# Pastoral mobility in a variable and spatially constrained South African environment

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## Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that it has not been previously in its entirety or in part submitted at any university for a degree.

Signature                                                                 Date

# Abstract

Pastoral mobility is viewed as ecologically rational and necessary to ensure livestock survival in environments which are characterised by variability and uncertainty. Around the world, mobile pastoral systems are becoming smaller and spatially constrained and there is a limited understanding of how pastoral mobility is adapted to rangelands of limited extent. This thesis sets out to establish how extensive pastoral systems have changed and investigated the role of the key legislative and policy influences on these changes. It examined the current key drivers of pastoral mobility and analysed the different movement patterns and their spatial extent within a spatially constrained environment. This thesis also investigated the role of vegetation type and condition in the distribution of grazing pressure and further discussed the implications of using variable stocking rates in a spatially constrained pastoral system.

The study was carried out in the 192 000 ha Leliefontein communal area located in the semi-arid region of Namaqualand in South Africa. The Leliefontein communal area is divided into ten unfenced village commons and is surrounded by private and land reform farms.

An analysis of the impacts of key legislation during five periods of political rule in South Africa on pastoral mobility showed that during the colonial era legislation resulted in pastoralists losing most of their grazing lands and they became unable to move over long distances into other agro-ecological zones. During Apartheid, legislation that promoted economic units to improve livestock production was not ecologically and economically viable due to the limited size of grazing camps and the restriction of herd mobility to access variable resources. Since democracy land reform was implemented to provide pastoralists with additional grazing lands but this opportunity has been taken up largely by the relatively more wealthy members of the communal areas.

An investigation into the key drivers of pastoral mobility from 1997 to 2006 in the study area showed that cold temperatures, livestock impacts on the rangeland, water

availability, rangeland condition and toxic plants are key environmental factors pastoralists consider before moving their herds. As opposed to larger pastoral systems, this study found that drought was not a key driver of mobility. Pastoral mobility was also strongly influenced by the need to protect growing crops from livestock damage as this prevents conflict with croppers and provides herds with important forage sites after the harvesting season. Decisions on herd movements were also affected by the need to be closer to the village due to personal reasons or when labour was required during the lambing and sowing seasons. Overcrowding conditions emerged as a key driver of mobility since it forced some pastoralists to move around to prevent herds from mixing. Herd mixing could have severe implications for reproduction and lambing percentages.

To assess the spatial scales of mobility between 1997 and 2006, I used a GIS analysis to examine the distances and patterns of stockpost movements in relation to resources and human settlements. Movement distances ranged from 0.1 km to 12.1 km within and 0.9 km to 31.8 km across village boundaries. By moving over these short distances, pastoralists could still move seasonally to avoid cold temperatures, access seasonal forage resources, protect growing crops and rest some pastures. Opportunistic movements were mainly employed to track resources while outmigration was used by some pastoralists when good quality forage was scarce in the communal area. Sedentarisation of herds is likely to increase due to a lack of competent herders and a reduction in water availability and the preference for village life as opposed to staying alone at a stockpost.

A GIS analysis on the effect of pastoral decision-making on the distribution of grazing pressures within the different vegetation types showed that during the winter months, Succulent Karoo as oppose to Fynbos vegetation was preferred by herds. Fynbos vegetation was, however, preferred by some pastoralists during the dry summer months. The benefits to pastoralists of using flexible and opportunistic stocking rates within different vegetation types include the ability to access key resource areas, to make optimal use of increased primary production during the wet periods and to rebuild their herds at faster rates after drought periods. Ecological implications however, include overgrazing of some vegetation types during their recruitment period.

The knowledge and understanding of short-range movements developed through this study could be regarded as a case study of how mobile pastoral systems that are becoming increasing smaller and spatially constrained can be managed in the future. The Leliefontein mobile pastoral system remains functional because it is built on strong social cohesion and the sophisticated ecological knowledge and management skills of pastoralists that have been developed over centuries. These attributes and the qualities of pastoralists themselves are crucial to ensure the continued existence of mobile livelihoods in a changing pastoral landscape.

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# Chapter One

## Introduction

### 1.1 Problem statement

Mobile pastoralism is a livestock production system that has been practiced for millennia in numerous ecosystems across the world. In arid and semi-arid environments mobility is a response to temporal and spatial variability in resources since it allows herds to optimally use vegetation, which varies in quality and quantity (McCabe, 1994; Schareika, 2001). Mobility also enables pastoralists to access water sources (Bassett, 1986; Penn, 1986; Behnke, 1999) and other key resource areas that are important for the survival of livestock during the dry season (Illius and O' Connor, 1999) and helps them to evade disease stricken areas (Touré, 1990; Homewood, 2008; Behnke et al., 2011). Socio-economic benefits of pastoral mobility include access to local and international markets (Touré, 1990; Adriansen, 2003; 2008; de Jode, 2010), evasion of conflict (de Weijer, 2007) and maintaining social ties with other pastoralists where ecological knowledge and livestock products are shared (Waller and Sobania, 1994; Samuels, 2006; Butt, 2010).

Throughout history, mobile pastoral systems have changed in order to adapt to dynamic social-ecological environments. As discussed later in this chapter, the factors that influence pastoral systems are complex, occur across several scales, and include environmental, socio-economic and political components (Dong et al., 2011; Flintan, 2011). A general trend has been for mobile pastoral systems to become increasingly spatially constrained and in many parts of the world pastoralists no longer have the option to move over long distances. For example, in pre-colonial Botswana, communal rangelands were managed by traditional institutions which allowed for inter-territorial grazing between unfixed tribal boundaries so that animals could access forage and water (Makepe, 2006). During colonisation, the British established administrative boundaries that restricted pastoral mobility and thus livestock's access to resources that vary in space and time. After independence, policies such as the Tribal Lands Grazing Policy of 1975 led to the privatisation of some communal lands. As a result, communal rangelands continued to shrink, pastoral mobility became constrained and increased pressure was exerted on the limited resource which led to overgrazing (Makepe, 2006).

The Leliefontein communal area in South Africa, which forms the focus of this study, has undergone several changes over the last 300 years. Before the Namaqualand region, which Leliefontein is part of, was colonised by European settlers, indigenous Nama pastoralists utilised millions of hectares of grazing lands which extended into southern Namibia (Blench, 2001). They were able to move over distances of up to hundreds of kilometers to the Orange River in the north or southwards to the Olifants River when environmental conditions were unfavourable for their livestock (Rohde and Hoffman, 2008).

In the late 1600's in the Cape, indigenous tribes allowed the Dutch access to their grazing lands based on a system of usufruct rights (Marinus, 1997) but the colonists viewed access to grazing as permanent. During the early 1700s there was an encroachment of colonists into Namaqualand and from 1750 to 1772, white farmers gained sole tenure of the land they occupied from the state (Penn, 1995; Webley, 1982). Leliefontein was established in 1816 as a mission station to protect the indigenous people from land hungry colonists and secure them access to some of their traditional grazing lands (Kotze et al., 1987). In 1854, Leliefontein was proclaimed a reserve (Melvill, 1890). The reserve was incompletely surveyed and white farmers encroached further onto reserve land. Between the early and mid-1900s, private farms were fenced off from the communal area and mobile pastoralists[1] in Leliefontein became spatially constrained.

Presently, Leliefontein is approximately 192 000 ha in size and informally divided into 10 unfenced village commons ranging from 12 000 to 25 000 ha in size. Despite being confined to relatively small areas within the broader Namaqualand region, Leliefontein pastoralists have managed to sustain large livestock populations for several decades (Todd and Hoffman, 2000).

*[1] A pastoralist in this thesis defined as anyone who owns at least one animal or identifies himself as a pastoralist even though he obtains most of his income from non-agricultural sources.*

There is a lack of understanding how mobile pastoralism has changed and adapted to the constraints imposed on it. This thesis aims to improve our understanding of herd mobility and the drivers of change in a spatially constrained pastoral system where resources availability still varies in space and time. Understanding the drivers of change in Leliefontein and how mobility has adapted, provides insights into how other mobile pastoral systems that are continually shrinking will be managed in the future. However, in order to do this, an understanding of pastoral mobility and the challenges pastoralists encounter is needed.

## 1.2 Background and Context

### *1.2.1 Understanding pastoral mobility in dryland ecosystems*

The perspectives on the use of pastoral mobility to counter the variability in natural resources differ between role players (Adriansen, 2008). Scientists view the use of mobility in drylands as ecologically rational whereas pastoralists say they use it to keep their animals in good condition (Adriansen, 2008). When countering environmental variability in pastoral systems, pastoralists have to move in response to certain factors within their grazing area. In some instances, one factor will be more prominent but usually a combination of factors is considered before a herd moves. To illustrate this, an example of Wodabee herd movements in West Africa is summarised in Box 1.



