredation and HEC).

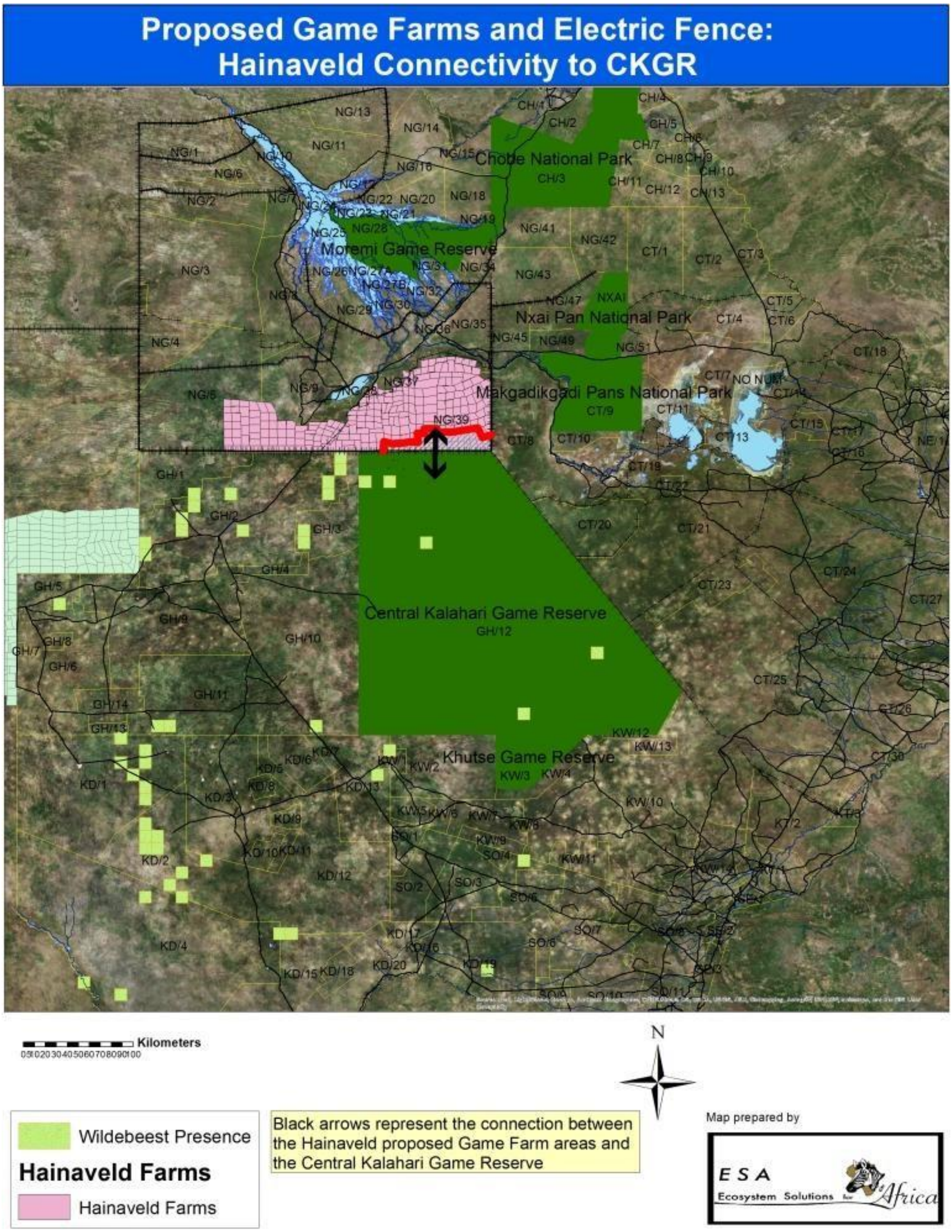


Figure 93 Proposed Connectivity between Hainaveld Farms and CKGR

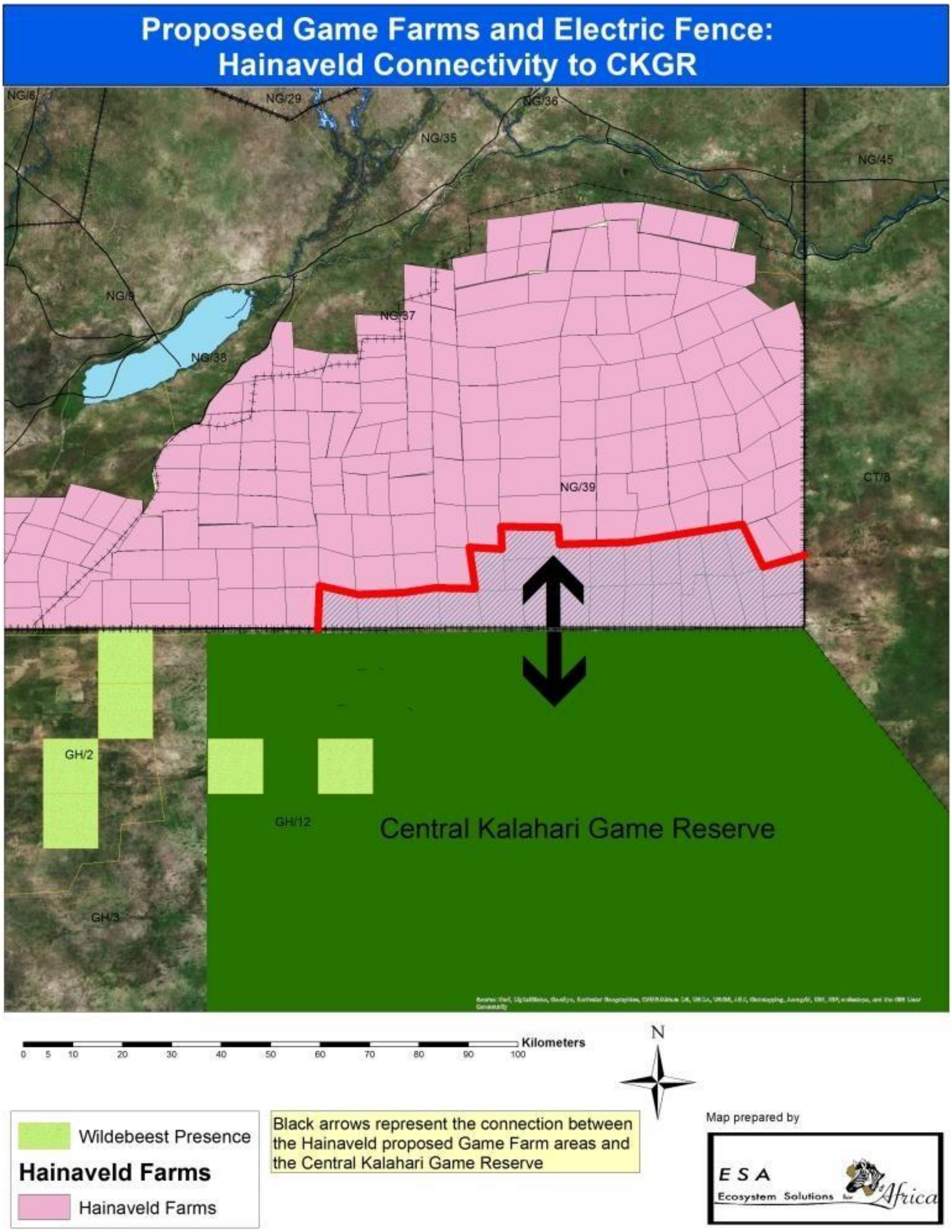


Figure 94 Proposed Electric Fence along northernmost boundary of Hainaveld Game Farms

Option 2 – Electrified fence

The second, less preferred option is just to fence the northernmost boundary of the Game Ranches in the Hainaveld without any linkage to the CKGR.

