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Adaptation strategies to environmental and policy change in semi-arid pastoral landscapes: evidence from Ngamiland, Botswana

Abstract

Semi-arid rangeland pastoral areas have been affected by diverse pressures; livestock diseases, human-wildlife conflicts, droughts and resource scarcity as a result of fragmented landscapes that constrain pastoral livelihoods. In Botswana, pastoralists' adaptations remain insufficiently documented. Adaptation strategies are responses to livelihood constraints and if mainstreamed into development programmes can counter negative impacts arising from ecosystem deterioration. Using iterative participatory rural appraisal methods, this study examines adaptation strategies that pastoral societies in Ngamiland, Botswana have used to cope with pressures in their pastoral socio-ecological system. Findings show a move towards mixed and spatially varied livelihood strategies. Mixed agro-pastoral farming, intensification of flood recession farming, fishing and a network of self-help groups have developed over the last few decades of significant policy and environmental change. Pastoralists have become more sedentary with increases in petty trade and higher dependency on social welfare programmes. As the ability to adapt has positive attributes for livelihood sustainability and resilience, there is a need for practical initiatives that improve pastoralists' adaptive capacity, such as reforming pastoralists' institutions and expanding infrastructural development in pastoral areas so as to enable access to markets. These also include the need to share insights more widely across the district, nationally and regionally.

Keywords: Socio-ecological system; Land fragmentations; Climate variability, Vulnerability; Adaptive capacity; Coping strategies

1. INTRODUCTION

Dryland pastoral landscapes are characterised by unpredictable rainfall changes and frequent ecological disasters such as droughts and livestock diseases (Ellis and Swift, 1988). The International Panel on Climate Change's Fifth Assessment Report predicts that the impacts of climate change will lead to more droughts which could have a negative effect for millions of people in the poorest parts of the world, especially Africa (IPCC, 2014). Moreover, people living in dryland areas will continue to be increasingly affected by the effects of climate change because of the marginal nature of the resources to which they have access. Despite unpredictable environmental conditions, dryland areas have for many years supported pastoral livelihoods that employ strategic mobility to access water and quality grazing resources in these areas of high rainfall variability (Schnegg and Bollig, 2016). For instance, pastoralists have historically integrated their accumulated environmental knowledge of

dryland systems with traditional adaptation mechanisms, which has enabled them to sustain livestock production and livelihoods even in difficult times (Niamir-Fuller, 1999, Scoones, 1995). Using locally available resources, pastoralists have always had to act to avoid the worst impacts of drought and other disasters such as livestock diseases (Ifejika Speranza, 2010). However, most pastoral socio – ecological systems have undergone dramatic changes due to landscape fragmentation, shifts in institutions and the multifaceted role of markets (Goldman and Riosmena, 2013). Increasingly, livestock mobility is dictated by rangeland policies and conservation objectives rather than herder's choice of grazing sites (Basupi et al., 2017a). This tends towards reducing pastoral mobility so potentially increasing exposure to adverse impacts of climate variability (Dougill et al., 2010).

The ability of pastoralist communities to cope with, and adapt to changes to their environment and livelihoods has been given greater attention in environmental research agendas (Agrawal, 2010, Paavola, 2008). However, this attention has tended to focus on particular types of change, notably climate change. This bias is reflected in National Adaptation Plans (NAPs) and National Adaptation Programmes of Action (NAPAs). This is despite significant evidence suggesting that marginalised pastoral communities are faced with a number of challenges including fragmented landscapes and livestock diseases (AU, 2010). Since the 1970s countries in sub-Saharan Africa have caused significant disruption to pastoral socio-ecological systems through privatisation of communal grazing lands (Rohde et al., 2006), wildlife reserves, mining operations and rapid economic adjustment (Neumann, 1995). This is in addition to exposure to extreme events such as droughts and disease epidemics (Hitchcock, 2002). This situation makes pastoral adaptation necessary and disaster risk management a primary need (Bollig, 2010). Studies of pastoralism in drylands show that securing the mobility of herders and their access to relevant natural resources (pasture and water) is a key strategy for adaptation to constraints and risk management (Scoones, 1995). In pastoral areas, risk management includes activities geared towards reducing livelihood vulnerability due to system deterioration (Moritz et al., 2011). Restricting access to resources that are unevenly distributed in space leads to increased vulnerability due to limitations imposed by traditional coping and adaptation strategies.

Botswana's poor tend to be more rural and has struggled with increasingly unreliable rain-fed agriculture and significant environmental change affecting the resources they depend upon. Key environmental problems in Botswana include land degradation, water scarcity and biodiversity loss (DoL, 2009, DTRP, 2003). The main factors contributing to land degradation are the growing human population with increased livestock numbers kept on smaller areas of communal land. Some studies emphasise that large tracts of the Kalahari sandveld are degraded, with indicators of declining productivity such as soil erosion, loss of vegetation cover, and bush encroachment evident in communal areas (Stringer and Reed, 2007). Major threats to biodiversity include rangeland degradation, inappropriate harvesting methods,

habitat destruction, climate change, increased elephant population (especially in northern areas) (DeMotts and Hoon, 2012), fuel wood collection and the impacts of rangeland policies. Botswana's Tribal Grazing Lands Policy (TGLP) of 1975, was initiated to alleviate grazing pressure on the eastern hardveld, mitigate the 'Tragedy of the Commons' (Hardin, 1968) and commercialise the livestock sector through the creation of a series of cattle ranches in 'unused' sandveld areas (White, 1993). This was then rolled out to other parts of the country; the largest TGLP block is in Ngamiland district (Basupi et al., 2017b). It was believed that large herd owners would transfer their herds into ranches and leave the dwindling communal grazing land to subsistence agro-pastoralists (White, 1993). Studies have shown that the policy has failed to achieve this and as a result has drastically changed animal husbandry practices and herder livelihoods (Magole, 2009). The idea that they were ample unused land that could be reserved for future use was misleading as most land was already occurred by smallholder pastoralists (Basupi et al., 2017a). Moreover, those allocated ranches continued to enjoy dual grazing rights by keeping their livestock in communal areas and ranches (White, 1993). This led to environmental threats through concentration of livestock in reduced areas.

The government of Botswana continued with the ranch model in the subsequent National Policy on Agricultural Development (NPAD) issued in 1991; prompting fears that the concentration of rural poor on the country's remaining communal lands may cause further social and environmental problems (Rohde et al., 2006, Peters, 1994). Through NPAD, ranches were not limited to 'unused' areas, because demarcation of ranches depended on the number of cattle, the availability of land and its carrying capacity, and individuals could apply to fence areas within the vicinity of their boreholes (Basupi et al., 2017b). Veterinary disease control fences have also been constructed alongside TGLP/NPAD ranches resulting in severe landscape fragmentation. In Ngamiland, the most recent and controversial veterinary cordon fence is the ranches protection buffer fence constructed at the request of Ngamiland ranchers in 2012 (Basupi et al., 2017a). Current communal land across the district is becoming increasingly fragmented and is under increased pressure from shrinking land area, increases in livestock numbers and competing land uses (Basupi et al., 2017b). These issues have so far only been considered in terms of how they impact on pastoral livelihoods (Rohde et al 2006). Research has yet to consider how pastoralists respond to these constraints. Pastoralists' coping and adaptations in these marginal environments remain poorly understood.