**Box 1**: **Exploiting seasonal variation in forage by Wodabee pastoralists**

A primary aim of the Wodabee herders in West Africa is to optimise herd production to maximise their income from market sales. To achieve this, they have to provide animals with the best nutritive fodder available during the different seasons including drought periods when forage is scarce and of poor quality. Before moving the herd, herders consider livestock condition, use their ecological knowledge of the grazing areas, negotiate access agreements with other pastoralists and croppers, and consider market locations and armed rebels. The Wodabee use long and middle distance transhumant[2] patterns to exploit seasonal forage abundance between ecological zones. When the

[2] *Transhumance is the regular seasonal movement of livestock (Niamir-Fuller, 1999b) and herding families (Beinart, 2007) between well-defined agro-ecological zones.*

survival of their animals becomes of increased concerned, they access sandy areas as opposed to clayey areas because of faster resprout after light rains even though toxic plants are first to emerge. These sandy areas are the only hope for survival since all animals are in poor condition. Wodabee also engage in short-range camp transfers when forage is depleted around the camps. - Schareika, 2001

Pastoral mobility is ideal for the Wodabee since it allows them to exploit rangeland resources which vary in space and time. When extensive mobile pastoral systems become smaller and spatially constrained, we might expect that livestock would not be able to optimise their quality and quantity of forage intake. This is because there would be reduced access to forage that might be outside the boundaries of the constrained area.



Transhumance is also practiced between altitudinal zones where herds are moved to lower altitudes to avoid cold temperatures as in the case of Lesotho (Turner, 2003) and Afghanistan (de Weijer, 2007). In Peru, transhumance is used to exchange goods not produced at certain altitudes with other communities (Sendón, 2009). Grazing reserves also play an integral part in transhumance systems such as in Kenya (Grandin et al., 1989; Oba, 2001; Letai and Lind, 2012) and Mongolia (Fernandez-Gimenez and Swift, 2003) where they serve as fall back areas in times of drought when pastoralists need access to dry forage.

In contrast to transhumance, nomadic movements are opportunistic and irregular at different times of the year (Fernandez-Gimenez and Swift, 2003). Opportunistic movements occur as a result of both push factors that force a herd out of an area and pull factors that attract a herd to an area. An example how push and pull factors determine the location and direction of herd movements of a Turkana herd in East Africa is summarised in Box 2.

**Box 2**: **Pastoral mobility amongst the Turkana in East Africa**

The low rainfall during 1980 in East Africa resulted in a lack of herbaceous vegetation and one Turkana herd moved to higher altitudes to seek better forage until the mid-dry season. The herd then moved south in search of better forage. The herder split his herd into milking and non-milking livestock presumably to minimise competition for resources. The non-milking herd was herded to other highland areas by a few of the herder's brothers. The non-milking herd was split again into strong and weak individuals. The weaker animals were taken to the flatter riverbanks since they were not in a condition to climb hills. However, the riverine area was prone to disease but its green vegetation was the only hope to ensure that at least some of the animals would survive the dry season. Meanwhile, the main milking herd was attacked by bandits from other tribes and two family members were killed and more than half of the herd stolen. To avoid further conflict, the rest of the herd moved northwards where the condition of the rangeland was poor while the non-milking herd remained in the southern areas. The separate herds joined when the forage became available on the central plains in the north.

- McCabe, 1994



During drought periods when primary productivity is low, resulting in forage scarcity for livestock, pastoralists may purchase supplementary feed for the animals (Vetter and Bond, 1999). However, not all pastoralists can afford to buy or have access to feed. Mobility is a strategy that pastoralists use to make maximum use of the availability of forage during droughts with minimal external input. In Zimbabwe, moving herds around during drought has resulted in more animals surviving a drought as opposed to herds that did not move (Scoones, 1992). The movement patterns of those herds are summarised in Box 3.

**Box 3**: **Pastoral mobility as a survival strategy during drought**

During the 1982-84 drought in Zimbabwe, Karanga pastoralists used opportunistic strategies to manage their cattle herds during this period of uncertainty. During the drought herders responded to the spatial and temporal variability in fodder resources by moving between key resource areas which were from clayey into sandy soil areas. Due to the influx of herds into the key resource areas, the available fodder became insufficient and cattle herds move out of the area. Firstly, they moved to the outskirts of a residential area and then some herds moved south to abandoned farms that had sufficient forage available. Other herds moved to the northern parts of the communal area and then illegally onto commercial ranches. Few herders hired grazing land from private land owners whereas other land owners allowed pastoral herds access to their land for free.

- Scoones, 1992

The study described above demonstrates the importance of mobility for livestock survival in Zimbabwe. The fact that these pastoralists have large grazing areas and options to move over long distances, allow them to evade drought conditions. In a spatially constrained environment, there might be insufficient space to move to areas where pastoralists could evade drought conditions and access key resource areas.

Croplands could also be regarded as key resource areas for livestock (Bayer and Waters-Bayer, 1989; Scoones, 1995a; Bennett et al., 2007). Combining cropping with livestock production may increase the total production per unit area since livestock graze on crop residues which are low-cost feed sources (Bayer and Waters-Bayer, 1989). Box 4 summarises how cropping plays a crucial role in the temporal and spatial movement patterns of pastoral herds occupying the grasslands of the Drakensberg Mountains in South Africa.



**Box 4**: **Pastoral mobility and cultivation**

The Zulu herders in the Drakensberg Mountains take their cattle herds deep into the mountains during the wet summer season. Non-lactating cattle are moved to the higher slopes away from growing crops on the lowland areas by herders who stay permanently with the herd. Lactating cows and oxen are moved into the nearby hills daily and return to their kraal in the village at night. After the oxen have been used to plough the lands, they too are moved deeper into the mountains to join the rest of the herd.

Time of movement into the mountains is made by a tribal leader but penalties are only imposed on owners whose animals damage crops and not for herds remaining on the lowlands. Oxen will return to the lowlands to transport harvested crops and then the rest of the herd move down the mountain during winter to graze on crop residues. Recently, there has been an increased concern about stock theft and most owners prefer to graze their animals close to the village to watch them. Then again, owners do not want to pay penalties for crop damages. - Chonco, 2009

Mobile pastoralists do not make their decisions in isolation. They still work within a community that has formal and informal institutions to regulate life. Box 5 summarises how a pastoral group, The Raikas, manages the decision-making process.



**Box 5**: **Management of decision making amongst Raikas pastoralists**

The Raikas in western India arrange themselves in several groups and each group has three centres of decision-making with regard to herd mobility. The three centres are the camp leader, shepherds and the camp council. The camp leader who is an experienced, knowledgeable and highly influential shepherd makes the decisions regarding the timing, direction and duration of migration; distance to travel; location of camps and interaction with outsiders for his group. Wrong decisions could lead to livestock mortalities and conflict with other land users, thus the camp leader bases his decisions on his detailed gathering of information about grazing areas and experience of other shepherds.

Decisions regarding long-range migrations are made after reconnaissance trips made over long periods by the camp leader. Shepherds make decisions regarding grazing, watering and treating sick animals in their individual flock within the confines of the area chosen by the camp leader. Shepherds also elect the camp leader. The camp council consists of five experienced persons who assist the leader with decisions regarding migration, market interactions and external relations. - Agrawal, 1993

The delegation of decision-making amongst Raika pastoralists ensures that there is control over decision-making and that responsibilities are distributed amongst all the interest groups within their herding camp. This informal institutional arrangement also ensures effective utilisation of available information, that economies of scale are promoted and that no person or group abuses their power and personally benefits from the decisions (Agrawal, 1993).

In other pastoral systems such as in Namaqualand in South Africa (Debeaudoin, 2001; Baker and Hoffman, 2006) decisions regarding the location of stockposts[3] are made by individual herd owners. This is because herds are kraaled separately and graze alone during the day (Samuels, 2006). The locations of stockposts are often in areas used historically by the owner or his family and are usually thus not contested by other herd owners. The selection of daily grazing routes of herds is made by the herder who bases his decision on a set of criteria (Allsopp et al., 2007). The selection of a daily grazing route might be contested by croppers if livestock graze on their growing crops. The local municipality does not actively enforce the grazing rules and usually leaves it up to land users themselves to resolve their disputes.

Nama pastoralists also benefit from economies of scale when they share costs of medicines and feed (Marinus, 1997). Other pastoral groups such as the Turkana of Kenya arrange themselves in groups during the wet season and separate into individual herds during the dry season when resources are scarce (McCabe, 1994). Separation into individual herds results in reduced competition for forage and water amongst the animals. Herding in smaller herds based on species, breed, animal condition or age of the herd allows for more efficient utilisation of resources and reduces stock losses through disease, predation and raiding (McCabe, 1994; Fernandez-Gimenez and Swift, 2003). Decision-making and institutional arrangements amongst mobile pastoral groups are variable and the strategy used depends on the local conditions and circumstances of pastoralists and their animals. Despite these variations, they gain similar benefits through their informal arrangements.

[3] *A stockpost is the living quarters for small stock herds and herders who stay with their animals at night. A stockpost consists of a corral (kraal) for confining animals at night, a sleeping shelter (khaya) for the herder and a cooking shelter (kookskerm).*

### *1.2.2 Understanding the factors that spatially constrain mobile pastoralists*

Mobile pastoralists are affected by changes in the environment, socio-economic pressures and political marginalisation that hinder their access to resources and services (Turner, 1999a; Nori and Davies, 2007). One area that has received considerable recent attention has been the conflict between protected area establishment and the effect this has had on the ability of pastoralists to move across traditional grazing areas (Ngoitiko et al., 2010). Mobile pastoralism has been particularly negatively affected by conservation initiatives when grazing space has been limited (Galaty, 2012). For example, the formation of a national park in Niger resulted in the park being at the centre of conflict because animals were herded through the conservation area to access resources on the other side (Turner, 1999a). In Kenya parks host important resources including water and salt licks that the Maasai depend on for the survival of their animals (Kipuri and Naikuni, 2008). Elsewhere in East Africa, mobile pastoralists near the Ngorongoro conservation area are restricted in accessing traditional grazing resources (Galaty, 2012). This is because conservation policies are based on the segregation of people and wildlife and thus human activities are restricted in game controlled areas (Ngoitiko et al., 2010).