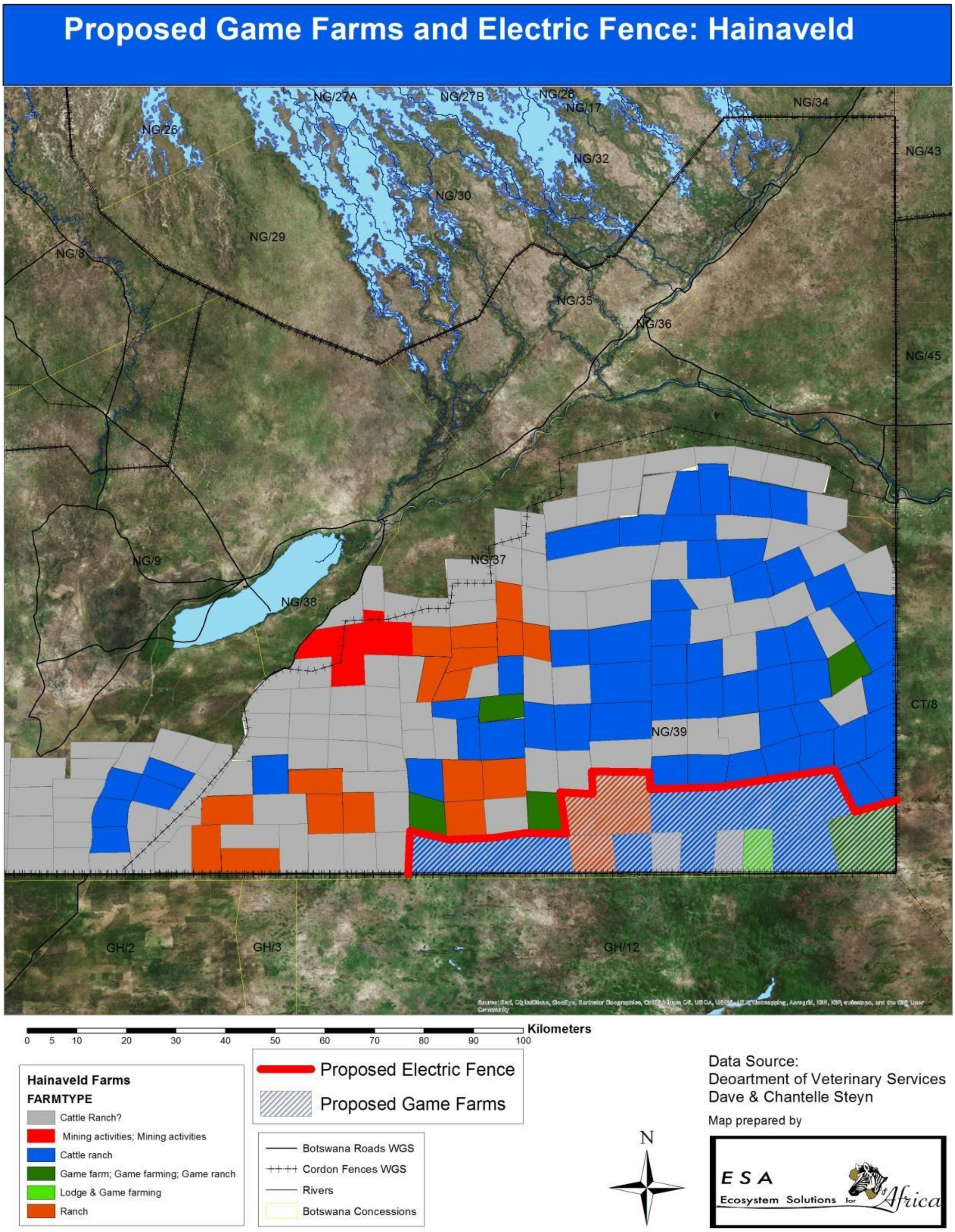


Figure 95 Proposed Electrified Game Fence in the Hainaveld

11.5 Conclusion

The land use management options proposed in this report build upon the recommendations of past reports and are believed to offer the most flexibility in terms of the key challenges Botswana faces, namely, range degradation and desertification, poverty alleviation, extreme inequity, diversification through CBNRM, sustainable land management, multi species production systems, an increasing elephant population and the mitigation of climate change.

12 CONCLUSION

A number of critical recommendations have been made throughout this report at a variety of spatial scales. One of the most important concerns the need to plan at the landscape or ecosystem level and optimise the sustainable use of both the livestock and wildlife sectors. In this respect NG2 should be kept as an open unfenced rangeland system and wildlife connectivity with the ODRS restored. Reduced stocking rates and improved rangeland management in communal and commercial areas appear to offer the best opportunities to improve livestock productivity and relieve overgrazing pressures. Indeed, with most producers currently having unlimited access to grazing in communal areas such as Lake Ngami, and many commercial ranches subject to overgrazing, the only effective way to reduce grazing pressure is through increases in the cattle offtake through improved outlets and marketing.

Within the current socio-economic set up around Lake Ngami there is little that can be done to solve the current natural resource management crisis. High stocking rates and limited marketing/offtake opportunities can only have one outcome in a highly variable environment – namely large die-offs in the late dry season. The establishment of Lake Ngami Conservation Trust has been an important step in the right direction, as has the production of Lake Ngami Management Plan (Ecosurv, 2013). However, the governance capacity of the Trust and broader will of the local communities to implement sustainable land management, is clearly lacking at present, such that the Ecosystem appears to be locked into a period of excessive resource exploitation, characterised by boom and bust, the peaks and troughs of which have been accentuated by the presence of water in Lake Ngami. The absolute lack of forage around Lake Ngami, the dearth of markets and offtake options, the high stocking rates and the fact that it will not rain for several months at best, makes for a very bleak outlook with large numbers of domestic stock expected to perish. Once the rains come the herds can build up again and the whole cycle can repeat itself.

It is a depressing scenario that shows little prospect of change as it is impossible to move from the current system that is characterised by extreme inequity and largely individualistic management practices to one dominated by equity and cooperation amongst range users, when access to the area is so uncontrolled and unlimited. Integrated management of a welldefined natural resource area by Lake Ngami Conservation Trust is possible, but only if the diverse array of current users will abide by the necessary rules concerning access and the placement of limitations on their earning potential, that will need to accompany any imposition of sustainability, whether it be in the fishing or livestock sector. The point of continuing along the current path of over-exploitation of natural resources must also be questioned, particularly as it is likely to damage the resilience of the ecosystem and make it more susceptible to invasive species – as already seems to be occurring.

Effective management of the grazing resource will be easier once the Lake dries up again, as livestock will at least be limited by groundwater availability. Nonetheless, access and effective _ownership' of the Commons is governed by those with the means, namely a borehole, to water their stock. It is a desperately inequitous system and while those unable to pay to water their stock at such boreholes can currently set up kraals around Lake Ngami, there is no grazing there. Indeed it is likely to take many years of awareness and capacity building among affected communities before a sustainable management framework at Lake Ngami is implemented in any shape or form. It must go hand in hand with the reality that it is not necessarily a _right' for any individual to keep as many stock as they wish on communal land. Currently the political will to effect this change is lacking and further complicated by _dual grazing rights‘ that has limited range management options for close to half a century. A number of _ranch‘ or cattlepost management options are presented in this report. All involve the need to move away from the notion of fixed stocking rates as a _number of animals‘ but also consider the length of time they graze the veld. The current system of continuous grazing does not allow for periods of rest and recovery for perennial grasses and is damaging the potential of the rangeland to carry both domestic and wild ungulates. It is appreciated that while there is little enthusiasm for increased herding on the one hand, there little point in re-promoting a system of rotational grazing and intensive production on the other, that has so clearly failed to work for the majority of farmers.

It is hoped that the recommendations made in this report will provide a solid platform for SLM to move forward in Ngamiland and by the example it sets, also positively influence range management in other parts of the country.

13 LITERATURE CONSULTED

Abel, N.O.J., Flint, M.E.S., Hunter, N.D., Chandler, D. and Maka.G. (1987) *Cattle- Keeping Ecological Change and Communal Management in Ngwaketse.* ILCA/IFPP/ODG. Norwich. East Anglia.

Andrew, M.H. (1988) Grazing impact in relation to livestock watering points. Trends in Ecology and Evolution.3: 336-339.