Through a case study of pastoralist communities in Ngamiland, Botswana, we illustrate how pastoralists are coping and adapting to multiple constraints in fragmented landscapes. We study factors (termed constraints) affecting pastoralists livelihoods in communal areas. Livelihood decisions or strategies to deal with these constraints are identified as household coping or adaptation strategies. The aim of this study is to investigate the ways in which pastoral communities cope and adapt to constraints due to environmental and policy changes in Ngamiland, Botswana. The study is driven by the following questions: 1. What processes constrain pastoral livelihoods in Ngamiland pastoral landscapes? 2. How do communities

respond and adapt to environment and policy changes in Ngamiland pastoral landscapes? 3. What processes constrain or enable pastoralists' adaptive capacity in Ngamiland?

1.1. Conceptualising coping and adaptation strategies

In dryland pastoral areas, environments and livelihoods are intrinsically connected (Herrero et al., 2009). Agro-pastoral communities depend on the services provided by the socio-ecological system for their wealth and security. However, human actions, policy impacts and environmental factors such as drought can render ecosystems unable to provide environmental services, with consequences for livelihoods (Folke et al., 2002). Robust socio-ecological systems are those that can absorb shocks without changing in fundamental ways (Anderies et al., 2004). However, when transformation is inevitable, a flexible system which can cope, adapt or reorganise (Magnani et al., 2014) without sacrificing the livelihoods dependent upon it is necessary. Such a system is said to be resilient. Resilience refers to the capacity of a socio-ecological system to tolerate disturbance without shifting into a different state (Abel et al., 2006). Management that causes continued ecosystem fragmentation and excessive sub-division can erode resilience and reduce the capacity of the system to self-organise (Abel et al., 2006). The system is hence in a state of fragility (Figure 1) and livelihoods become threatened because of ecosystem deterioration. This requires adaptive responses that increase the range of pathways or alternative livelihoods so as to enable the system to cope and sustain livelihoods (Folke, 2006).

Adaptation strategies represent pathways that individuals develop to reduce vulnerability (Smit and Wandel, 2006). These strategies can be autonomous or spontaneous or a result of directed intervention by a public agency (Forsyth and Evans, 2013). For this study we adopt the definition provided by Smit and Wandel (2006, pp 282), which defines adaptation in the context of human dimensions as a ''process, action or outcome in a system (household, community…) in order for the system to better cope with, manage or adjust to some changing condition, hazard, risk or opportunity…". Adaptive capacity is the central element in this adaptation discourse (Engle, 2011, Adger and Vincent, 2005). Adaptive capacity enables a socio-ecological system, including its components, to be robust to disturbance and be capable of responding to change (Folke, 2006). In this study, we define adaptive capacity as the ability of a pastoral socio-ecological system to adjust to constraints or potential damages by taking advantage of available opportunities to self-organise and implement new strategies that can help manage the consequences of constraints and reduce livelihood vulnerability. The capacity of a household to respond to constraints depends on the enabling environment of the community and whose adaptive capacity is reflective of the available resources and institutional processes therein (Smit and Wandel, 2006). In this study, we understand short-term and temporary responses to shocks as coping strategies (Davies, 1993). While adaptation strategies are perceived as longer term adjustment to livelihood activities which also involve alternative livelihood activities and are backed by some institutional processes.

Development of strong social organisation and institutions are key to improving adaptive capacity and can help transform coping responses into adaptive strategies (Speelman et al., 2014). Figure 1 provides the framework used to distinguish between coping and adaptation strategies and was used to structure the results section (A = constraints to livelihoods, B = System behaviour in response to constraints or deteriorating socio-ecological system and C = Pastoral communities' response to constraints).

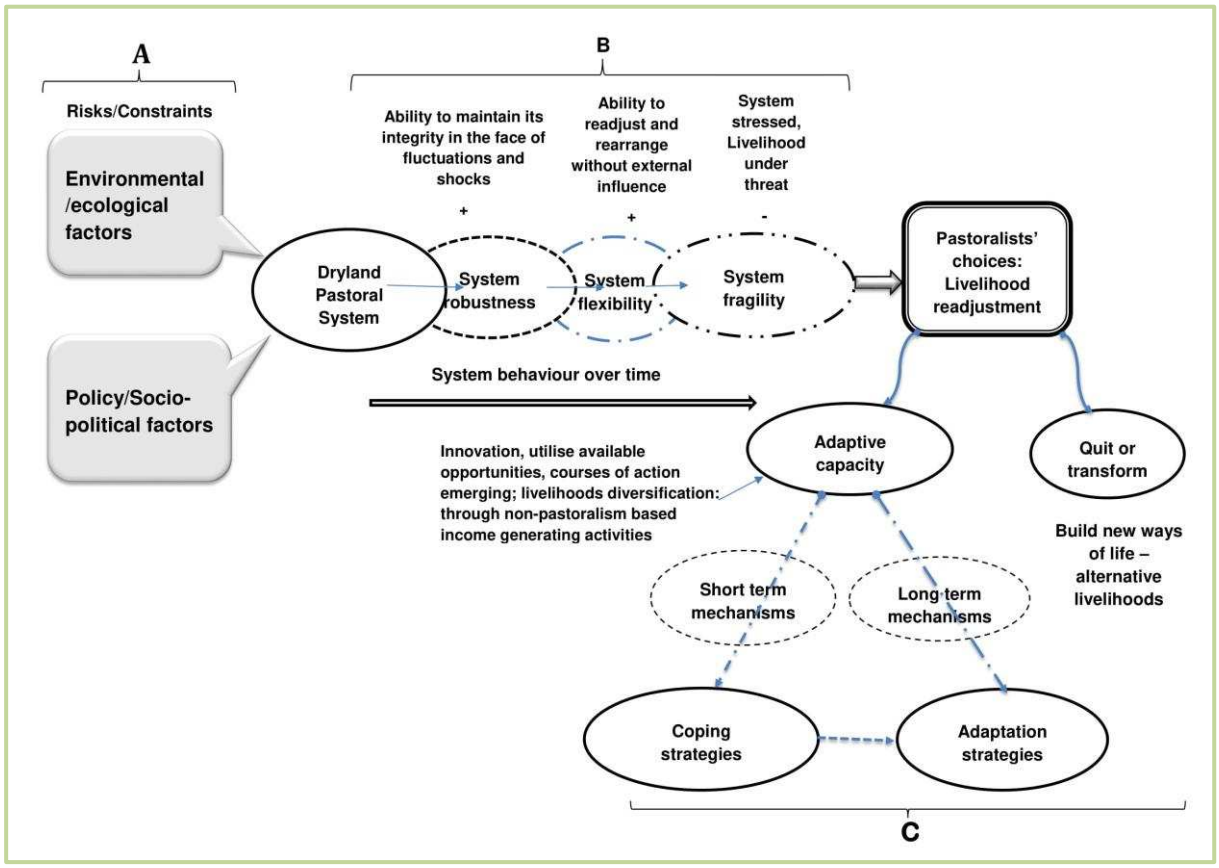

Figure 1: Schematic of constraints and coping/adaptation strategies in pastoral socio-ecological systems.