In South Africa, a few contractual parks have been formed to ensure that conservation and other land uses can co-exist (Grossman and Holden, undated). However, this system of conservation is complex and poses several challenges to park management. Box 6 summarises challenges posed by mobile pastoralists within the Richtersveld National Park in semi-arid South Africa.



**Box 6**: **Pastoral mobility and the challenges facing biodiversity conservation**

The Richtersveld National Park is the first contractual park in South Africa where livestock farming and conservation co-exist. Pastoral herds are allowed inside the park but the number of herds and animals are restricted. About 31% of the park is considered conservation worthy because of the occurrence of rare and endemic species as well as sensitive habitats. Between 1995 and 2001, 64% of the conservation worthy sites were grazed by livestock and the park management was concerned about degradation. To reduce the impact of grazing on the conservation worthy sites, restrictions on the movement of herds and establishment of new stockposts are now regarded as the only viable options to the park management. Destocking is unpopular amongst the herders and was not an option when agreements were made between the park and the herders. Fences are also not suitable because of the visibility to tourists. - Hendricks, 2004

Changes in climates that lead to diseases expanding the risk of transmission over larger spatial scales might result in animals not being able to graze in certain areas. This was the case in Zimbabwe where herd mobility was restricted between disease zones during an outbreak of Foot and Mouth Disease which reduced long-range movements (Scoones, 1992). Similarly, African horse sickness periodically expands its range from sub-Saharan Africa (Mellor et al., 2000). This might restrict pastoral mobility into these regions since pastoralists often use equines to transport their possessions during migrations. As a result, herds might become spatially constrained since some parts of their rangeland will no longer be available for grazing.



There are between 100 and 200 million mobile pastoralists around the world (FAO, 2003 cited in Davies and Hatfield, 2007) and these pastoral communities could be expected to by grow in the future. The growing pastoral community may struggle to find enough land for grazing if all households in the community continue to practice livestock keeping. As the human populations around pastoral communities also continue to grow, governments see this as a growing market for meat and other animal products. In Africa, pastoral herds produce between 50 to 75% of the continent's milk and meat (de Haan et al., 1997 cited in Galvin et al., 2008) and the demand for animal products is expected to increase significantly by 2025. Governments therefore want mobile pastoralists to settle down and become commercialised in order to satisfy this increase in demand.

In agro-pastoral systems, it is the more productive pastures that are used for cropping and these are usually key grazing sites for pastoralists (Niamir-Fuller and Turner, 1999; Bassett and Turner, 2007). The use of land as migration routes by pastoralists to access seasonal resources are contested by non-pastoralists or foreign investors who want to use the land for other purposes such as cultivation (Lengoiboni, 2011; Galaty, 2012). In

Sudan, migration routes are increasingly becoming narrower and shorter due to the encroachment of cultivated fields (Babiker, 2012). In Lesotho, mobility has declined partly due to crop expansion onto historical grazing lands (Turner, 2003). It has been widely reported that conflict sometimes arises between herders and croppers over crop damages (Bassett, 1986; Fratkin, 1997; Shazali and Ahmed, 1999; Touré, 2004). An increase in rainfall in certain areas could result in further encroachment of cultivation into pastoral lands (Kirkbride and Grahn, 2008). In contrast, a decrease in rainfall and an increase in rainfall variability could lead to an area becoming more marginal which could result in the abandonment of cropping because it will be too risky (Hoffman and Vogel, 2008). For example, Jones and Thornton (2003) used simulation models to assess the possible impacts of climate change on maize yields and show that overall crop yields could decrease by 10% by 2055 in Africa and Latin America. The implications of a decrease crop yields would be that people's livelihoods might become more dependent on livestock products and that cultivated lands might be used again as rangelands for pastoral herds in these areas.



The Pashtunistan conflict during the 1960s resulted in the borders between Pakistan and Afghanistan being closed and Afghan nomads were prevented from accessing their traditional winter grazing areas. This resulted in a permanent change in grazing patterns of Afghan nomads who had to seek alternative winter forage inside their own borders (de Weijer, 2007). Stock theft is a major concern for pastoralists near the South Africa-Lesotho border (Salomon et al., 2013) and elsewhere in Lesotho where it resulted in a decrease in transhumance and underused areas as herders are afraid to graze some areas (Turner, 2003). In Uganda, Jie pastoralists started to vacate remote areas in the 1990s where they obtained good quality wet season forage and settled in areas with high human densities as a defense strategy against conflict and raiding (Niamir-Fuller, 1999a).

Colonial and post-colonial governments have also used discriminatory policies to grab land from indigenous pastoralists (Galaty, 2011). For example, in Sudan state policies continue to advocate privatisation of grazing land. Due to privatisation, traditional grazing patterns and coping strategies of pastoralists have been disrupted resulting in them being more vulnerable to the impact of droughts (Babiker, 2012).

Mobile pastoral systems are continually shrinking and short-range migrations are being more used as a strategy to manage herds as long–range movements are no longer possible. Studies that have described certain aspects of short-range movements in pastoral systems are mainly from a few individual herds under drought conditions (e.g. Grandin et al., 1989; McCabe, 1994) whereas other studies (e.g. Turner, 1999a; de Weijer, 2007; Behnke et al., 2011; Akasbi et al., 2012; Dongmo et al., 2012) described short-range movements where it is practiced in conjunction with longer-range movements. In Niger, pastoralists use short range movements of 5-20 km to move away from growing crops and to permanent water sources during the late dry seasons (Dupire 1972 cited in Tuner, 1999). They also move over longer distance of up to 50 km to access better forage after the early rains. In Afghanistan, short-range movements account for 33% of migratory patterns and are used during times of war when pastoralists do not want to be far away from home. Short-range movements are also used when herds are small and livestock do not have to move far due to less competition for food within the herd (de Weijer, 2007). Long range movements, which account for 52% of migratory patterns in Afghanistan, occur across provincial and national boundaries and are used to access seasonal grazing resources (de Weijer, 2007). About 15% of herds do not migrate as some pastoralists have obtained ownership of the land. Other pastoralists have not moved since they consider the risk of losing animals during migrations too high.



Historically, in Sudano-Sahelian West Africa, long-range latitudinal movements of up to 500 km occurred to access nutritional grasses in the north during the rainy season and during the dry season herds moved to the south to be closer to water (Behnke et al., 2011). Movements between 15 to100 km occur towards floodplains during the dry season due to the abundance of water and better forage and away from the floodplains during the wet season to avoid deep water and diseases.  Short-range movements between 3 to15 km occur around human settlements and water points (Behnke et al., 2011).

Long and short-range movements are very crucial in dryland ecosystems in order for mobile pastoralists to meet specific objectives. However, when mobile pastoral systems in drylands become smaller and spatially constrained and long-range movements are no longer possible, we need to determine whether short-range movements will still be effective in managing livestock and rangeland resources. Our understanding for short-range movements within mobile pastoral systems is limited. This thesis aims to improve our understanding of short-range movements by studying the movement patterns of pastoral herds in the spatially constrained Leliefontein communal area.

### *1.2.3 Pastoral mobility in Namaqualand*

Allsopp et al. (2007) examined the management of selected herds in four villages in the Leliefontein communal area and developed a daily grazing route model around stockposts to understand the grazing patterns of individual herds. Their study demonstrated the variability and complexity in decision-making by pastoralists on when and where to graze their animals. Allsopp et al. (2007) also developed a typology of daily herding practices in normal rainfall years. Samuels (2006) extended the typology to include herd management during drought periods in Paulshoek, one of the villages that forms part of the Leliefontein communal area (Fig. 1.1). These typologies were based on several factors that included: whether the herder or the animals select the daily grazing route; how long the herder stays with the herd during the grazing period; whether animals are actively directed by the herder or whether the herder only follows the herd to look out for predators; and how the herd returns to the stockpost in the late afternoon.



Samuels et al. (2007) investigated micro-mobility that entailed examining daily grazing routes of herds during a drought period in Paulshoek village. They determined the size of the daily grazing area, how often herds rotate their daily grazing routes and how often herds graze the same patch within their grazing area around stockposts. The study identified mountains as key resource areas for herds during the drought period. It was also found that a trade-offs exists since not all the animals are in good physical condition to climb steep mountains daily in search of better forage. However, some animals might have to be sacrificed so that the rest of the herd could survive the drought.