Annual Agricultural Survey Report, (2013). Statistics Botswana. Published 2015.

Aubault, H., Webb, N.P., Strong, C.L., McTainsh, G.H. Leys, J.F. and J.C. Scanlan (2015) Grazing impacts on the susceptibility of rangelands to wind erosion: The effects of stocking rate, stocking strategy and land condition Original Research Article Aeolian Research, Volume 17, June, Pages 89-99

Barnard, S. and M. Elliott (2015) The 10-tenets of adaptive management and sustainability: An holistic framework for understanding and managing the socio-ecological system. Environmental Science and Policy, 51, p.181-191.

Bartlam-Brooks H.L.A., C. Bonyongo, and Harris, S. (2011) Will reconnecting ecosystems allow long-distance mammal migrations to resume? A case study of a zebra migration in Botswana. Oryx 45, 210-216.

Baumgartner, S.A., Treydte, A.C., Grant, C.C. and J.van Rooyen (2015) Can diverse herbivore communities increase landscape heterogeneity? Comparing wild and domestic herbivore assemblages in a South African savannah. Perspectives in Plant Ecology, Evolution and Systematics 17; 34–43

BCA (2012) Poverty and Social Impact Assessment of the Integrated Support Programme for Arable Agriculture Development (ISPAAD) in Botswana. Botswana College of Agriculture, Gaborone, Botswana.

Bensen, H. (2002) The dynamics of the land use systems in Ngamiland and changing livelihood options and strategies. In: Environmental Monitoring of Tropical and Subtropical Wetlands (Eds F. E. Bernard, K. Mosepele and L. Ramberg). Proceedings of a Conference, HOORC, Maun.

Berkes, F., Colding, J., Folke, C., (2003) Navigating Social-ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge, UK.

Bhalotra, Y.P.R. (1987) Climate of Botswana - Part II: Elements of Climate. Department of Meteorological Services. Ministry of Works and Communications. Gaborone.

Biotrack Botswana (2014) DML Boseto Mine Enlargement, Draft Final Report. For Discovery Metals Limited (Pty) Ltd.

Biotrack Botswana (2015) Consultancy to Identify Forest Areas in Communal Areas in Central, North and North-Western Botswana. For Forestry Conservation Botswana, Gaborone, Botswana.

Birdlife Botswana (2009a) Okavango Floodwaters reach Toteng. http://birdlifebotswana.blogspot.com/2009_06_01_archive.html

Birdlife Botswana (2009b) A Little Piece of the Okavango Restored, http://birdlifebotswana.blogspot.com/2009_06_01_archive.html

Bransby, D.I. & Tainton, N.M. (1977) The disc pasture meter: possible applications in grazing management. *Proceedings of the Grassland Society of Southern Africa*, **12,** 115-118.

Briske, D.D., Ash, A.J., Derner, J.D. and L. Huntsi (2014) Commentary: A critical assessment of the policy endorsement for holistic management. Agricultural Systems 125, p.50–53

Bromilow, C. (2001) Problem Plants of South Africa. Briza Publishers, South Africa.

Brooks, C. and Chase, M. (2014) Transboundary wildlife corridors. Botswana Wildlife Research Symposium, Botswana Wildlife Training Institute, Maun, February 4th – 6th, 2014.
BSAP (2007) Revised Botswana Strategic Biodiversity Action Plan. Government of Botswana

CAR (2006) Study on the viability and long term development strategy for the livestock subsector in Botswana. For the World Bank. Centre for Applied Research, Gaborone.

Chase, M. (2011) Dry season fixed Wing Aerial Survey of Elephants and Wildlife in Northern Botswana. Elephants Without Borders.

Chase, M.J. and Griffin, C. (2009) Elephants caught in the middle: Impacts of war, fences and people on elephant distribution and abundance in the Caprivi Strip, Namibia. African Journal of Ecology, 47: 223-233

Child, G., Parris, R. and Le Riche, E. (1971) Use of mineralised water by Kalahari wildlife and its effect on habitats. *E.Afr. Wildl.J.*: 9., 125-142

CSDA (1991) Ngamiland District Communal Second Development Area. Western Part. Socio-Economic Baseline Survey and Land Suitability Analysis. Final report. University of Utrecht.

CSO (2011) Central Statistics Office. Botswana Population and Housing Census.

Dean, C., Kirkpatrick, J.B., Harper, R.J. and D.J. Eldridge (2015) Optimising carbon sequestration in arid and semiarid rangelands. Ecological Engineering 74, 148–163

de Ridder, N. and Wagenaar, K.T. (1984). A comparison between the productivity of traditional livestock systems and ranching in eastern Botswana. ILCA Newsletter, 3: 5–7.

de Villiers, A.C., Esler, K.J. and A. T. Knight (2014) Social processes promoting the adaptive capacity of rangeland managers to achieve resilience in the Karoo, South Africa. Journal of Environmental Management 146, 276-283

DFRR (2007) Fire season report, 2006. Department of Forestry and Range Resources, Botswana.

DHV (1980). Countrywide Animal and Range Assessment Project. 7 vols. Gaborone: European Development Fund and Ministry of Commerce and Industry. 357 pp.

Duraiappah, A.D. and Perkins, J.S. (1998) ORIA: Optimal Rangeland Integrated Assessment - The Case of Botswana. IV Conference on Ecological Economics, Nov. 16-20th. Santiago, Chile.

Druce D.J, Shannon G, Page B.R, Grant R, Slotow R (2008) Ecological Thresholds in the Savanna Landscape: Developing a Protocol for Monitoring the Change in Composition and Utilisation of Large Trees. PLoS ONE 3(12): e3979. doi:10.1371/journal.pone.0003979

DVS (2013) Cattle Crush Statistics, Ngamiland. Depratment of Veterinary Services, Maun. Botswana.

Duraiappah, A.D. and Perkins, J.S. (1998) ORIA: Optimal Rangeland Integrated Assessment - The Case of Botswana. IV Conference on Ecological Economics, Nov. 16-20th. Santiago, Chile.

DWNP (1994) Aerial Census of Animals in Botswana. Dry Season 1994. Department of Wildlife and National Parks (DWNP), Gaborone. Botswana.

DWNP (2012) Aerial Census of Animals in Botswana. Dry Season 2012. Department of Wildlife and National Parks (DWNP), Gaborone. Botswana.

Ecosurv (2012) Strategic Environmental Assessment For the Okavango Delta Ramsar Site (ODRS) Final Report. Prepared for Department of Environmental Affairs and SAREP By Ecosurv in Collaboration with SAIEA.

Ecosurv (2013) Lake Ngami Management Plan. For USAID, SAREP, Maun.

Evans, L.A and W.M. Adams (2016) Fencing elephants: The hidden politics of wildlife fencing in Laikipia, Kenya. Land Use Policy, Vol. 51, pp. 215-228.

Ferguson, K. and J. Hanks. Eds., (2010) Fencing Impacts: A review of the environmental, social and economic impacts of game and veterinary fencing in Africa with particular reference to the Great Limpopo and Kavango-Zambezi Transfrontier Conservation Areas. Pretoria: Mammal Research Institute.

Field, D.I (1978) A Handbook of Basic Ecology for Range Management in Botswana. Ministry of Agriculture. Botswana.

Flinton F. & Cullis, A. (2009) Introductory Guidelines to Participatory Rangeland Management in Pastoral Areas. Save the Children. USA

Fynn, R.W.S., O'Connor, T.G. (2000) Effect of stocking rate and rainfall on rangeland dynamics and cattle performance in a semi-arid savanna, South Africa. J. Appl.Ecol. 37, 491–507.

GCS (2007) Assessment of the Feasibility of Providing Livestock Watering Points in the Sandveld Areas in the Okavango Delta. Geotechnical Consulting Services (Pty) Ltd. Report produced for the Okavango Delta Management Plan.

Geeson, N., Quaranta, G., Salvia, R., Brandt, J. (2015) Long-term involvement of stakeholders in research projects on desertification and land degradation: how has their perception of the issues changed and what strategies have emerged for combating desertification? J. Arid Environ. 114, 124–133.