2. MATERIALS AND METHODS

2.1. Study area

The research area is located on the southern fringes of the Okavango Delta in Ngamiland District, North-western Botswana (Figure 2). This region is characterised by inherent climatic variability, particularly in rainfall, and exhibits low and highly variable biomass productivity (DoL, 2009). The average annual rainfall is 350mm. Unpredictable precipitation changes mean that droughts are endemic and the most obvious characteristic of the local climate. Temperature is characterised by large diurnal variations, with winter temperatures as high as 26^0C to as low as 7^0C. During summer months, temperatures equally vary from a maximum of about 35^0C to a minimum of about 18^0C (DMS, 2017). In recent years, maximum temperatures around 40^0C have been recorded, especially in January. The vegetation is dominated by open low shrubs and bush savanna. Associated herbaceous

species include *Anthephora pubescens, Aristicla meridionalis, Eragrostis spp, and Stipagrostis uniplumis (BRIMP, 2002)*.

A prominent feature in the region is Lake Ngami, which is a terminal portion of the Okavango Delta distributaries (Nhabe and Kunyere Rivers). The delta is fed with water through the Okavango River that rises in the Angolan highlands, flowing through Namibia before entering Botswana. The lake flood regime has been characterised by periodic fluctuations. Between 1989 and 2004 there was no water inflow and the lake dried (DoL, 2009). However, exceptional flooding in the Okavango Delta since 2008 has resulted in extensive surface water in the Kunyere, Nhabe and Boteti rivers thus filling Lake Ngami to unprecedented levels. This has resulted in an increase in livestock numbers in the region as watering has become possible on the lake.

A mosaic of tenure arrangements and natural resource management regimes, ranging across core protected areas, wildlife management areas, communal subsistence agro-pastoralism and fenced commercial ranches have existed side by side since the introduction of rangeland enclosures by the TGLP (Basupi et al., 2017b), later extended by the ranches of the NPAD (RoB, 1991). Two-thirds of the district's land area is utilised for wildlife conservation and tourism (DoL, 2009). Land use types are affected by environmental factors such as the distribution of surface water and soil quality, regulating the spatial distribution of cattle, wildlife, and dryland and floodplain cultivation. Within the study area the six study villages were: Semboyo and Makakung 50 km north of Lake Ngami (sandveld villages) and villages' adjacent Lake Ngami: Bothatogo, Bodibeng, Sehithwa and Toteng (riparian villages) (Figure 2). The sites were purposively selected based on an understanding that there are mainly pastoral communities with high numbers of livestock (Table 1). The location factor (sandveld vs riparian) and distance from the privatised ranches also influenced selection of these sites. Pastoral and agro-pastoral communities in the area include the Ovambanderu, Ovaherero and to a lesser extent the Bakgalagadi, Batawana and BaYeyi ethnic groups (Tlou, 1985). The majority of residents follow an agro-pastoral lifestyle keeping multispecies livestock. Livestock statistics indicate that the communal areas south of the Setata veterinary cordon fence have the highest concentration of livestock in Ngamiland (DVS, 2016).

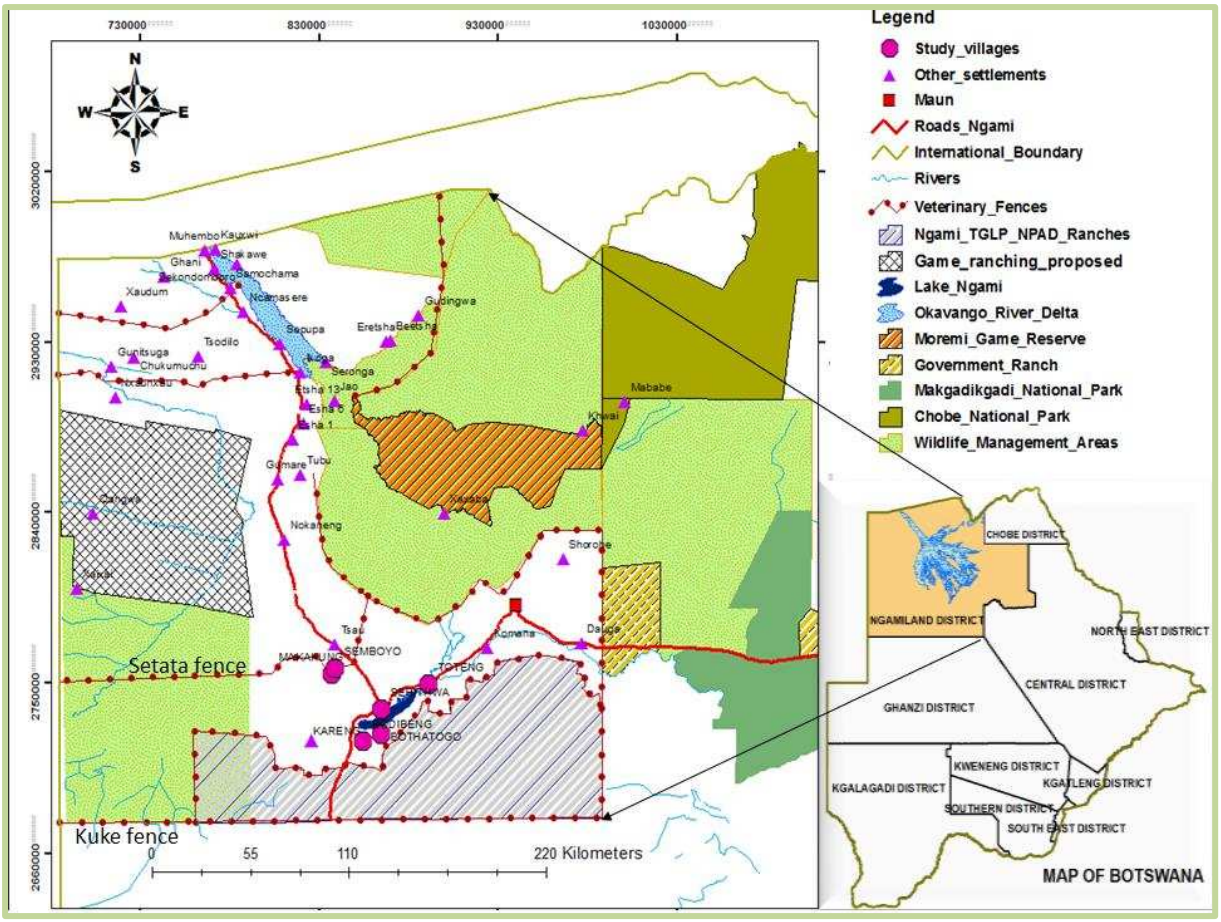

Figure 2: Location of the study sites and adjacent land use zones; privatised communal lands (ranches) and conservation areas.