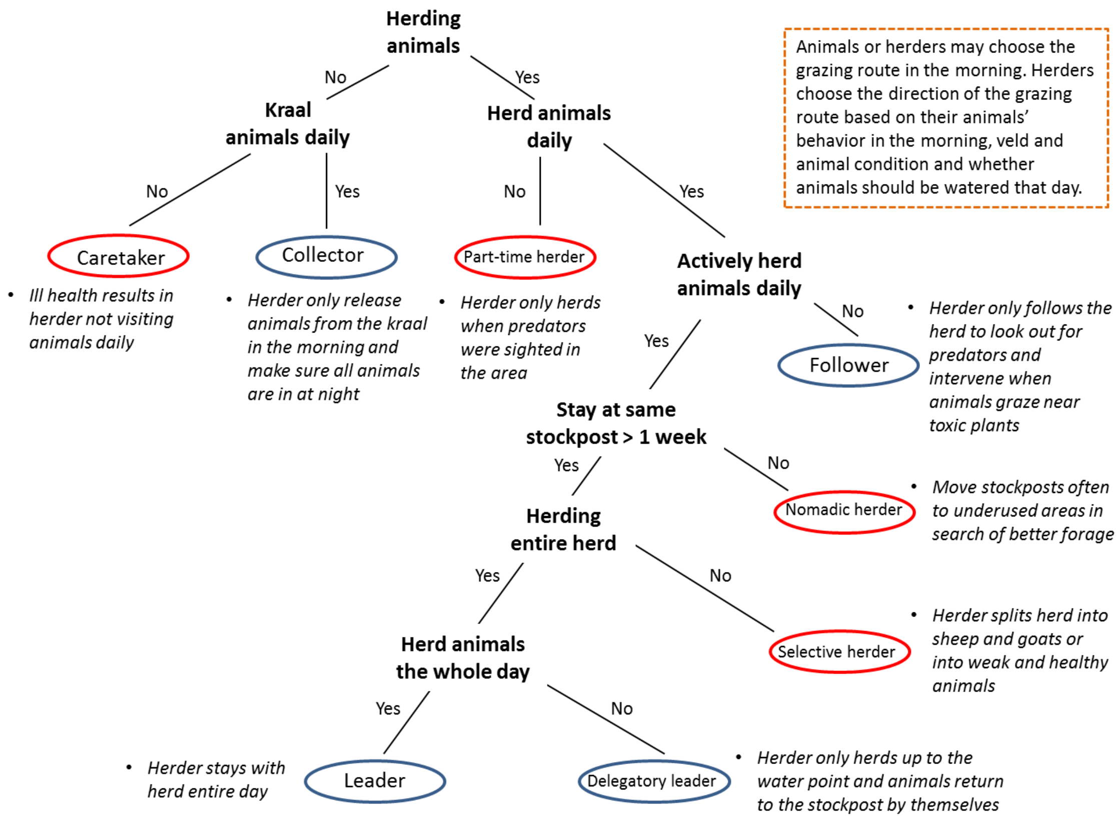


**Figure 1.1**: The typologies of herding strategies identified during normal rainfall years and a drought period in the Leliefontein communal area (Allsopp et al., 2007; Samuels, 2006). Herding strategies in red were identified only during the drought whereas the strategies in blue were found in both normal rainfall years and the drought period.

We need to understand pastoral mobility at a macro level to assess how other factors such as human settlements and climatic variability influence mobility patterns. We also need to understand how seasonal and annual variability in resources affect pastoral mobility and whether mobile practices constantly change or have stabilised in this dynamic environment.

Baker and Hoffman (2006) investigated stockpost movements of 24 herds over a period of six years in Paulshoek village and assessed environmental and non-environmental factors affecting herd movements. Half of the herds were identified as sedentary while the others were relatively mobile and herders made movement decisions based on social, economic, or personal situations. Pastoral mobility resulted in lower grazing pressure around stockposts than sedentary herds. However, this village is not isolated as it is one of ten village commons in Leliefontein and thus this study could not capture the effect of inter-village herding dynamics. Baker and Hoffman (2006) also did not investigate pastoral mobility in relation to heterogeneity in vegetation.

In the Richtersveld National Park in Namaqualand, pastoral mobility is dictated by conservation objectives rather than herder's choice of grazing sites (Hendricks, 2004). Factors that would affect pastoral mobility patterns are those that would threaten the conservation status of an area and thus grazing would be prohibited in that area. Moreover, the fact that livestock compete directly with indigenous herbivores for space, food and water means that the number of herds inside the park are limited to 26 or an equivalent of 6 000 small stock units (SSU). Conservation concerns are not significant factors regarding decision-making in Leliefontein and thus mobility is likely to be influenced by factors other than conservation.

Mobile pastoral systems are complex and dynamic and to understand them it is crucial to consider all the factors that affect pastoral mobility. Also, we need to understand how different levels of management within a pastoral system interact. This study will analyse pastoral mobility at a herd, village commons and communal rangeland level.

### 1.3 Objectives of this study

The overall objectives of this study were to determine and discuss the extent to which pastoral mobility still occurs in the variable environment of the Leliefontein communal area, how mobility has changed over time and space and what are the key drivers for these changes. This thesis analysed the roles of socio-economic and agricultural factors as well as rangeland resources, including the unique vegetation of this semi-arid biodiversity hotspot, in pastoral mobility. This study also identified and discusses which aspects of mobile pastoralism are lost, changed or maintained when environments become spatially constrained. In addition this study analysed which new strategies (including those that do not depend on mobility) emerge under a spatially constrained environment.

To achieve these overall objectives, specific objectives, related to each of the four main data chapters, included the following:

1. To examine how the mobile pastoral system in the Leliefontein communal area has changed over time and space;
2. To understand the key drivers of changes in pastoral mobility in this variable and spatially constrained environment;
3. To analyse the spatial scales of pastoral mobility in relation to resources and human settlements in a constrained pastoral system;
4. To assess and discuss the effect of different vegetation types in the study area on pastoral mobility and how grazing affects the conservation of the flora of the region.

## 1.4 General Approach, Research Design and Thesis Structure

Chapter One contextualises the study and sets out the study objectives. It also provides a justification for the study. Chapter Two describes the physical environment of Leliefontein and the lifestyles of the people inhabiting this environment. Chapters Three to Six are in the format where research questions are asked, the methods and statistical treatment outlined, results interpreted and discussed to answer those questions.

- Chapter Three documents and discusses the historical changes in the Leliefontein pastoral system as a result of past and present legislation. I identified the key bits of legislation that were promulgated during five periods of political rule in South Africa and analysed its impacts on the geography of pastoral mobility in Leliefontein. I also examined the literature and archival records such as government reports and private correspondence kept in state libraries which refer to specific legislation and the time period of its implementation. Furthermore, I examined this material to see if any impacts of legislation on the mobility of herds were recorded.
- Chapter Four analyses and discusses the decisions that were made in relation to temporal changes in rangeland resources, climatic conditions and socio-economic conditions to affect pastoral mobility from 1997 to 2006 in Leliefontein. It also outlines when and why pastoralists moved their herds. I conducted interviews with pastoralists at stockposts or in the field while livestock was being herded in

order to get a better understanding of the herd's environment and herder's reasons for using certain management strategies.

- Chapter Five examines and discusses herd movements in this spatially constrained semi-arid environment and whether these patterns changed between 1997 and 2006. I conducted interviews with pastoralists and used GIS to analyse temporal and spatial patterns of herd movements in relation to resources and human settlements.
- Chapter Six examines and discusses the distribution of grazing pressure within the major vegetation types found in the study area. I calculated grazing densities at each stockpost using livestock censuses from a range of sources. A grazing density map was produced using GIS and was overlaid onto the vegetation map of southern Africa (Mucina and Rutherford, 2006). The vegetation map of southern Africa identifies 440 vegetation types. This fine scale map with its detailed descriptions defines a vegetation type based on the dominant and rare plant species in the landscape and how these species are associated with the physical environment (Mucina and Rutherford, 2006). In the Leliefontein communal area, nine vegetation types have been identified and their distribution boundaries have been refined by Helme and Desmet (2006).

The thesis concludes with Chapter Seven which provides a synthesis of the knowledge gained in this study and makes recommendations regarding future research that would further improve our understanding of pastoral mobility in other variable and spatially constrained environments.

# Chapter Two

## Study Area

### 2.1 Introduction

Pastoralists and agro-pastoralists need to know their environment very well in order to make informed management decisions. This chapter first describes the biophysical environment of Leliefontein. Secondly, it describes the people who occupy these environments and their diverse land use activities.

### 2.2 Geographical Location

There are six communal areas (formerly known as Coloured Reserves under the apartheid government of South Africa before 1994) in Namaqualand. The Leliefontein communal area, comprised of about 192 000 ha is one of the six areas and is situated in Namaqualand in the northwestern part of South Africa (Fig. 2.1). The communal area is divided into 10 village commons with unfenced and permeable boundaries. Village commons vary between 12 000 and 25 000 ha in size. Leliefontein is surrounded by 84 farms which include: seven communal farms that are owned by the local municipality and 77 privately owned farms. The average size of the adjacent communal farms is 6 283 ha while the adjacent private farms average 1 615 ha in extent. Between 1998 and 2001, five of the seven communal farms (which are located on the eastern boundary of the communal area) were acquired through the Land Reform Programme of South Africa for the residents of the ten villages. The other two communal farms are used by the residents of Garies, which is a nearby town that borders the Kheis village commons.

### 2.3 Landscape

Leliefontein extends across the Kamiesberg mountain range in an east-west direction. Altitude in the lowlands in the western parts of the communal area is about 250 m above sea level. Villages located in the lowlands are Spoegrivier, Kheis and Klipfontein. In the uplands near Leliefontein[4] village the altitude is about 1 350 m above sea level. On the

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[4] *Leliefontein is also the name of one of the 10 villages in the Leliefontein communal area. In this thesis I will refer to the communal area as Leliefontein and the village as Leliefontein village.*

plateau in the east around Rooifontein and Kamassies villages the height is about 800 m above sea level. The villages of Kharkams, Tweerivier, and the western parts of Nourivier and Paulshoek villages are located on the Kamiesberg escarpment.