Gibbes, C., Cassidy, L., Hartter, J. and Southworth, J. 2013 The monitoring of land cover change and management across gradient landscapes in Africa. In Moran, E. And Brondizio, E. Human-Environment Interactions – Current and Future Directions. Springer, New York.

Gillon, D. (1983) The fire problem in tropical savannas. In Bourliere, F. (Ed) Tropical Savannas. 617-641. Elsevier Amsterdam.

GoB (2006) Elephant Management Plan. Government of Botswana.

GRM (1986) Re-Establishment of a National Range Resource Assessment and Monitoring Programme. Draft Final Report. GRM International Pty. Ltd., Ministry of Agriculture. Gaborone.

Grove, A.T. (1969) Landforms and climate change in the Kalahari and Ngamiland. Geographical Journal, 135:191-212.

Hannah, L. Wetterberg, G. and L.Duvall (1988) Botswana Biological Diversity Assessment. Natural Resources Management Support Project. USAID.

Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini,, L., Justice, C.O. and J. R. G. Townshend (2013a) High-Resolution Global Maps of 21stCentury Forest Cover Change. Science, 342 p.850 – 853, DOI: 10.1126/science.1244693

Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. (2013b) ―Hansen/UMD/Google/USGS/NASA Tree Cover Loss and Gain Area.‖ University of Maryland, Google, USGS, and NASA. Accessed through Global Forest Watch on [date]. www.globalforestwatch.org.

Hoare, R.E. (2001). A decision support system for managing human-elephant conflict situations in Africa. In. *IUCN/SSC/African Elephant Specialist Group*, Nairobi.

Hubbard, M. (1982). Stock limitation — any economic alternatives for Botswana? Pastoralist Development Network Paper, 14c. London: Agricultural Administration Unit, ODI. 8 pp.

Huntley, B.J., 1982. Southern African savannas. In: Huntley, B.J., Walker, B.H. (Eds.),Ecology of Tropical Savannas. Springer, Berlin, pp. 101–669.

IUCN (2011) Red Data List. International Union for Conservation of Nature.

Jeltsch, F., Milton, S.J., Dean, R.W. and N.van Rooyen (1997) Simulated pattern formation around artificial waterholes in the semi-arid Kalahari. *Journal of Vegetation Science, Vol 8(2), p177-188*

Jensen, J.R. (2000) Remote Sensing of the Environment – An Earth Resource Perspective. Prentice Hall, New Jersey.

Kastens, J.H., and Legates, D.R (2002) Time series remote sensing of landscape-vegetation interactions in the southern Great Plains, in Photogrammetric Engineering & Remote Sensing 68(1): 1021-1030.

Keakabetse, B. (2011) Maun abattoir reopens for Angola market. Mmegi Online, Friday, 16 December 2011, Issue: Vol.28 No.190. http://www.mmegi.bw/ index.php?sid=4&aid=736&dir=2011/december/friday16

Kgathi DL, Ngwenya BN, Wilk J (2009). Shocks and rural livelihoods in the Okavango Delta, Botswana. Dev South Afr. 24:268–308.

Khoemacau Copper Mining (KCM) 2014, Social Impact Assessment – part of the Environmental Impact Assessment carried out by SIAPAC.

Khoemacau Copper Mining (2015). Baseline Survey Report for the Social Action Programme, prepared by Social Impact Assessment and Policy Analysis Corporation (SIAPAC) for Khoemacau Copper Mining (Pty) Ltd., Toteng, Botswana.

Kujinga. K, Vanderpost, C., Mmopelwa, G., Masamba, W. (2014) Analysis of Gender and Other Social Dimensions of Household Water Insecurity in Ngamiland, Botswana Journal of Management and Sustainability; Vol. 4, No. 4; 2014

Landflow (2009) Ngamiland Integrated Land Use Plan. Final report. Department of Lands, Ministry of Lands and Housing, Gaborone.

Lange, R.T. (1969) The piosphere: Sheep track and dung patterns. Journal of Range Management.22:396-400.

Laris, P. S. (2005) "Spatiotemporal problems with detecting and mapping mosaic fire regimes with coarse resolution satellite data in savanna environments." Remote Sensing of Environment 99(4): 412-424.

Kong, T.M., Marsh, S.E., van Rooyen, A.F., Kellner, K., Orr, B.J., (2015) Assessing rangeland condition in the Kalahari Duneveld through local ecological knowledge of livestock farmers and remotely sensed data. J. Arid Environ. 113, 77–86.

Landflow (2009) Ngamiland Integrated Land Use Plan. Final report. Department of Lands, Ministry of Lands and Housing, Gaborone.
Lange, R.T. (1969) The piosphere: Sheep track and dung patterns. Journal of Range Management.22:396-400.

Laris, P. S. (2005) "Spatiotemporal problems with detecting and mapping mosaic fire regimes with coarse resolution satellite data in savanna environments." Remote Sensing of Environment 99(4): 412-424.

Literacy survey 2014, Stat brief, Statistics Botswana, published 2015.

Mackinson, S. and Nottestad, L. (1998) Combining local and scientific knowledge. Reviews in Fish Biology and Fisheries, 8. 481-490.

Manry, D.E. and Knight, R.S. (1987) Lightning density and burning frequency in South African vegetation. Vegetatio., 66., 67-76

McGarry, D. & Sharp, G (2001) A rapid , immediate, farmer usable method of assessing soil structure condition to support conservation agriculture. In Proceeding of the 1st World Congress on conservation agriculture, Madrid, Spain, 1-5 Oct. Vol 2.

McGowan and Associates (1987) National Land Management and Livestock Project. For Ministry of Agriculture, Gaborone.

Mkhize, N.R., Heitkönig, I.M.A, Scoging, P. F., Luthando L.E., Prins, H.H.T, and W.F. de Boer (2015) Condensed tannins reduce browsing and increase grazing time of free-ranging goats in semi-arid savannas. Applied Animal Behaviour Science 169, p.33–37

MoA/FAO (2012) Botswana Agricultural Value Chain Project Beef Value Chain Study. Second Draft for Review. Agricultural Hub of the Ministry of Agriculture Botswana and FAO.

Moller, H., Berkes, F., Lyver, P.O.B., Kislalioglu, M. (2004) Combining science and traditional ecological knowledge:monitoring populations for co-management. Ecol. Soc. 9 (3), 2. Available at: http://www.ecologyandsociety.org/vol9/iss3/art2/.

Nash, D.J. and P.A. Shaw (1998) Silica and carbonate relationships in silcrete-calcrete intergrade duricrusts from the Kalahari of Botswana and Namibia. Journal of African Earth Sciences. Volume 27, Issue 1, July 1998, Pages 11-25

NBSAP (2007) National Biodiversity Strategic Action Plan. DEA. Ministry of Environment, Wildlife and Tourism, Gaborone.

NFS (1992) Chobe Forests Inventory and Management Plan. Prepared for the Ministry of Agriculture Division of Crop Production and Forestry. Government of Botswana. Norwegian Forestry Society.

Ngami East Sub-District: Population and Housing Census Selected Indictors 2011, Statistics Botswana, Volume 8.0., published 2015

Ngami West Sub-District: Population and Housing Census Selected Indictors 2011, Statistics Botswana, Volume 8.1., published 2015
NRP (2000) Panhandle Management Plan. Prepared for Tawana Land Board by Natural resources and people (Pty) Ltd. Gaborone.

OAG (2011) Protection of Forests from wildland fires by Department of Forestry and Range resources (DFRR). Performance Audit Report. Office of the Auditor General, Report No 4 of 2011. Ministry of Finance and Development Planning. Gaborone.

O'Connor, T.G., Kuyler, P., Kirkman, K.P., Corcoran, B., 2010. Which grazing management practices are most appropriate for maintaining biodiversity in South African grassland? Afr. J. Range Forage Sci. 27, 67-76.

ODMP (2006) Okavango Delta Management Plan. Draft Final. Okavango Delta Management Plan Project Secretariat, Maun. Botswana.