2.2. Research methodology

The study uses iterative participatory rural appraisal (PRA) methods. PRA approaches seek to enable local people to share their knowledge of life and conditions (Narayanasamy, 2009). Field data collection took place from April to September 2016 using a number of PRA tools; qualitative semi-structured interviews, Focus Group Discussions (FGD), Key informant interviews and participant field observations. A total of 112 households in the 6 study villages participated in semi-structured interviews. Participants were selected from a cross-section of the pastoral community and included both genders, different age groups and different tribal groups in different localities (Table 1). In each study area, pastoral households were randomly selected with the aid of extension officers from the ministry of agriculture and field assistants recruited from the villages. In each household a head, or available adult member, who was either a pastoralist or agro-pastoralist was interviewed. All interviews were conducted face to face and tape recorded, with each lasting for about 30 minutes. Table 1 shows the population in the study villages, ethnic groups and numbers in semi-structured interviews. Further discussions were held with a total of 26 people considered to be key informants; village elders, local chiefs, chairperson of farmers associations, village extension officers and political leaders. In addition, 6 focus group discussions were held (1 focus group per village,

each with 10 – 14 participants). Purposive sampling and snowballing techniques (Tongco, 2007) were used to identify key informants. Farmers' committees, village leadership and village development committees were used to solicit names of participants for key informant interviews and focus groups. Participants were selected based on their pastoral and local environmental knowledge. Respondents were asked to talk, in open-ended terms, about constraints that they have to deal with as pastoralists. Information about coping or adaptive strategies was collected by asking respondents about how they responded to constraints. This also included both changing pastoralist practices as well as livelihood diversification and other sources of income. Respondents were further asked how long they had been using the identified strategy and how significant it was to their livelihood.

Field observations and community guided walks were used to corroborate the information from interviews and focus group discussions. Volunteers mostly comprising of community elders guided the field observations. In each study village the number volunteers were as follows: Semboyo (n = 3), Makakung (n = 4), Bodibeng (n = 2), Bothatogo (n = 4) Toteng (n = 3), Sehithwa (n = 2).

Table 1: Demographics of interview participants, Population of study villages and livestock numbers per village

Variables	Study areas (semi-structured interviews n=112)			
	Sehithwa (n =28)	Toteng (n=20)	Bodibeng & Bothatogo (n=31)	Semboyo & Makakung n=33)
Gender				
(i) Male	18 (64%)	12 (60%)	13 (42%)	15 (45%)
(ii) Female	10 (36%)	8 (40%)	18 (58%)	18 (55%)
Age group				
(i) 20 to 40 years	11 (39%)	8 (40%)	11 (35%)	10 (30%)
(ii) 41 to 60 years	9 (32%)	9 (45%)	12 (39%)	12(36%)
(iii) 61 - 80 years	8 (29%)	3 (15%)	8 (26%)	11 (34%)
Ethnic groups				
Ovambaderu	12 (43%)	8 (40%)	10 (32%)	9 (27%)
Ovaherero	7 (25%)	3 (15%)	5 (16%)	15(46%)
Batawana	3 (11%)	4 (20%)	3 (10%)	6 (18%)
BaKgalagadi	2 (7%)	2 (10%)	11 (35%)	2 (6%)
Others	4 (14%)	1 (5%)	2 (7%)	1 (3%)
Village population	2748	909	1333	691
Livestock numbers per village				
(i) Cattle	19251	29319	39916	28030
(ii) Goats	1712	3743	4070	3484
(iii) Sheep	471	1015	1313	632
(iv) Donkeys/Horses	953	1444	1816	1299

Data source: Statistics Botswana, 2011; Department of Veterinary Services 2016; Author's Interview transcripts

2.2.1. Data processing and analysis

Our qualitative analysis procedure was done in accordance with principles of qualitative content analysis: (i) identifying major themes emanating from the discussions; (ii) assigning codes to major themes; (iii) classifying responses under the identified themes; (iv) writing the research narratives and discussions. Each testimony from semi-structured interview respondent was converted to text using Microsoft word. The process involved close observation of data through repeated careful listening. This was done simultaneously with the researcher's reflective field notes (memos). Transcribed interviews were imported into Nvivo 10 (QRS 2012) for coding. Themes were organised into tables, arrived at by counting the number of times (entries) each theme was mentioned. Further, data was rearranged by categorising it into coping or adaptation strategies, allowing for cross checking against the objectives so that only the most pertinent findings are included. This also facilitated comparison between villages. Relevant quotes from focus groups and key informant interviews were used to explain and clarify data (Patton, 1990).

3. RESULTS

3.1. Constraints to pastoral livelihoods in Ngamiland pastoral landscapes

Table 2 gives a summary of thematic analysis of livelihood constraints across the six study villages. Constraints related to environmental changes were cited as livestock diseases, drought, wildlife issues and limited water availability. Livestock diseases were closely linked to market constraints. Respondents across the study villages frequently cited increased landscape fragmentation due to land privatisation policies, dual grazing by ranchers' and fencing related to animal health policies as major contributors to the constraint of limited grazing lands and livestock congestion in communal areas.

Table 2: Entries (counts) identifying livelihood constraints in the six study villages.

Themes	Study villages (n = 112)						
Livelihood Constraints	Bodibeng (n=16)	Makakung (n=16)	Semboyo (n=17)	Bothatogo (n=15)	Toteng (n=20)	Sehithwa (n=28)	Total
Livestock diseases	13	15	14	14	18	25	99
Limited markets	15	14	15	13	17	23	97
Limited grazing land	11	14	12	9	15	19	80
Human-wildlife - conflicts	10	9	9	11	13	16	68
Stray animals	6	8	12	9	10	8	53
Drought/declining rains	7	6	11	8	10	9	51
Dual grazing by ranchers	8	0	0	7	11	7	33
Access to water	2	7	5	1	6	11	32
Underground water salinity	4	6	6	0	2	5	23

3.1.1. Data from semi-structured interviews, generated though Nvivo 10 (QRS 2012)Livestock diseases and market access

Livestock diseases are endemic to Ngamiland and have a significant effect on livelihoods and herd management. For example in 1995, there was a severe outbreak of a cattle lung disease (contagious bovine pleuro-pneumonia - CBPP) which resulted in the culling of the entire district herd (DVS, 2000) leaving many households on the brink of destitution and dependent on government social welfare programmes. In the period from 2007 to 2017, the district experienced an outbreak of foot and mouth disease (FMD) (Basupi et al., 2017a). Continuous outbreaks of livestock diseases have meant a dramatic collapse of a major livelihood asset as the market and value of cattle has dropped significantly and households continue to experience a serious loss of income leading to instances of 'destitute' pastoralists. Market access was not simply defined by the numbers of cows sold to Botswana's meat abattoirs or local butchers, but by a combination of other factors such as labour, time and sustainability of livelihoods dependent upon livestock herding. Many pastoral households reported that they had lost herding labour through reallocation to other more productive pursuits. The remaining herders, mostly elderly men and women, were often constrained as out-migration of young men and women led to higher workloads, *'….many young men and women are growing impatient about the lack of sale and most have migrated to towns or are pursuing other means of livelihood…'* (FGD data, Sehithwa). Substantial variation in herder behaviour was observed throughout the study area. Those with smaller herds were in a better position to perform daily herding and sometimes night kraaling of cattle. Large herd owners preferred to leave their cattle to roam around and only rounded them up for vaccination or when performing management practices such as branding. Together these factors contributed to the decline in the quality of herding, increasing environmental stress and the spread of livestock diseases through livestock congestion around water resources.