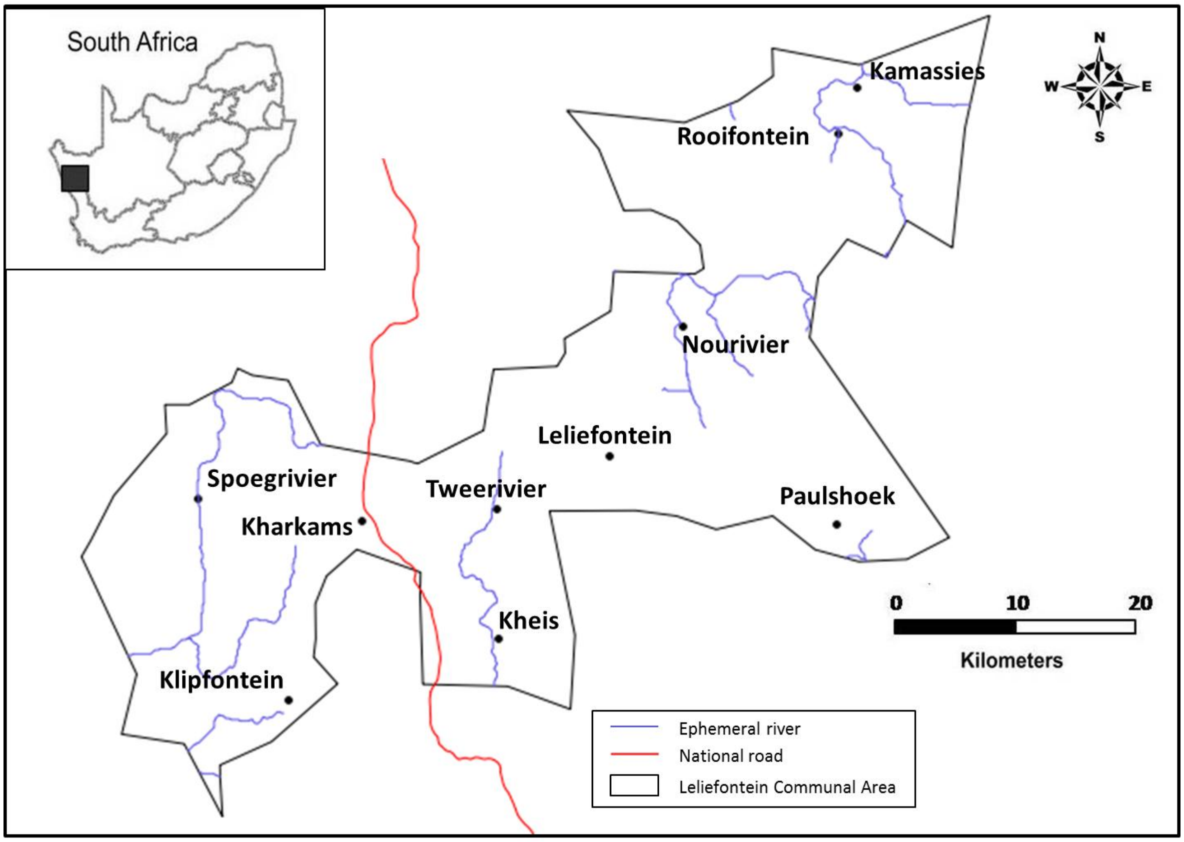


**Figure 2.1**: The location of the Leliefontein communal area in Namaqualand, Northern Cape Province of South Africa.

The uplands and escarpment are characterised by large granite gneiss boulders, inselbergs and steep mountains. The topography in the lowlands in the west and the plateau in the east is flatter and sandy due to fewer gneiss intrusions.

All the rivers within the communal area are ephemeral and flow only for short periods during the winter months and after occasional heavy summer rainfall events. Groundwater is the primary source of water for domestic use and livestock in all the villages (Fig. 2.2). Herders who live at stockposts transport drinking water from the villages or from springs up in the mountains. This is because most of the livestock boreholes deliver water with a high concentration of salts and other minerals which render the water unfit for humans (Titus et al., 2002). In Paulshoek village, water from boreholes for domestic use is usually mixed with rainwater, if available, before it is piped to the homes.

**Figure 2.2**: A pastoralist filling the trough with water from a hand dug well for his animals.



## 2.4 Soils

Soils on the western side of the study area near Spoegrivier village consist mainly of deep red, yellow and grey sands. Soils of upland areas and the escarpment are shallow, red soils on dorbank especially in the flatlands between the mountain ridges. On the eastern boundary of the study area, shallow red sandy soils are underlain by calcrete and dorbank on the plains (Ellis, 1998 cited in Francis et al., 2007).

The physical and chemical properties of soils affect biodiversity distribution (Petersen et al., 2004) as well as ecosystem function in Namaqualand (Francis et al., 2007). However, nitrogen distribution patterns are also influenced by organic matter accumulation in the soils around shrubs. Soil moisture levels in the landscape are also patchy since perennial shrubs take up water after rainfall events and thus deplete soil moisture faster than open areas which do not have perennial shrubs (Allsopp, 1999). Cultivation of soils on the flatlands results in the loss of soil nutrients (Allsopp, 1999).

## 2.5 Climate

Temperatures in the communal area during the summer months from December to February may exceed $40^{0}$C, particularly in the lower-lying areas. In the winter months (May to August) temperatures often fall below freezing, particularly in the higher-lying areas where snow may fall and sleet is not uncommon. Rainfall occurs predominantly during winter but summer rainfall increases towards the east (Fig. 2.3). Over the last 100 years, the mean annual precipitation for Leliefontein village in the uplands is 392 mm (CV=0.44) and 145 mm for Garies, a town adjacent to Kheis village in the lowlands (CV=0.35) (South African Weather Service Unpublished data). Figure 2.4 shows the mean annual precipitation during the 10 year study period from 1997 to 2006 that was recorded from seven weather stations located in and around Leliefontein.

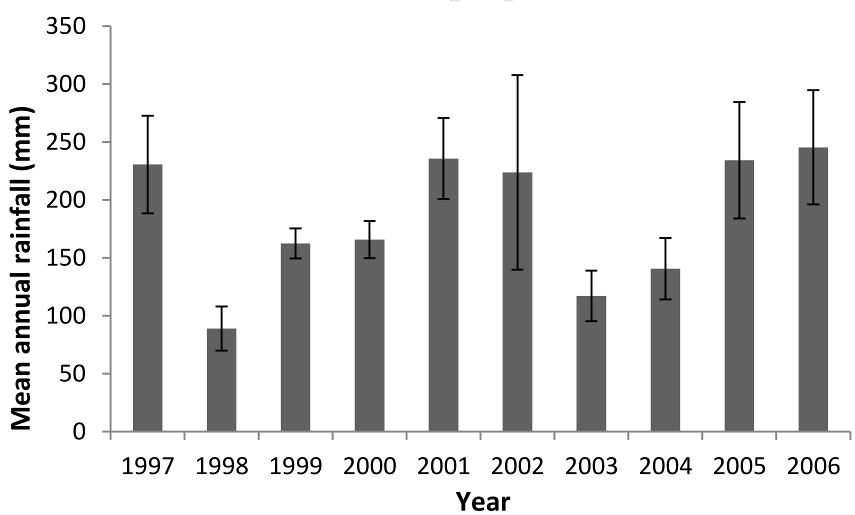


**Figure 2.4**: The mean annual rainfall recorded between 1997 and 2006 in and around the Leliefontein communal area (South African Weather Services Unpublished data; MT Hoffman Unpublished data).