Perez, C., Jones, E.M., Kristjanson, P., Cramer, L., Thornton, P.K., Fohrch, W. and C. Barahon (2015) How resilient are farming households and communities to a changing climate in Africa? A gender-based perspective. Global Environmental Change
Volume 34, September, Pages 95–107

Perkins, J.S. (1991) The Impact of Borehole Dependent Cattle Grazing on the Environment and Society of the Eastern Kalahari Sandveld, Central District, PhD Thesis, Botswana. University of Sheffield, UK.

Perkins, J.S. (1997) Development of a Vegetation Monitoring Technique for Botswana. Users' Manual. Version 1.1. A Manual developed for the Botswana Range Inventory and Monitoring Project (BRIMP). A collaborative project between the Ministry of Agriculture and the Overseas Development Agency (UK).

Perkins, J.S. (2002a) Manual for Long-Term Rangeland Monitoring in Botswana. A Manual developed for the Botswana Range Inventory and Monitoring Project (BRIMP). A collaborative project between the Ministry of Agriculture and DfID (UK).

Perkins, J.S. (2002b) Critical Review of Long-term Rangeland Monitoring Methodologies in Botswana. A Manual developed for the Botswana Range Inventory and Monitoring Project (BRIMP). A collaborative project between the Ministry of Agriculture and DFID (UK).

Perkins, J. and Ringrose, S., (1996,) Development Co-operation Objectives and the Beef Protocol: The Case for Botswana: A study of Livestock/wildlife/tourism /degradation linkages, Unpublished Report commissioned by Metroeconomica Limited on behalf of the European Union.

Perkins, J.S. and Thomas, D.S.G. (1993) Spreading deserts or spatially confined environmental impacts? Land degradation in the Kalahari Desert of Botswana. Land Degradation and Rehabilitation. 4, 179-194.

Perkins, J.S., Stuart-Hill, G., Eckardt, F. and Murray, M. (2003) Keeping up with the neighbours – The squandering of the Kalahari rangeland resource in Botswana. African Journal of Range and Forage Science.

Pickup, G., Bastin, G.N. and Chewings, V.H. (1998) Identifying trends in land degradation in non-equilibrium rangelands. Journal of Applied Ecology.35.p.365-377.

Plantec (2012) Mid-Term Review and Gap Analysis of ODMP. Maun.

Powell, M.J. and Pulles, J.H.M. (1996) Animal Production Simualation and Range Assessment Model for Botswana (APSRAMB). Volume 1: Theory, User Manual, and Vegetation Inventory. FAO/UNDP/Government of Botswana. 152pp.

Pricope, N.G. and M.W.Binford (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; pp72-85

Ranglack, D.H.and J. T. du Toit (2015) Wild bison as ecological indicators of the effectiveness of management practices to increase forage quality on open rangeland. Ecological Indicators 56, p.145–151

Raymond, C.M., Fazey, I., Reed, M.S., Stringer, L.C., Robinson, G.M., Evely, A.C., (2010) Integrating local and scientific knowledge for environmental management. J. Environ. Manag. 91, 1766–1777.

Reed, M.S., Stringer, L.C., Dougill, A.J., Perkins, J.S., Atlhopheng, J.R., Mulale, K and N. Favretto (2015) Reorienting land degradation towards sustainable land management: Linking sustainable livelihoods with ecosystem services in rangeland Systems. Journal of Environmental Management 151; 472-485

Reeves, M.C. and L.S. Baggett (2014) A remote sensing protocol for identifying rangelands with degraded productive capacity. Ecological Indicators 43, 172–182.

Richardson, D. (2011) The STAC Method, Assessing forage in brittle environments. In Practice, No. 136, March/April 2011. A publication of Holistic Management International.

Rohde, R.F., Moleele, N.M., Mphale, M., Allsopp, N., Chanda, R., Hoffman, M.T., Magole, L., Young, E., (2006) Dynamics of grazing policy and practice: environmental and social impacts in three communal areas of Southern Africa. Environmental Science Policy 9, 302–316.

Ruggiero, L.F. (2009) The value of opinion in science and the Forest Service Research organization. J. Wildl. Manag. 73, 811–813.

SAIEA (2012) Thresholds for use in the Strategic Environmental Assessment of the Okavango Ramsar Site. Submitted by: The Southern African Institute for Environmental Assessment to SAREP, July 2012.

Sandhage-Hofmann, E. Kotzé, L. van Delden, M. Dominiak, H.J. Fouché, H.C. van der Westhuizen, R.J. Oomen, C.C. du Preez, W. Amelung (2015) Rangeland management effects on soil properties in the savanna biome, South Africa: A case study along grazing gradients in communal and commercial farms. Journal of Arid Environments, Volume 120, September, Pages 14-25

Sandford, S. (1980) Keeping an eye on TGLP. NIR Working Paper. Gaborone.

Savory, A., (1983). The savory grazing method or holistic resource management.Rangelands 5, 155-159.

Savory Institute (2015) Monitoring your land for informed management. E-Book Fourteen.

Scott Wilson (2000) Environmental Assessment of Veterinary Fences in Ngamiland. Summary Report. DfID and Government of Botswana.

Scudder, T., Manley, R.E., Coley, R.W, Davis, R.K., Green, J., Howard, G.W., Lawry, S.W., Martz, D.‘ Rogers, P.P., Taylor, A.R.D., Turner, S.D.. White, G.F. and E.P. Wright (1993) The IUCN Review of the Southern Okavango Integrated Water Development Project. International Union for the Conservation of Nature. Gland. Switzerland.

Shaw, P.A. (1983): Fluctuations in the level of Lake Ngami: the his-torical evidence. -Bots. Notes & Records 75:79-84.

SMEC. (1991c) Southern Okavango Integrated Water Development. Maun Reservoir and Associated Works. Review Report. Detailed Design. Report to Government of Botswana. Solh, M. and M. van Ginkel (2014) Drought preparedness and drought mitigation in the developing world's drylands. Weather and Climate Extremes, Volume 3, June 2014, Pages 62-66

Southworth, J., Waylen, P., Child, B., Binford, M., Keys, E., Qui, Y., Kiker, G.,MundozCarpena, R., Cassidy, L., Gibbes, C., Cui, X., Bunting, E., Steele, J., Muwenga, S., Sun, J. and Perez-Falcon, G. (2011) Understanding and predicting the impact of climate variability and climate change on land use and land cover change via socio-economic institutions in southern Africa. Presentation to the LCLUC Science Meeting at University of Maryland. URL: http://lcluc.umd.edu/sites/default/files/lcluc_documents/Southworth.pdf (Accessed 1 Aug 2016)

SRK (2010) Environmental Impact Statement incorporating the Environmental Management Plan for the Boseto Copper Project. Report Prepared by SRK Consulting for Discovery Metals Limited.

Stoddart, L.A., (1967) What is range management? Journal of Range Management, Vol 20, No 5 (September 1967)

Stoddart, L.A., Smith, A.D. and Box, T.W. (1975). Range Management. New York: McGraw-Hill Book Company. 225 pp.

Stuart-Hill. G., Diggle, R., Munali, B., Tagg, J. and D.Ward (2005) The Event Book System: a community-based natural resource monitoring system from Namibia. *Biodiversity and Conservation*; 14:2611–2631.

Tainton, N.M. (1999) (Ed.), Veld Management in South Africa. University of Natal Press, Pietermaritzburg, South Africa.

Taylor, R. (2012) An historical perspective of fencing in Namibia, Botswana and Zimbabwe: The Future of Wildlife, livestock and TFCAs in SADC. In: Proceedings of the SADC TADs Project Scientific Symposium on ‗Foot and Mouth Disease in SADC' and the Joint SADC/AHEAD Workshop on ‗Reconciling Livestock Health and Wildlife Conservation in Southern Africa: Strategies for Sustainable Economic Development'. Prepared by the Wildlife Conservation Society's AHEAD Program team. 13-16 November, 2012, Phakalane Golf Estate, Gaborone.

Teague, R., Provenza, F., Kreuter, U., Steffens, T and M.Barnes (2013) Multi-paddock grazing on rangelands: Why the perceptual dichotomy between research results and rancher experience? Journal of Environmental Management 128, 699-717.