3.1.2. Resource scarcity and limited access to rangelands

The most persistently discussed aspect of resource scarcity in all study villages was a shortage of grazing lands because of fragmented and disconnected landscapes that restricted access to pasture and water resources. Limited grazing land placed limitations on the ability of pastoralists to carry out livestock management practices such as herding and kraaling of animals, controlled grazing, control of animal diseases and increased the likelihood of livestock loss during drought years. Conflicts between herders over the limited key pasture resources also remained an issue. Respondents also referred to higher incidences of dual grazing by ranchers and stray animals, blamed on absentee pastoralists who have migrated to towns. These animals were considered problematic because they accumulate near major roads causing road accidents especially at night, encroach on arable fields and make vaccination against FMD difficult. Similarly, the Ministry of Agriculture's Livestock Management and Infrastructure Development Programme (LIMID) and the Ministry of Youth

Development are said to have been funding livestock projects despite disease outbreaks and lack of markets. This has contributed to the increase in livestock numbers, worsening the problem of intensive grazing in communal areas as there is no offtake.

3.1.3. Elephant raids

In the study villages, especially around Lake Ngami, elephants were blamed for crop damage, especially on flood recession arable fields, and ecosystem deterioration, and considered a threat to human life. In the sandveld villages, the threat was attributed mostly to the destruction of veterinary fences and water resources such as boreholes, *'…For us the cost of living alongside these animals is the hectares of crops crushed, that borehole-pumping machinery routinely destroyed or the life of a farmer that is constantly under threat…' (FGD data, Bodibeng)*. Explanations given for the increasing elephant threats were mainly related to land use changes as fencing has significantly affected ecosystem integrity. Respondents argued that policies favour wildlife compared to pastoralism. Notwithstanding these challenges, the pastoral community is confronted with the reality of having to live with elephants.

3.1.4. Drought and associated constraints

Respondents mentioned recurrent drought and decreasing and more irregular rainfall patterns as a primary risk factor. Like in many sub-Saharan African countries, over-reliance on cattle makes rural communities more vulnerable to climate variability, especially trends in low rainfall (Herrero et al., 2009). Respondents reported that their vulnerability to climate-related environmental shocks was mainly due to their inability to adapt to changes brought about by rangeland policies that hamper livestock mobility and the capacity to access critical grazing and water resources. Rainfall in Ngamiland, as in the rest of the country, is characterised by large annual variability (Batisani and Yarnal, 2010). Some years are characterised by significantly less than average rainfall (drought). This risk was defined by the impacts on pasture regeneration, rainfed arable agriculture and the impact of societal reliance on ecosystem services. Other constraints associated with low rainfall were defined in terms of availability of potable water for livestock, with ephemeral water sources said to be especially congested during dry years, while ground water sources were said to be mostly saline and not suitable for livestock.

3.2. Pastoral communities' response to constraints

3.2.1. Coping Strategies

A thematic analysis of coping strategies across the study villages is summarised in Table 3. Coping strategies are more reactive and involve the short term and temporary arrangement of livelihood activities in response to constraints faced. In all the study villages, respondents emphasised the importance of government relief programmes in providing temporary safety nets in the face of a lack of alternative livelihoods and formal employment opportunities.

Over-reliance on the government's Labour Intensive Public Works Program (LIPWP) and transfer payments in the form of old age pensions was mentioned in all villages. The LIPWP is a government strategy employed to address problems of rural income and poverty. It provides temporary employment, especially to young people. In all the study villages, respondents reported that some able bodied people were employed to work for wages on LIPWP such as routine road maintenance and bush clearing, fire control in rangelands, village cleaning, sorghum stamping for the school feeding programme and the community policing programme. In almost all the interviewed households, one or more person per household worked for LIPWP. Other government social–welfare programmes included food packages for the very poor and school feeding programmes.

Table 3: Coping strategies mentioned per village

Coping strategies	Study villages (n = 112)						
	Bodibeng (n=16)	Makakung (n=16)	Semboyo (n=17)	Bothatogo (n=15)	Toteng (n=20)	Sehithwa (n=28)	Total
Labour intensive programmes (LIPWP)	9	10	11	12	14	16	72
Social alliances/self-help groups	10	12	8	9	11	13	63
Social welfare programmes	6	5	7	6	8	9	41
Household splitting	0	6	7	0	10	13	36
Old cows for household consumption	5	4	9	3	6	7	34

Data from semi-structured interviews, generated though Nvivo 10 (QRS 2012)

Because of the vagaries of livestock production: livestock diseases, markets conditions, and limited pastureland, income from livestock is subject to great uncertainty. One of the important mechanisms that communities, especially women, used to buffer livelihood constraints in was the ability to participate in informal institutions of self–help groups and social alliances known as *'metshelo'*. These networks are developed in a reciprocal and participatory manner and are defined by kinship, friendship, or neighbourhood and some extend beyond village boundaries to incorporate members from other villages. They pursue active give-and-take links which include labour exchange (during ploughing season), the establishment of saving schemes and a traditional non-cash gift system that includes food and household utensil donations on a rotational basis among members. In the sandveld village of Makakung, the village network went a step further to establish a traditional choral group that was often engaged to perform in cultural events both locally and in neighbouring Namibia. Proceeds from the choir went towards the saving scheme, some of which linked into a burial society fund used to help members bury loved ones by contributing food and money.

Households that were able to invest resources in such schemes were able to buffer shocks, such as enabling them to borrow money to buy school uniforms.

Respondents also reported that they compensated for labour lost through reallocation to other activities by relying on social networks or support from friends. This included cooperation over herding related tasks and practices of labour sharing such as watering of livestock on a rotational basis. Families with more labour subdivided their household spatially (household splitting) such that they had a cattle post on either side of the veterinary fences. Having two or more cattle posts strategically located was considered advantageous because it allowed such a family to sell when a market opportunity arose on either side of the fence.