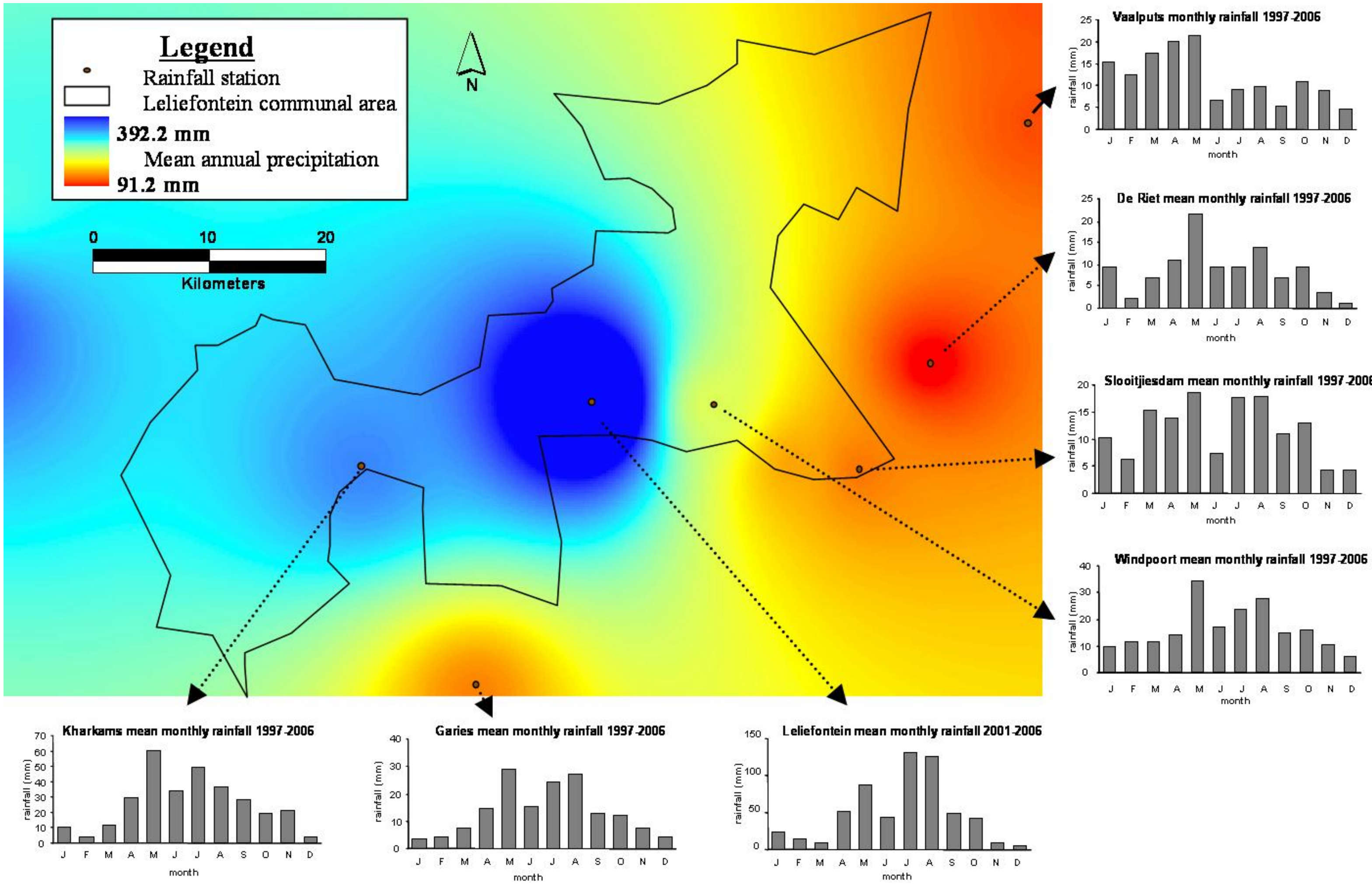


**Figure 2.3**: Interpolated mean annual rainfall for the study period (1997-2006) in and around the Leliefontein communal area. The map was produced from data of the seven weather stations shown above. The bar graphs indicate the mean monthly rainfall at the specific weather stations (South African Weather Services Unpublished data; MT Hoffman Unpublished data).

## 2.6 Biodiversity

### *2.6.1 Fauna*

Historically, Namaqualand supported a wide variety of indigenous mammals which are now extinct in the region. These included *Equus zebra hartmannae* (Hartmann's mountain zebra), *Antidorcas marsupialis* (springbok), *Oryx gazelle* (gemsbok), *Alcelaphus buselaphus* (Red hartebees) and *Pelea capreolus* (Grey rhebok) (Skead 1980 cited in Landman et al., 2006). If some of these species were to be re-introduced then livestock populations will have to be reduced because these animals compete for the same resources (Landman et al., 2006).

Presently, the study area still contains a wide variety of indigenous invertebrate, reptile, bird and other mammal species. 164 insect species have been recorded in the uplands area alone of which 80% are endemic to the biome (Colville, 2006). Mammal species that occur in the study area include herbivores such as *Lepus capensis* (Cape hare), *Procavia capensis* (Cape hyrax), *Raphicerus campestris* (steenbok) and *Oreotragus oreotragus* (klipspringer) and carnivores such as *Canis mesomelas* (Black-backed jackal) and *Felis caracal* (rooikat). Both of these carnivores prey on livestock and are thus viewed as pests to livestock keepers.



### *2.6.2 Flora*

The study area forms part of the Succulent Karoo biome, a biodiversity hotspot of global significance that supports the world's richest succulent vegetation (Cowling et al., 1999). The Succulent Karoo has been identified as the biome most threatened from climate change in South Africa (Rutherford et al., 2000). This biome contains 4 750 plant species (Cowling and Hilton-Taylor, 1994) and Namaqualand contains 75% of the hotspot's plant species (Cowling and Pierce, 1999). Nine vegetation types occur in the study area (Table 2.1) (Mucina and Rutherford, 2006) including Renosterveld (Fig. 2.5), which is one of the most threatened vegetation types in South Africa (Winter et al., 2005). The vegetation of the Leliefontein communal area will be discussed in greater detail in Chapter Six.

**Table 2.1**: The nine vegetation types found in the Leliefontein communal area and their proportion relative to the total size of the study area (Mucina and Rutherford, 2006).

| Vegetation type | Proportion in relation to the study area (%) |
|---|---|
| Kamiesberg Granite Fynbos | 1.8 |
| Kamiesberg Mountains Shrubland | 6.0 |
| Namaqualand Blomveld | 20.3 |
| Namaqualand Granite Renosterveld | 6.8 |
| Namaqualand Heuweltjieveld | 11.2 |
| Namaqualand Inland Duneveld | 0.6 |
| Namaqualand Klipkoppe Shrubland | 52.3 |
| Namaqualand Riviere | 0.9 |
| Namaqualand Sand Fynbos | 0.1 |

**Figure 2.5**: Renosterveld landscape in the uplands where livestock is grazing in a patch of ephemeral wetlands around the watering point.

Heavy grazing due to overcrowding in communal areas has resulted in significant changes in the vegetation (e.g. Todd and Hoffman, 1999; 2009). In flatter areas, abandoned croplands and areas in close proximity to stockposts and livestock watering points, perennial palatable shrubs have generally been replaced by shrubs unpalatable to livestock (Todd and Hoffman, 2000; Riginos and Hoffman 2003; Anderson and Hoffman, 2007). The dominant unpalatable woody shrubs that establish on these disturbed areas are *Elytropappus rhinocerotis* (renosterbos) in the uplands, *Hermannia amoena* (jeukbos) on the plateau and *Galenia africana* (kraalbos) in other parts of the communal area. Annual plants have also increased in abundance and cover in areas with the greatest grazing densities (Todd and Hoffman, 1999).

## 2.7 Land use

In Namaqualand, extensive livestock farming on communal areas and private farms is the main land use. Irrigated commercial agriculture mainly occurs along the Orange and Olifants Rivers. Diamond mining occurs on 397 000 ha (7.54%) of the land along the Namaqualand coast. Several copper mines are still operational in towns around Springbok, the main town in Namaqualand. Formal conservation occurs in the Namaqua National Park (141 000 ha) and Goegab Nature reserve (15 004 ha) where no other land use is allowed. In the Richtersveld National Park, however, which borders on Namibia, communal livestock herds are allowed to move in and out the park. This protected area is managed as a contractual national park where livestock numbers are regulated. Conservation stewardship agreements are also currently being developed by the NGO, Conservation South Africa in association with land users on communal and private lands.

There are 420 private farms in Namaqualand which occupy about 52% of the area while communal lands occupy 30% of the area (May and Lahiff, 2007). Livestock farming on private farms is mostly profit driven and animals are managed through a rotational grazing system with the use of multiple paddocks which are referred to locally as ‘camps’. These practices were promoted by subsidies and legislation from the 1950s onwards for white farmers. Most private farm owners have more than one farm which in some cases are located in a different agro-ecological regions (Van Zyl, 1957; Rohde and Hoffman, 2008) providing these land owners with the opportunity to move their livestock seasonally between farms. Moving between agro-ecological zones in response to drought and variation in resources mimics the transhumance patterns adopted by Nama-pastoralists before Namaqualand was colonised (Webley, 1986; Rohde and Hoffman, 2008). Commercial farming is a profit driven enterprise where meat is produced for national and international agricultural markets.

There are two main types of communal tenure in the Northern Cape Province. Municipal commonages are owned by local municipalities and include land acquired by the Department of Land Affairs after 1994 through South Africa's Land Reform programme. In addition, six historic communal areas in the Northern Cape are held in trust by the Minister of Land Affairs for the people of the region and services are provided by local municipalities.

Municipal commonage holdings include 367 817 ha which are owned by municipalities in the Northern Cape alone, excluding the large Namaqualand and Mier areas (Benseler, 2003). These sizes should increase dramatically as the Land Reform programme of South Africa aspires to transfer a total of 30% of agricultural land of the country to previously disadvantaged people by 2014. Municipal commonages are managed on a camp system[5] whereby a fenced paddock (camp) is rented out to an individual or a group of farmers. Stocking rates are fixed according to regulations set out by the Department of Agriculture. There are instances where more than one camp is rented out to the same person or group of people, usually the wealthier farmers (Lebert and Rohde, 2007). Since all the camps are rented out at the same time, farmers cannot practice rotational grazing. With the camp system, as opposed to an open grazing system without the use of fences, there is no means for people to move to better grazing areas when environmental conditions are unfavourable. However, the municipality insists that the land is best managed by using camps. Prior to 1994, grazing rights on municipal commonages were awarded to individual white and coloured[6] farmers at a nominal fee. These farmers either

[5]*A camp system refers to a grazing system whereby livestock is rotated between three or more fenced paddocks seasonally or at temporal intervals depending on factors that include rangeland condition, water availability and grazing pressure.*

*6 Under the apartheid government in South Africa, the population was classified into three racial groups and these groups were treated differently as a consequence of legislation. The three groups are the natives (blacks of Bantu descent), whites (European descent) and coloureds (people that are neither white nor of Bantu descent).The people of Namaqualand were classified as coloureds.*

had access to other grazing lands or were awarded access to the entire municipal commonage.