Thomas, D.S.G. and Shaw, P.A. (1991) The Kalahari Environment. Cambridge University Press. Cambridge. UK.

Thomson, G. (2012) Management of FMD in Southern Africa: Status, challenges and opportunities. In: Proceedings of the SADC TADs Project Scientific Symposium on ‗Foot and Mouth Disease in SADC' and the Joint SADC/AHEAD Workshop on ‗Reconciling Livestock Health and Wildlife Conservation in Southern Africa: Strategies for Sustainable Economic Development'. Prepared by the Wildlife Conservation Society's AHEAD Program team. 13-16 November, 2012, Phakalane Golf Estate, Gaborone.

Thomson, G and Penrith, M-L (2011) Animal Health Policy, Legislation and Trade in Beef in the Five Participating States of the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA). Technical Report to the Wildlife Conservation Society's AHEAD Program. 132 pp. http://www.wcsahead. org/workinggrps_kaza.html.

Trollope, W.S.W., (1980). Controlling bush encroachment with fire in the savannah areas of South Africa. Proc. Annu. Congresses Grassl. Soc. Southern Afr. 15,173–177.

Trollope, W.S.W., (1996) Report On The Fire Ecology Of The Ngorongoro Conservation Area In Tanzania With Particular Reference To The Ngorongoro Crater. Department Livestock & Pasture Science, University Fort Hare, Alice:1 - 21.
Trollope, W.S.W., (1999). Veld Burning In Different Vegetation Types: Savanna. In: Veld Management In South Africa. Ed. N.M. Tainton. University Natal Press, Pietermaritzburg. 236 - 242.

Trollope, W.S.W., L.A. Trollope, L.A. , de Bruno, C.A., Held, A.C., Emery, A. and C.J.H. Hines (2006) A Fire Management Plan for the Okavango Delta Ramsar Site in Botswana. Developed for the Department of Forestry and Range Resources, Botswana Government.

Tsalyuk, M., Kelly, M., Koy, K., Getz, W.M. and H. S. Butterfield (2015) Monitoring the Impact of Grazing on Rangeland Conservation Easements Using MODIS Vegetation Indices. Rangeland Ecology and Management, Volume 68, Issue 2, March, Pages 173-185

UNAM (2008) Research on Farming Systems Change to Enable Adaptation to Climate Change Undertaken for the Ministry of Environment and Tourism and the
United Nations Development Program Namibia, in preparation of Namibia‘s Second National Communication to the United Nations Framework Convention on Climate Change. Prepared by University of Namibia.
Washington-Allen, R. A., Van Niel, T. G., Ramsey, R. D., and West, N. E. (2004) Remote sensing-based piosphere analysis. GIScience & Remote Sensing, 41(2): 136-154.

Water Surveys Botswana (2013) Annual Wellfield Monitoring Report for 2012 Discovery. Report for Discovery Copper Botswana February 2013, by Water Surveys Botswana (Pty) Ltd.

Weare, P.R. and Yalala, A. (1971) Provisional vegetation of Botswana. Botswana Notes and Records. 3. 131-152.

Weaver, C., R. Diggle and R. Taylor (2012) Enhancing sustainable livelihoods through crosssectoral integration: wildlife, livestock and the promise of KAZA – the Caprivi experience. In: Proceedings of the SADC TADs Project Scientific Symposium on _Foot and Mouth Disease in SADC‘ and the Joint SADC/AHEAD Workshop on _Reconciling Livestock Health and Wildlife Conservation in Southern Africa: Strategies for Sustainable Economic Development‘. Prepared by the Wildlife Conservation Society's AHEAD Program team. 1316 November, 2012, Phakalane Golf Estate, Gaborone.

White, F. (1983). The Vegetation of Africa. A descriptive Memoir to accompany the Unesco/AETFAT/UNSO vegetation map of Africa, Natural Resources Research, Volume XX, Unesco, Paris www.intechopen.

Woods, S.R. and G.B. Ruyle (2015) Informal Rangeland Monitoring and Its Importance to Conservation in a U.S. Ranching Community. Rangeland Ecology & Management, In Press, Corrected Proof, Available online 7 August 2015.

https://www.cupriccanyon.com/assets/docs/Toteng-Water-Supply.pdf

https://en.wikipedia.org/wiki/North-West_District_(Botswana)

14 ANNEXES

Annex 1: Introductory Letters

ALONG MAGISTRATE COURT ROUTE
OPPOSITE BANA BA LETSATSI SCHOOL
TEL : 686 2455/1133
FAX : 686 2630
TELEGRAMS : M.E.W.T
REF: NG/FRR
3/3/4 I (80)
REFERENCE : NG/FRR

REPUBLIC OF BOTSWANA

MINISTRY OF ENVIRONMENT
WILDLIFE & TOURISM
DEPARTMENT OF FORESTRY
& RANGE RESOURCES
Private Bag 111
Maun

ALL CORRESPONDENCE MUST ADDRESSED TO THE DISTRICT COORDINATOR

30 May 2016

TO: WHOM IT MAY CONCERN

Dear Sir or Madam

INTRODUCTORY LETTER FOR ECOSYSTEM SOLUTIONS FOR AFRICA CONDUCTING INTERGRATED RANGE ASSESSMENT STUDY FOR LAKE NGAMI CATCHMENT, HAINAVELD AND NG2

This communiqué serves to introduce Ecosystem Solutions for Africa (PTY) LTD, an environmental consulting company that has been engaged by UNDP – GEF Sustainable Land Management Project (SLM) through the Department of Forestry and Range Resources. The Company has been engaged to undertake an Integrated Range Assessment study for Haina veld ranches, Lake Ngami catchment area and NG2 (WMA) in North West District.

The purpose of undertaking this study is to develop specific land-use plans, maps and other reports for each of the targeted areas with clear management actions to be implemented by the project and other stakeholders during and after project life. Stakeholder consultation forms an integral part of the project to make sure that their views on the project are taken into consideration and incorporated in the final report.

You are therefore kindly requested to participate in the stakeholder consultation exercise which will be conducted by the Ecosystem Solutions for Africa Company. Your cooperation and assistance to the Company will be highly appreciated

Yours faithfully

Peter Olekantse

District Coordinator
Department of Forestry and Range Resources _ North West District

Our Vision: *To protect the environment; Conserve the country's renewable and natural resources; Derive value out of environment for the benefit of Botswana*

BOTSWANA
our pride, your destination

ESA
Ecosystem Solutions for Africa

Post: P.O. Box HA 77 HAK, Maun
Cell: 72782507
Email: chris@esabotswana.com

1st June 2016

Dear Sir/Madam,

INTRODUCTION OF TEAM CONDUCTING INTEGRATED RANGE ASSESSMENT FOR LAKE NGAMI CATCHMENT, HAINAVELD AND NG2

Ecosystem Solutions for Africa has been engaged by UNDP-GEF Sustainable Land Management Project (SLM) to undertake a project entitled Integrated Range Assessment For Lake Ngami Catchment, Hainaveld and NG2.

This letter serves to introduce team members Zoe Parr Kennaugh and Tamunee Komazenge from Karunya Consultancy who are working on this project.

If you require further information please do not hesitate to contact me.

Yours faithfully,

C. B

Dr Chris Brooks (Director)

Annex 2: Consultations

Name	Category	Type of engagement	Comment
Mr. Killa Ledimo	Chairman of the Hainaveld Farmers' Association	Interview	
Mr. Frank Mafela	Chairman of the Joint Hainaveld Farmers' Association	Interview	
M. Bingana	Hainaveld livestock farmer	Interview with questionnaire	
Mr. Dikobe	Hainaveld livestock farmer	Questionnaire distributed	Not filled in as he doesn't own a farm in the Hainaveld, dairy farmer elsewhere)
Mr. Frank Ramsden	Hainaveld livestock farmer	Questionnaire distributed	Questionnaire not returned. Traveled to the farm.
Mr. Mundu	Hainaveld livestock farmer	Call and sms for interview	Phone call did not go through so sent and sms. Did not get any response.