3.2.2. Adaptation and livelihood diversification strategies

Livelihood diversification involves the creation of a portfolio of non-pastoral livelihood activities. Table 4 gives a summary of thematic analysis of livelihood adaptation strategies across the six study villages. Most households still keep a significant number of diversified livestock; cattle, sheep, goats, donkeys and horses. Hence these strategies are most commonly used to complement pastoralism rather than as a substitutes.

Table 4: Adaptation and livelihood diversification strategies mentioned per village

Themes (Adaptation Strategies)	Study villages (n = 112)						
	Bodibeng (n=16)	Makakung (n=16)	Semboyo (n=17)	Bothatogo (n=15)	Toteng (n= 20)	Sehithwa (n=28)	Total
Fishing	11	0	0	10	12	13	46
Flood recession agriculture	10	0	0	9	13	14	46
Migration to towns for wage labour	5	9	8	6	4	5	37
Farmers association	5	4	4	5	9	9	36
Petty trade/handicrafts	7	3	1	7	7	10	35
Buy arable lands/ Fodder accumulation	3	6	5	5	7	9	35
Use of chili pepper	4	1	0	3	4	6	18
Livestock diversification	4	3	3	0	3	4	17

Data from semi-structured interviews, generated though Nvivo 10 (QRS 2012)

Issues of limited pastureland were at the forefront of adaptation strategies, especially in the riparian villages. '…Limited access to rangelands means we cannot set aside any pastures for use in late winter or dry seasons…' (Interview data, Bothatogo). Many respondents expressed interest in establishing fodder storage facilities. Some respondents reported that they had been buying and accumulating supplementary feeds. While others were negotiating with

arable farmers to use their arable lands for grazing in winter. Those with financial resources were buying arable lands exclusively for livestock grazing during the dry season. Management strategies to improve forage or plant fodder were mostly insignificant.

The recurrent outbreaks of livestock diseases meant that many households were vulnerable and had to constantly search for viable alternatives. The majority of households reported livelihood diversification as a major adaptation strategy, *'…We have to find alternative ways of putting food on the table. It is greedy to kill cows just for meat, except of course on special occasions…' (Key Informant Interview data, Makakung).* Livelihood diversification strategies included; fishing, migration to towns by some members of the household in search of wage labour, petty trade, artisan work such as basket weaving and leather tanning, and a shift to agro-pastoralism especially the intensification of flood recession agriculture. The primary source of petty commodity income was described in terms of the artisan production of crafts as marketable commodities, table traders who sell produce in the market and some illicit brews in homes.

The outbreaks of FMD since 2007 have resulted in an intensification of two livelihood activities: fishing and flood recession cultivation. The riparian villages (Sehithwa, Toteng, Bodibeng, and Bothatogo) all mentioned fishing as a livelihood diversification strategy. Some young people have obtained loans from the Youth Development Fund with the intention of investing in fishing activities. However, interviews with key informants revealed that even though proceeds from fishing are attractive, fishing in the area is not sustainable because of the nature of the lake's flood regime. The high number of people from across the district, and the country, flocking to the lake in search of an alternative livelihood also make fishing a problematic activity. This has prompted the Department of Wildlife and National Parks to frequently suspend fishing in the lake citing hygiene issues and pollution problems, as well as conflicts between fishers and other users; '*…issues of squatters, poor sanitation, untidy surroundings and criminal activities, including incidents of drowning were rife…the decision to suspend fishing activities had to be taken…' (Key informant interview, Department Wildlife and National Parks, Fisheries Division, 2016).*

Most of Ngamiland sandveld areas lack adequate rainfall for arable agriculture and soils are generally poor. Discussants in both FGD and interviews reported that flood recession agriculture, known locally as *Molapo* farming, is an important land use and livelihood diversification activity for the rural poor living on the fringes of the Okavango Delta. *Molapo* is a local term coined to refer to the seasonally flooded plains (Motsumi et al., 2012). Villages along the rivers Kunyere, Nhabe and Lake Ngami flood plains reported that they preferred *Molapo* farming over dryland farming because soils are higher in fertility and tend to retain moisture for a long time. *Molapo* cropping is less risky as the residual flood water in the soil acts as a supply of moisture during seasons of low or poorly distributed rainfall. Respondents reported that they also accessed government transfer payments to bolster dryland rain-fed arable agriculture through the government's Integrated Support Program for Arable Agriculture Development (ISPAAD). Through ISPAAD, villagers received free seeds, fertiliser

and farming implements. Farmers who did not use the ISPAAD tractors and ploughed using their own resources were given money equivalent to the amount that the government would have spent to plough for them. However, frustration towards elephants that destroy crops has caused many respondents to be sceptical about arable farming, at least on a large scale. '*…with ISPAAD you can have some of your money back, but if you are lucky and the elephants avoid you, you can have the money and the harvest*' (FGD data, Toteng).

Strategies to deal with human-elephant conflicts were limited. Traditional scare tactics mentioned by respondents included making noise by beating drums, lighting fires close to arable lands and keeping them burning overnight, or clearing vegetation around the fields and boreholes so as to see elephants from a distance. *'…these tactics are not always effective as elephants quickly get used to them and with time ignore them…'* (Key Informant Interview data, Toteng). Respondents expressed frustration that elephants have become increasingly aggressive and less fearful of humans. A few households reported that they had resorted to using chilli pepper as a deterrent; a concept that was introduced to them by the Department of Wildlife and National Parks. According to respondents, chilli is a natural irritant and its smell causes intense but short-lived pain that drives elephants away. Chilli is dried, mixed with cow dung and sun-dried into a brick, which is burnt by the edge of a field or borehole at night. Others reported that they mix the chilli powder with used engine oil or grease, which is then smeared on fences.

3.2.3. Processes that constrain or enable pastoralists' adaptive capacity

Understanding adaptation processes requires scrutiny of the combination of conditions that affect the ability to adapt, and incentives or barriers that affect adaptive capacity (Adger, 2006). In Ngamiland, focus group discussions perceived a nexus of adaptation under three categories as detailed in Figure 3; Physical/Natural environment, Economic resources and knowledge and Institutional structures. The three can be considered pillars of adaptive capacity due to their influence on how pastoral communities respond to constraints.