The six communal areas (Fig. 2.6) are approximately 1 010 703 ha in total size and have been stocked at 1.6 times the recommended stocking rate between 1974 and 1997 (Northern Cape Veterinary Services Unpublished data). This excludes the cattle population of between 500 and 1200 individuals during this period for four of the areas combined and the equine population (horses and donkeys) which could be several thousand animals in the six communal areas. As in other communal areas of Namaqualand (Hendricks, 2004), small stock herds which include sheep and goats are aggregated at stockposts scattered around the rangeland. Various breeds of sheep (*Ovis aries*) are kept in Leliefontein which include Dorper, Damara, Karakul, Persian and indigenous Afrikaner breeds. However, rarely do we find pure breeds in the study area since pastoralists usually crossbreed their livestock to ensure that their animals are adapted to the variable climatic conditions and to ensure good quality mutton sheep. Pastoralists only keep boer goats (*Capra hircus*) but there are a few people who keep one or two Swiss breeds at their stockposts for milk which they use for home consumption or when a ewe dies or abandons her lambs. Small stock herds on the communal area are managed by herders who have developed several herding strategies as a response to environmental and social drivers (Samuels, 2006; Allsopp et al., 2007).

In Namaqualand, as in other pastoral systems in East Africa (Fratkin, 1986), different livestock species are kept for different reasons. Livestock numbers in the communal area have also varied significantly over the years (Fig. 2.7) and are closely related to fluctuations in annual rainfall (Todd and Hoffman, 2000). There has also been a significant change in the type of livestock species using the rangelands in the region. For example, in 1853, about 2 170 cattle were recorded in the Leliefontein communal area (Mellvill, 1890) but in 2002 this number had declined to only 354 animals (Fig. 2.7). The

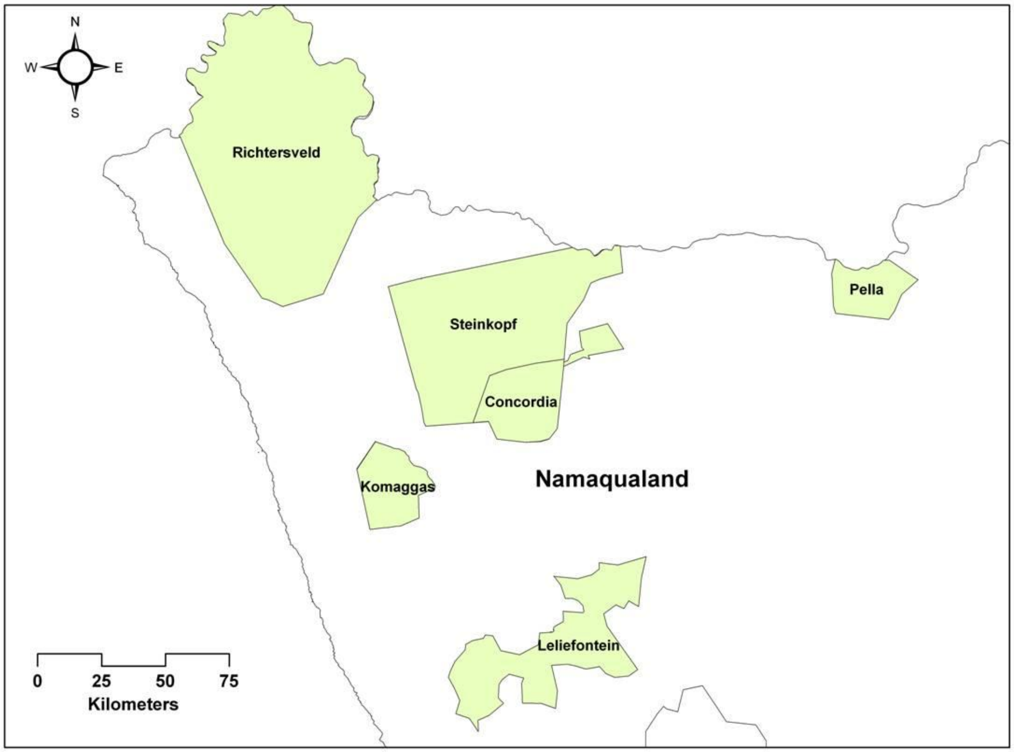


**Figure 2.6**: The locations of the six communal areas in Namaqualand, Northern Cape Province of South Africa.

decline in cattle is thought to be due to the decline in suitable habitats for cattle, the reduction in effective grazing area available to communal area farmers and the lower risk associated with the keeping of small stock as well as the better market opportunities for small stock (MBV Swarts Unpublished data). Presently, cattle are kept mostly in the eastern parts of the communal area near Kamassies village where perennial grasses are abundant. Cattle are also kept in the uplands where numerous small wetland areas provide reeds and grass for grazing (Fig. 2.8). It is estimated that the Leliefontein communal area supports an additional 2 000 donkeys. Most of these donkeys are feral although some are used for transportation or occasionally for draught power. Wild donkeys are regarded as a problem since they compete for grazing, damage crops and food gardens or injure lambs.

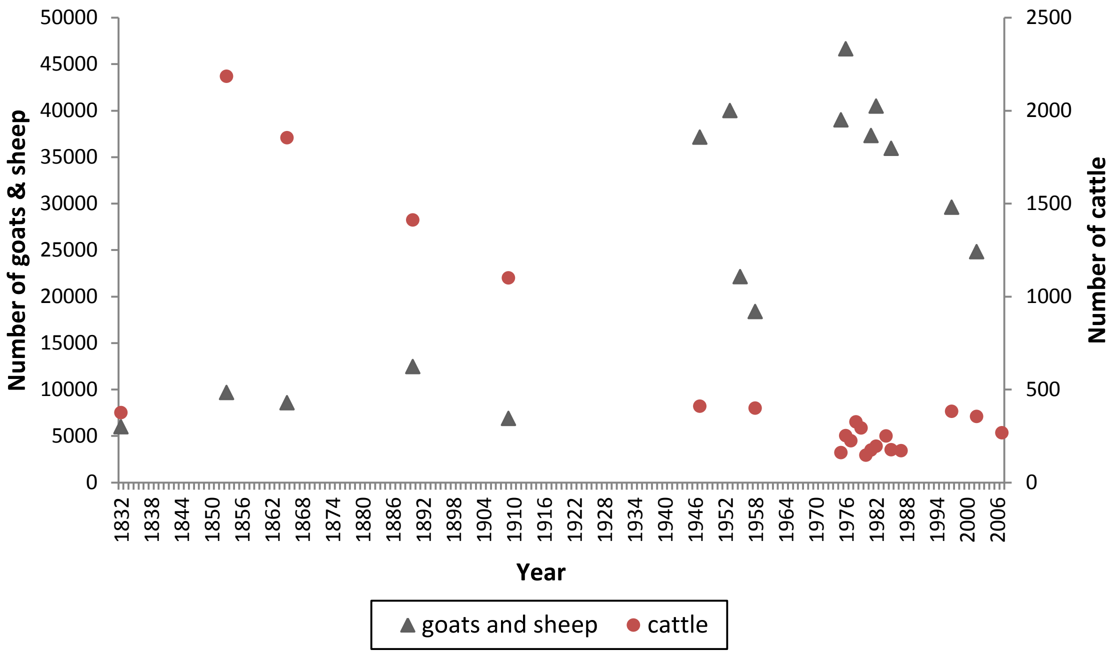


**Figure 2.7**: The number of small stock (goats & sheep) and cattle recorded between 1832 and 2007 in the Leliefontein communal area. Data was gathered from multiple sources[7].

**Figure 2.8**: Cattle graze mostly in ephemeral wetlands in the uplands during the dry season.

[7]Kamiesberg Local Municipality Unpublished data; Agri-Kameelkrans Farmers Union Unpublished data; May, 1997; Northern Cape State Veterinary Services Unpublished data; MT Hoffman Unpublished data.

There are  a range of other land use activities in the communal area including firewood harvesting, medicinal plant collection, harvesting of reeds to build traditional '*matjieshutte*' (reed mat houses) and food gardening. Dryland cropping is also practiced on the flatter, deeper soils of valley bottoms.  Croplands comprise 12% of the total area and consist of 559 rented units ranging from less than 1 ha to 302 ha in size.

Ninety-five out of the 117 croppers (81%) that cultivated their land during the study period owned livestock. However, most croppers did not have their own herds but kept their animals with other pastoralists whom they are related or have good social relations. Access rights to croplands are retained by an individual as long as the annual rental fee is paid. This right is inherited customarily by a family member.  The most common crop grown in recent decades is oats which is sown during winter. The grain and straw are used as fodder for livestock, particularly during dry periods when the rangeland is in poor condition (Fig. 2.9). Wheat, as a source of food for people or for sale, is cultivated on a relatively small scale.  Other crops grown for livestock fodder are barley, rye and lucerne.

**Figure 2.9**: Livestock grazing on the stubble after the crops have been harvested.

The relatively low rainfall is the main environmental constraint to crop farming in the area. Crop farmers will usually only sow and plough if there are good rains before mid-August.  Harvesting takes place towards the end of November or early December. Croplands are traditionally regarded as open grazing lands after the crops are harvested but individuals seek to retain rights to graze their stubble.

## 2.8 The people of Leliefontein

The latest complete population census in 2001 for the Leliefontein communal area indicated that there were 7 571 people within 1 399 households in the region (Atkinson and Ravenscroft, 2002). This is about three times more than the 2 467 residents reported in Leliefontein in 1936 (Van Zyl, 1957).The largest village in terms of the number of households is Kharkams and the smallest is Tweerivier (Fig. 2.10). As a result of the growth of 307% of the human population in the last century more households in the study area own livestock (OO Ogidan Unpublished data). This means that more households are now dependent on livestock products. However, livestock numbers have remained constant suggesting that the rangeland cannot accommodate more animals. Since there has been a decrease in livestock owned per capita in the study area, pastoralists in Leliefontein have diversified their income which includes non-agricultural income sources (Rohde et al., 2003). This strategy has also been observed in other mobile pastoral systems (Reid et al., 2008).