Mr. Simon Bojosi	Hainaveld livestock farmer	Call and sms for interview	Phone call did not go through so sent and sms. Did not get any response.
Mr. Tops Ledimo	Hainaveld livestock farmer	Called for interview	Not able to meet as he was traveling a lot and out of Maun during the study.
Mr. Sekeletu	Hainaveld livestock farmer	Questionnaire completed	questionnaire returned
Mr. Modisaemang	Hainaveld livestock farmer	Questionnaire distributed	Email sent 21/6/2016 with questionnaire (as requested). No response regarding returning of the questionnaire.
Nicco	Hainaveld livestock farmer	Interview with questionnaire	
L.M. Sethoko	Hainaveld livestock farmer	Questionnaire distributed	Not filled in as he doesn't own a farm in the Hainaveld anymore (sold a few years ago).
Gimil	Hainaveld livestock farmer	Questionnaire completed	Returned questionnaire
Goldish	Hainaveld livestock farmer	Questionnaire distributed	email sent 21/6/2016 - no response
Mr Makwati	Hainaveld livestock farmer	Phone call	Requested more information. No email address to send to.
Mr. O. S. Ntsie	Hainaveld livestock farmer / DAC rangeland management field officer	Interview	
Mr. David Steyn	Hainaveld game farmer	Questionnaire completed	Returned questionnaire
Mr. Marius Viljoen	Hainaveld mixed game and livestock farmer	Questionnaire completed	Returned questionnaire
Mr. Brian Gibson	NG2 game farmer	Semi-structured Interview	
Dr. Comfort Nkgowe	Principal Veterinary Officer, DVS - Maun	Interview	
Mr. Oabona Ramotshwara	Plant Manager, BMC - Maun	Interview	
Mr. Baagi Chilume	Head of Department of Animal Production - Maun	Interview	
Mr. Fred Camphor	Owner of Ngamiland Abattoir	Interview	
Paul Raseipei	Elderly cattle farmer in Gumare, with cattle in NG2	Interview with questionnaire	

Interview Summaries Department of Veterinary Services: Dr Comfort Ngkowe

- There are lots of impacts on the range from livestock.
- We are thinking of using a commodity based trade but this has been failing due to lack of resources.
- BMC doesn‘t have capacity to take off the amount that needs to be taken off.

- Ngamiland is zone 2, and zoned in to sub-zones of 2A, 2B, 2C, 2D, 2E (Hainaveld) These are the demarcated zones with fences. Now they are planning zone 2F which is the land to the south of Kareng. The EIA results will be out in August.

- Husbandry is poor with in Ngamiland and that why we are using fencing for managing the disease. If we improve the management we‘ll help control FMD without the fences.

- Fences are thought to be the only means to control disease but they are not. If we have herders we can protect against wildlife. However, the loss of culture has resulted in the loss of herding practices. In addition, cattle have lost value and cash flow is poor, so people can‘t pay the herd boys or maintain their borehole which means cattle roam freely looking for water.

- Within the protection zone (the Hainaveld) is having problems with maintaining boreholes and if the cattle don‘t have water, they destroy the fence to get to the lake for water.

- The protection fence was erected in 2011, but it is not serving its purpose.

- The big constraint for 2E was the outbreak of FMD in August 2015. We now need to start from the beginning and vaccinate over 2 years before we can demonstrate there is no virus present. Only once this has been proven then the area can be designated as a green zone.

- There are two types of FMD vaccines; the purified one is used in the Hainaveld. This is more expensive but better as the results are easier to analyse. The unpurified is used elsewhere in Ngamiland.

- The cattle are supposed to be vaccinated 3 times per year.

- The challenges are that farmers have lost interest in rounding up cattle and therefore the numbers being vaccinated are low. The target is 85% and the last vaccination period, only 79% were thought to be vaccinated (ended June 6th 2016).

- We have lack of resources for vaccinating all the cattle. Other districts call on the resources. We need to vaccine for a period of 2 months and then gap of two months.

- For the vaccination campaigns government have assisted in building crushes in the communities. We also have mobile crushes and casual labour, which is easier for rounding up cattle at Lake Ngami.

- Fences are a challenge to maintain especially with the elephants and the HWC is increasing. They will destroy agricultural land. The problem is getting worse as we can‘t shoot elephants here, so it is thought they come in to Botswana as a refuge from Namibia and Angola.

- We have very good antipoaching measures here but if conservationists don‘t address this problem then the conflict will increase.

- We are about to give up with the fences – we need to review the strategy, to find a way to control the disease. We need to collaborate with conservationist more than what is happening now. They are helping with maintaining the buffalo fence, motivated by the rhino conservation.

  The fencing at Setata is purposefully down to allow for the movement of wildlife migration routes.

- Lung disease was the catalyst for the fences, and initially they were very effective, but the challenge with wildlife was minimal, but now with the hunting ban the wildlife is causing a problem.

- Quarantining can improve famers' life and SLM. We need to reduce numbers but can't as we can't quarantine. FMD is density dependent. The infrastructure is now ‗dead' and not being used at the moment. If we can get these areas up and running again then Ngamiland can sell to Francistown again, as they slaughter a lot more. They slaughter 400 per day and export to SA.

- Challenges with engaging Ministry of Health on controlling the measles as it is not seen as a priority in humans but they are the main vector for spreading it.

Botswana Meat Commission: Mr. Oabona Ramotshwara, Maun Plant Manager

- BMC have a capacity of 120 daily. Currently operating at about 100 – 115 per day.
- There have been severe water issues which has been a major constraint to reach the full slaughter rate.
- BMC uses 450 cubes / day. Before the water system was resolved, they were trucking in water from Chanoga. Without the water they could not slaughter.
- They have a water treatment facility on site.
- They operate for 8 hours per day, and have an average loss of about 1 hour per day.
- Buying from the community – BMC give the community a quota and they divide it up. The quotas are just allocated as the census figures are not accurate. The villages, negotiate to increase the quota and BMC also increases the number of days in each village to help reduce the numbers.
- BMC covers the whole of Ngamiland on a cycle.
- Communities are not allowed individual quota.
- Currently BMC is paying BWP 19.50 for animals greater than 180 kg. This was in response to the outcry by the communities. There were also complaints about grading so that is why it was dropped for the pricing.

- BMC is only selling locally (choppies, spar, sefalana in Gabs as it is off the bone) so they need to find ways to cover their costs. They are looking to sell in DRC, Mozambique and Zambia.
- BMC was selling to Zimbabwe from the Hainaveld and Kareng (as they wanted heavy animals), but this was stopped due to the FMD outbreak.
  DVS has to lift the ban as BMC lost Zimbabwe as its customer and now new customers need to be found.

  There are no plans to slaughter game meat.
- Brexit could affect Botswana. The EU is attractive as the price is better than other markets.
- Ngamiland Abattoir has been suspended from selling to DRC.
- Transporters are guided by BMC and they are forced to set prices. However, transporters are meant to pay for dead animals on arrival at the abattoir (not the farmer).
- If we can do Hainaveld right this year then we can do better. We are anticipating to slaughter 3000 from the Hainaveld this year. We don‘t believe the numbers presented.
- Things will get better once we get through the bigger animals, which is one of the reasons why we increased the price to encourage people to sell their big animals. This is in the hope that next year we‘ll get smaller animals that are better quality.
- The biggest challenge we have as an organisation is FMD, which is limited by DVS, and the poor management of fences.
- Our problem is that we are a consumer driver market currently. It would be hard to go back to the commodity driven market as there is too much disease. Once we get approval from the EU then it opens the market for us.
- Communities need improvements in controlling measles, and FMD vaccinations.

Ngamiland Abattoir: Mr Fred Camphor

- Government of Botswana support is good and influential. The Minister of Agriculture is very aware of the marketing/sales problem in Ngamiland.
- BMC Monopoly is a major problem.
- Ngamiland should not be zoned a red zone, but blue, as is the case with similar areas in South Africa.

- Botswana is ready for a change and competition in the abattoir industry should be phased in.

- Slaughtering 12 yr old oxen just does not make sense, neither does the current system where it can take over a year for BMC to buy from a cattle crush area. If purchases were made from everywhere many problems such as the movement of cattle between zones would be solved.