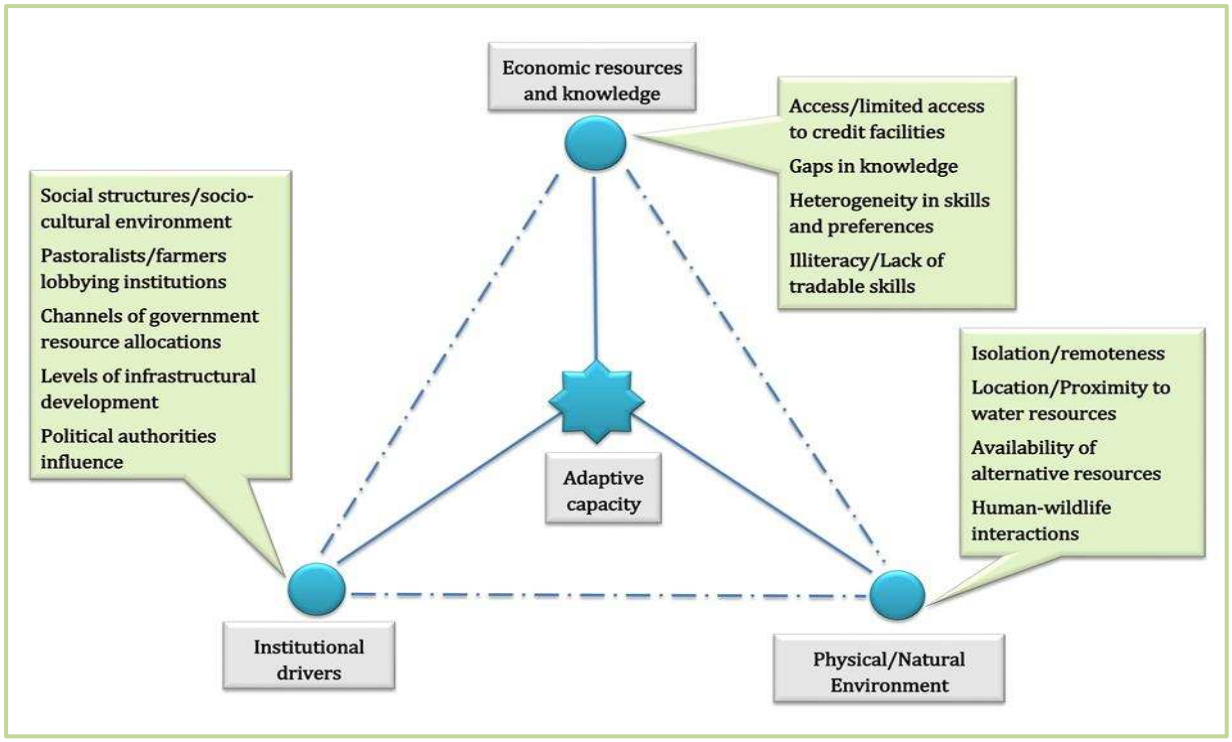

Figure 3: Adaptive capacity nexus in Ngamiland pastoral areas.

A clear disparity in adaptation strategies was noted between riparian villages (because of their proximity to Lake Ngami or main road) and the sandveld villages (Semboyo and Makakung) (as shown in Table 5). Villages closer to better roads (riparian villages) had more frequent and direct contact with the market of Maun and were able to produce more systematically for the market (Maun is the District's administrative centre, a primary tourism hub and the gateway to the Okavango Delta). The majority of products produced by villagers, including artisan work such as handicrafts, are sold in Maun. Good road infrastructure was perceived to reduce the cost of transport to markets as well as permitting entry into new and more profitable pursuits. Similarly, the resources of Lake Ngami were described as a pull-factor driving the transition to more intensive land-use around the lake and the few flood plains. Limited infrastructural development in the sandveld villages was noted as a key constraint to adaptation. Respondents in these villages discussed a lack of roads or seasonally impassable and poorly maintained gravel roads, which made it difficult to access critical resource areas. A marked distancing from government services was noted in these villages with focus group discussions and key informant interviews identifying a distinct lack of interest in providing assistance on the part of the government or political leaders. Noteworthy is that despite a recognition of the constraints related to pastoralism in these areas, inhabitants have not directly sought to deviate from or abandon pastoralism, with all the group discussions and key informant interviews pointing to a willingness to continue with pastoralism.

Table 5: Comparison of adaptation strategies between villages, complied from FGDs and key informant interviews

Village	Is pastoralism under threat?	Dominant adaption or coping strategies	Distance to the market of Maun	Access to the main road	Willingness to continue with pastoralism
Toteng	+	Fishing, FRA, LIPWP, Artisan works	65 km	+	+
Sehithwa	+	Fishing FRA, LIPWP, Artisan works	98 km	+	+
Bodibeng	+	Fishing, FRA, LIPWP	114 km	+	+
Bothatogo	+	Fishing, FRA LIPWP, Artisan works	95 km	-	+
Semboyo	+	MGR, LIPWP, Household splitting	145 km	-	+
Makakung	+	MGR, LIPWP, Household splitting	150 km	-	+
KEY = + YES - NO FRA = Flood Recession Agriculture MGR = Migration LIPWP = Labour Intensive Public Works Program					

Communities were developing deliberate collective actions to self-organise through associations, such as women's social groups and farmer associations. The rise of pastoralist/farmer associations was a response by the pastoral community to address the deepening crisis of vulnerability due to limited sales of livestock products and fragmented landscapes. According to key informants, the primary mandate of these associations is to propose policy options which promote the development of pastoralism, safeguard pastoralists land rights and negotiate for market quotas with Botswana's Meat Abattoir. Three notable associations were identified in the study area; Nhabe Meat Farmers' association, Ngamiland Integrated Farmers' Association and Hainaveld Ranchers Association. While some respondents appreciated the initial role of associations, many argued that the associations have since become highly politicised and some have been usurped by opportunistic individuals who are now using the plight of poor pastoralists to their own advantage. *'…all we were trying to achieve through these associations is a collective voice to negotiate a stake in our communal lands and sales of livestock so that we may return some of our lost glory… but, those with influence and money make decisions for their own benefits…' (Key informant interview data, Bodibeng).* Respondents argued that some of these associations have now limited themselves to issues of livestock sales and are charging pastoralists large sums of money to transport their livestock to markets. They do not address the broader patterns and nature of marginalisation. Such disjointed groups are unlikely to mobilise the necessary resources critical for pastoralists' adaptation or bring pressure on policy making processes to address pastoralists' needs.

4. DISCUSSION

This study investigated the ways in which pastoral communities respond to constraints due to changes in the environment and in policy. Here, a history of rangeland privatisation policies, animal health policies, and conservation policies have had a strong influence on the way in which rangeland resources are now accessed and managed by local pastoral communities (Basupi et al., 2017a). As illustrated in the theoretical framework (Figure 1), In

addition to fragmented and disconnected landscapes, pastoralists must also contend with environmental problems such as droughts, livestock diseases, human-wildlife conflicts and rangeland degradation. While a combination of factors can be attributed to the increase in livestock diseases, for example, climate change (Bett et al., 2017, Rojas-Downing et al., 2017), increasing pastoralist vulnerability can also be attributed to weakened coping mechanisms especially decreased mobility resulting from rangeland enclosures and concentration of livestock on ever reducing communal lands. Continuous contact and intermingling of herds at crowded water points and stresses due to pasture shortages may account for higher prevalence of FMD in these pastoral systems. The FMD crisis, its impact and management has taken on a new urgency because it is now obviously driving people who have long been productive into poverty (Basupi et al., 2017a).