- The movement of cattle in trucks under permits out of Ngamiland to such places as Kasane, should have their destination confirmed as being correct on arrival, before the seals put on the transport trucks are removed.

Butcheries should not be allowed to buy directly from Farmers as it is illegal. By law, they should only buy from abattoirs.

Ngamiland abattoir was selling to the DRC, and waiting for their export permit to be renewed. This route is not easy and could easily sell deboned meet to South Africa.

- They would like to also slaughter game at the abattoir.
- They need new export markets and are currently constrained by the fact that they cannot move their products through Namibia to Walvis Bay due to the EU restrictions that Namibia must comply by. Zambia (Zambeef) has a ban on Botswana_s beef.
- Some of the cattle are dead on delivery as they can be wild and damage themselves when loaded and transported to the abattoir.

Joint Ngamiland Farmers' Association: Mr Frank Mafela (Chairman)

There are three main associations:

o Nhabe Agricultural Association (replaced NAMA which was established in 1976 through an act of parliament).

o North West Integrated Farmers' Association o Hainaveld Farmers' Association Of which the Joint Ngamiland Farmers' Association is acting as an umbrella body. Which acts to avoid conflicting lobbying, and coordinates lobbying activities, and resolutions, and stakeholder engagement.

- NWIFA – Simon Bojosi is the Chairman and Frank Mafela is the Secretary
- Tjavnga Ureva is the secretary of the Joint Ngamiland Farmers' Association and to the Nhabe Farmers' Association.
- John Benn is the Chairman of the Nhabe Farmers' Association.
- The Joint Association meet on an adhoc basis, as and when. They are in the process of being registered.
- Nhabe – mainly in the Sehithwa, Lake Ngami area.
- NWIFA – is mainly in the Tsau, Nokaneng, Gumare, Shakawe and Seronga areas.
- The main challenge is the market (lack of). We are talking to try and sell to Francistown but it needs to go through the quarantine system. The areas need to be maintained as they were last used in the 1990s.
- Once the cattle numbers are reduced cattle will be easier to bring for vaccination and then FMD can be controlled.

- Kasane doesn‘t get FMD even though there are buffalo there. There are too many cattle here and they are too wild.
  It is not possible to make the Hainaveld a green zone due to all the elephant destroying the fences.

Head of the Department of Animal Production (DAP), Mr Baagi Chilume

- The Hainaveld was originally a cattle area, but now more are doing wildlife / game farming.
- We are interested in the production of animals and we hope this study may help us.
- Challenge for us is that farmers live off the farms and have other sources of income as they are not able to sell cattle for an income. So they look at other livelihood streams to survive.
- The game ranching farms fall under the DWNP management. We are not happy with the shift as the land was originally allocated as agricultural land.
- If farmers are not able to sell then they can‘t maintain infrastructure. Communications are poor, roads are poor, although the road to Dinaka has helped other farmers.
- It is thought that there are 178 farmer in total that were created during the first, second and third phases. 58 are thought to be game farms. Only 3 or 4 are unoccupied.
- The owners of the game farmer are not local Ngamiland farmers.
- Challenges to our department are resources (human, transport and capacity), and we‘ve lost the trust of the farmers as we can‘t help them instantly.
- If farmers had a market then they would know it was worthwhile. They are limited as they can only sell through the abattoir, and therefore it is not worth it.
- We need to nurture associations to help them grow and develop.
- Ngamiland is different to other districts because of the socio-economic status. Most farmers are getting out of farming due to lack of income. Something is lacking to assist them and the price disparity because of the FMD is a problem.
- Most farmers in the Hainaveld are being sold to outsiders to run their new enterprises that are beneficial to them. They are not selling because they want to but because they need to.

Rangeland Management Officer for DAP and Hainaveld Farmer, Mr OS Ntsie

- DAP collect other data apart from farm data. DAP normally has figures on the Bull / Cow ratio and the number of each livestock category (to help with calculating the carrying capacity). DVS only do the numbers.

- I use farm OM93 as part of a syndicate. It is next to game farms and there are lots of lions there. In June they ate 5 cattle and more than 20 goats.
- I escaped from Sehithwa recently with 89 head of cattle. I had lost 45 in 2011 due to drought and another 110 in 2012 due to drought. I had 288 originally.
  On the farm there are approximately 400 head of cattle using the borehole for watering. My cousin has 200+. The neighbour (T. Wellio) from OM93 is sharing the water point as his borehole is broken, has approximately 50 head. In addition cattle from OM92 are also sharing – they have approximately 100 head.
- The farm is standard size of 8 x 8 (6400 ha).
- Have not sold in large numbers since 2007. Plan to take 15 – 20 head this year. Transport per head is BWP 300.
- The new BMC prices are encouraging us to sell and get risk of the oxen.
- There is no market for a feedlot, who would take them there? Where will they go after being fed?
- CEDA is not funding the Hainaveld as there is no valid market. That is why more people from outside are buying the farms.
- I would like to buy a farm in Ghanzi.

Chairman of the Hainaveld Association: Mr Killa Ledimo

- Regarding health issues, FMD is the main problem. Other disease are controllable through vaccination.
- Production: the challenge is that there is no pattern of breeding – most farms have their bulls in with the cows throughout the year. There is not much help from LAC, no technical advice.
- I have a calving season from October to January.
- There is no government policy on advice from veterinary etc. we are on our own by and large.
- We keep calves back (separate from their mothers) to enable us to milk, for survival. We also keep them back to protect them against predators (lions / leopards).
- The heifers first calf at about 2 years old. We wean them from about 7 months and at 14 months old we put them to the bull. If there is enough food and they are happy they will take the bull and get pregnant.
- The calf numbers depend on the bulls and the frequency of getting calves from one cow.

- Bulls may be infertile but we don‘t check. So calving rate is low. Ratios may not be correct. Should have one extra bull to cover the females. We also look at which bulls give more through the weight and grading from the abattoir results.
- Only 1% of farmers in the Hainaveld may test their bulls. But others don‘t.
- Before Independence there were master farmers and pupil farmers. Contribution of agriculture to GDP was 40% now it is only 2%. – something is wrong.
  Rangeland: we all farm very differently. We went to Namibia and farms with 700+ cattle have grass high. Our farms have only 400 head but the veldt is poor.
- Education is needed on how to paddock farms and the correct sizes. We need to become grass farmers as well as cattle farmers. At the moment farmers only consider their boreholes and the perimeter fence. With paddocking we can get more livestock in it. We need to plan at seasons.
- Problems with fences and boreholes with the elephants.
- Namibia is just grass, and the Hainaveld is just thick bush.
- No one looks at carrying capacity and there is no advice from anywhere. Our assets are the farms. But when we can‘t sell cattle, the management is hard as there is no money to manage the farms.
- If we have veldt farms then the fences collapse but don‘t have the cash to replace.
- We pay land board rent of P5000 per year.
- When we can‘t sell it impacts on the vegetation and the management of the farm.
- We have a problem with lions and a problem with a specific grass that is spreading like wild fire – very spikey and it gets in the cattle‘s eyes and throat. This is not good for the cattle.
- The fencing policy was a relief to us.
- We just need technical advice with have the ability to make changes if we can sell.
- The old system of herding won‘t work here as it is difficult to get labour as herders.
- We like the idea of electric fencing as that is much cheaper.
- It is all about Pula and Thebe – as by September everything is dead by Lake Ngami.
- At my farm the water is brackish but we drink it.
- Government needs to look at cattle areas and which are wildlife areas. We need to separate the two. What is there for us with wildlife? We need educating on what to do with wildlife.
- I get my bulls from Ghanzi

- Sometimes the problem is not the rain, but poor management.
- We use horses/ donkeys / walk and drive around the paddocks to get to know if we need to rest the paddocks or not. We also watch how the cattle eat the grass.
- The only constraint would be finances
- We need to get farmers involved and get outside people to review government to see if they are doing enough e.g. NGOs.
  Approximately 90% of the farms are occupied.
- We want to sell to Francistown but waiting feedback from DVS.