Understanding changes in livelihoods is important in understanding rural communities' vulnerability and response to change, be that either policy or environment driven (Twyman et al., 2004). In Ngamiland, pastoral communities demonstrated a range of alternative livelihood activities, such as flood recession agriculture, fishing, and petty trade. These are in turn bolstered by access to government social welfare programmes; old age pensions, LIPWP, and destitute and school feeding programmes. These coping and adaptation strategies are not without challenges. Like in many other pastoral areas (Greiner and Mwaka, 2016, Rettberg, 2010), the ability to adapt is influenced by such factors as access to resources, access to markets, the institutional environment within which adaptation occurs, political influence, financial resources and kinship networks. Households with limited access to resources and financial services were more vulnerable. Those with financial resources were able to buy fodder or pay for private access to pasture in arable fields and hence cope with the effects of constraints such as drought or limited grazing lands. However, this option was only available to a limited number of households. Similarly, remote villages in the sandveld had limited access to natural resources, such as water and infrastructural services, compared to riparian villages, limiting their diversification options. These examples illustrate how institutional and landscape changes are leading to further uneven capacities within the pastoral communities.

A key finding from this study is that landscape fragmentation and a lack of market access threaten the sustainability of rangelands and challenge the practice of pastoral mobility. While this might be fostering a rise in livelihood diversification through non-pastoral activities, some of these strategies might actually undermine the long-term sustainability of pastoralism and complicate responses to climate change in the future. This has been found to be the case for many dryland pastoral areas, such as in Kenya and Tanzania (Goldman and Riosmena, 2013, Galvin, 2009). In the specific case of Ngamiland, flood recession agriculture and expansion of rain-fed crop cultivation is based on the use of seasonally flooded plains and areas with marginally higher productive potential, thus removing land from pastoralism that would otherwise be highly productive and would have been traditionally used for dry season grazing. Moreover, these strategies depend to a large extent on household labour availability

and ability of a household to direct their investment options to strategies that add value to the household economy. Stiff competition for labour has been noted as the demand for wage labour and migrations to towns' increases, thus posing a threat to traditional systems of labour sharing. Migration was more pronounced in the sandveld villages where alternative livelihood options are limited. Similarly, involvement in petty trade has removed an important source of labour from the household and placed extra workload on the elderly. Most traders are either absentee pastoralists or ex-pastoralists who have lost interest in livestock and are now trying to make a living through informal income generating activities. This has direct impact on livestock management and diseases control. As noted by Adger and Vincent, 2005, adaptation may reduce risks over the short term yet cause an increase in exposure to risk in the long term.

Similarly to other research in Botswana (Sallu et al., 2010), this study has found that family involvement in social networks buffered the impacts of stress caused by ecosystem deterioration and lack of alternatives. In most African communities, informal associations are becoming increasingly important in shaping and mediating local adaptation practices (Rodima-Taylor, 2012). For example, in the Tanzanian Maasailand, pastoralists with access to the right social networks and sufficient labour are more likely to have higher adaptive capacity compared to those who do not (Goldman and Riosmena, 2013). However, despite the importance placed on these associations, they face a number of challenges including a lack of entrepreneurial skills, inadequate leadership skills, inadequate managerial ability, low levels of production by member households and low purchasing power. In this study, pastoral households struggled to balance between producing for their families and fulfilling their obligations to these social networks. However, in-spite of the challenges, in most study villages, social networks were said to perform better than externally created initiatives.

Studies have shown how adaptive capacity is context specific, varies from community to community and that it is not equally distributed (Engle, 2011, Smit and Wandel, 2006). In this research, the capacity of the riparian villages to undertake adaptations was better than the more remote sandveld village communities who had limited access to resources and infrastructural services. Understanding the different adaptations that households implement and why provides some indication of adaptive capacity, and so the adaptation space within which adaptation decisions are likely to take place (Adger and Vincent, 2005, Twyman et al., 2004), It is important that policy makers accommodate the necessary preconditions for pastoral adaptation strategies in National Adaptation Programmes of Action (NAPAs). Therefore the argument is to develop meaningful scenarios of adaptive capacity rather than scenarios of adaptation per se. Often core causes of vulnerability such as poor access to land, especially by the marginalised and vulnerable, and poor infrastructural services need to be addressed first before impact-oriented adaptation efforts can be effective. Once the conditions are favourable, communities are likely to take the necessary steps to develop suitable adaptation strategies specific to their socio-ecological systems. In Ngamiland, there

is a need for practical initiatives that improve pastoralists' adaptive capacity at appropriate spatial and temporal scales. This also includes the need for strengthening the knowledge base, improving data gathering, surveillance/forecasting systems and sharing insights more widely across the district and nationally.

5. CONCLUSION

Adaptation is a social process that requires attention to the structures that influence vulnerability and adaptive capacity, including local level (on-the-ground) actions that pastoralists conduct in order to address vulnerability. Understanding these strategies, including their implications, through a participatory process could form the basis of better formulated policy intervention or development projects in pastoral areas. In Ngamiland, income from pastoralism is subject to great uncertainty arising from livestock diseases, market conditions and limited access to productive rangelands, and climate-related constraints such as droughts. Opportunities for wage labour are limited, and the high dependency on the Botswana government's labour intensive public works program suggests a society in dire need of alternative sources of income.

This study shows how social networks of self-help groups and farmers associations are now an important aspect of the vulnerability context and pastoralists adaptive capacity. Well managed networks provide solidarity within and across villages, and thus help manage multiple constraints collectively. Supporting pastoralists' adaptive capacity in this context is not about targeting one particular strategy but empowering local pastoral communities in acquiring flexibility and inclusiveness in their response system. Assistance from practitioners is essential in empowering and assisting pastoral communities to self-organise. The requirement on the part of practitioners is to provide a platform for the formalisation of these groups and ensure that they are backed by necessary legislative instruments and also supported to establish simple constitutional documents, functional leadership, formal registration and training. These groups, when functional, can then develop their own action plans that allow each community to identify their own situation-specific entry points and level of involvement in livestock and land management, including a long-term strategy for engagement with the government.

The capacity and options of pastoralists to adjust their livelihood options are shaped in turn by infrastructural development and institutional structures. Like in other dryland areas, Ngamiland drylands are disadvantaged in the distribution of public resources and provision of services. The availability of livelihood options that depend more on infrastructural development like inter-village trade is hence hampered by poor roads and other development policy biases against dryland areas. The dynamics of household labour availability also comes into focus as pastoralists redirect their household labour with negative impacts on herd management strategies. Livelihood diversification is happening but some opportunities like fishing may not be feasible over the longer term unless backed by a more sustainable fisheries

sector (e.g. improved fishing, processing and market access infrastructure) and an adequate legislative framework aimed at developing the livelihoods of communities around the lake and safe guarding the lake environs. As the ability to adapt has positive attributes for livelihood sustainability and resilience, there is a need for practical initiatives that improve pastoralists' adaptive capacity, such as reforming pastoralists' institutions and expanding infrastructural development in pastoral areas so as to enable access to markets. These also include the need to share insights more widely across the district, nationally and regionally.

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