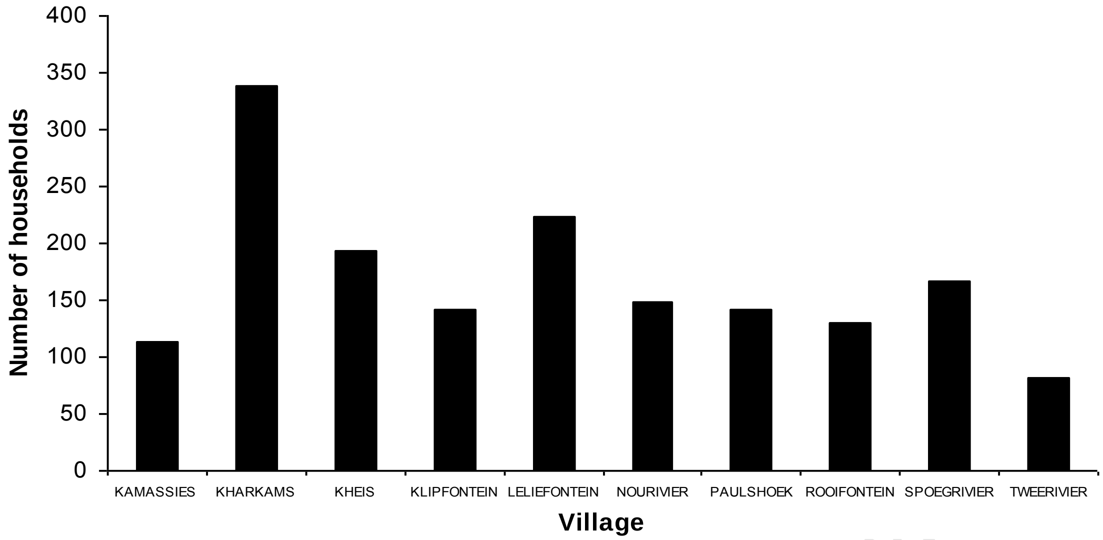


**Figure 2.10**: The number of households recorded in 2010 for each of the 10 villages found in the Leliefontein communal area (Kamiesberg Local Municipality Unpublished data).

**Figure 2.11**: Two Nama pastoralists outside their traditional cooking shelter (*kookskerm*).

The people of Namaqualand (Fig. 2.11) are amongst the poorest communities in South Africa (Rohde and Hoffman, 2008). With a human development index of 0.340

Namaqualand has a substantially lower value than the national and provincial indices (Rohde et al., 2003). However, there is a significant wealth differentiation gap between households in the study area.

Anseeuw et al. (2001) identified seven different household typologies in the Leliefontein communal area which was based on their income streams. The highest earning households receive an income of R43 800 per year and have motorised transport, which allow them to move their animals to the land reform farms (Lebert and Rohde, 2007). They have salaried herders and own an average of 300 small stock animals. The poorest households earn R615 or 1.4% of the richest household's income per annum. They do not have motorised transport and own on average 33 small stock animals. The middle income groups own between 69 and 84 small stock animals. They obtain an income from temporary jobs that are often unreliable or from social grants or remittances sent by migrants working outside the communal area. Most of the middle income groups do not have motorised transport (Anseeuw et al., 2001). Therefore, the fact that the land reform farms are located far away from some villages in the study area means that poorer and most of the middle income groups cannot access the new lands made available for pastoralists in Leliefontein.

In analysing the typologies of households in Paulshoek village, which is one of the ten villages in the study area, Rohde et al. (2003) identified five household types based on sources and amount of income and household characteristics such as education, household size and age. The average income per household in 1995 for the poorest households is 9.6% that of richest households. Within the richest households in the village, most household heads have permanent jobs or are self-employed and have multiple sources of income. The poorest households live below the poverty line and rely on assistance from others in the village to survive. In 1999, the poorest households earned 25.3% of richest households (Rohde et al., 2003). This increase could be attributed to an increase in the amount of social grants obtained in the village over the years.

The contribution of different income sources vary between pastoral communities. In Kenya, some communities are more dependent on livestock products whereas other communities rely more on wage labour when income from livestock is low (Lesorogol, 2005). In Mongolia, livestock sales and consumption account for 67%, wage labour (13%) and government grants and pensions (20%) of household income (Lkhagvadorj et al., 2013). Similarly to Leliefontein, different households within a pastoral community in Kenya also depend on different income streams. Wealthy households rely more on sales of livestock products and home consumption of milk and crops whereas poorer pastoral households rely more on wage labour and selling natural products such as firewood and honey (Lesorogol, 2005).

## 2.9 Why do people in Leliefontein keep livestock?

Pastoralism in the Namaqualand region has shifted from being a core subsistence activity historically to one of several income sources for pastoralists. Rohde et al. (2003) show that in 1995 the income derived from livestock accounts for less than five percent of some household incomes but this value fluctuates significantly from year to year depending on rainfall. In 2011 in the Leliefontein communal area, livestock contributed 27% or R6 422 of the total income of livestock owning households per annum (OO Ogidan Unpublished data). In Leliefontein, livestock mostly serve as an investment function that can generate cash in times of economic hardship (Debeaudoin, 2001; Samuels, 2006) and this build up resilience as it diversifies the sources of income for households (Berzborn, 2007). Pastoralists in Leliefontein also invest in livestock until they retire so that they have some form of savings they could fall back on.

Livestock products such as meat and milk are also often shared amongst family and friends (Fig. 2.12) which contribute to social cohesion and the strengthening of social networks (Debeaudoin, 2001). Moreover, food from livestock provides pastoralists in Leliefontein with critical supplements to their diet (Rohde and Hoffman, 2008). In other pastoral systems livestock plays an important cultural role such as maintaining connections to ancestors (Siegmund-Schultze et al., 2012; Ainslie, 2013) and in

Leliefontein owning livestock ensures elevated status and respect in the community (Debeaudoin, 2001). Keeping livestock also ensures that pastoralists retain access to their traditional grazing areas within the communal area (Rohde and Hoffman, 2008).

**Figure 2.12**: Goats are milked in the morning and the milk is shared amongst pastoral families.

# Chapter Three

## The impact of legislation from five periods of political rule on the geography of pastoralism in a semi-arid region of South Africa

**Abstract**

Legislation is one of the key tools used by governments to change a pastoral landscape. This study assessed the historical changes in the geography of pastoral mobility in the Leliefontein communal area by analysing different sets of legislation introduced by different political rulers since 1652 in South Africa. During Dutch rule from 1652 to 1805, policies were implemented to seize land from indigenous people, which resulted in them losing access to traditional grazing resources. British rule from 1806 to 1909 promoted leasehold tenure or private ownership and focused on bettering livestock productivity. During the Union of South Africa from 1910 to 1947, legislation was passed to promote segregation. Privately owned white farms were fenced off, which resulted in mobile pastoralists in Leliefontein becoming spatially constrained. During the Apartheid era from 1948 to 1993, legislation promoted privatisation as a means to develop the communal area and to prevent overgrazing and soil erosion. Privatisation did not lead to development but to increased stocking densities and restriction of herd mobility. Since democracy in 1994, land reform was implemented to rectify the injustices of the past and alleviate poverty amongst rural people. New legislation was developed using developmental discourses that are not supported by scientific evidence. As a result, land reform legislation failed to address the problems in communal areas and in some cases achieved the opposite effect of its initial objectives.

### 3.1 Introduction

All pastoral areas around the world have undergone changes in their environment and management systems through time. This is often driven by factors such as changes in climate, political systems and human population densities. Previous studies on pastoralism have attempted to understand these factors that cause change and have analysed their impacts on pastoral management. Kelso (2010) reconstructed the climate of Namaqualand using archival records and examined how changes in the climate affected the livelihoods of pastoral people. Her study in Leliefontein shows that the ability of people to cope with the intensity and frequency of droughts declined during the 19th century. This decline was due to factors that included encroachment of settlers onto traditional lands, increased reliance on cultivation and the decline in grazing lands available to practice transhumance. The encroachment of colonial farmers onto traditional grazing lands resulted in less land available to support Nama herds. This is particularly important during droughts, for example when approximately 60% of livestock died during the 2002-2003 drought period (MT Hoffman Unpublished data). Areas which herders had historically used to access variable resources outside their traditional grazing areas when conditions became harsh were no longer available (Kelso, 2010). Furthermore, with the increased reliance on wheat cultivation, droughts reduced crops on which people had become reliant for food.

Political marginalisation is one of the key challenges facing mobile pastoralists (Nori and Davies, 2007; Oseni and Bebe, 2011). Political discrimination and exclusion have been used by colonial governments to take land from indigenous pastoralists (Galaty, 2011) and to pressure them into wage labour (Bundy, 1988; Kreis, 2001). For example, during the 18$^{th}$ and19$^{th}$ centuries in England, landlords used their influence within government to pass laws to seize public land which they could then acquire cheaply. More than 900 pieces of legislation were passed between 1800 and 1810 alone that allowed for the enclosure of communal pastures which resulted in the impoverishment of landless rural communities (Kreis, 2001). This led to a surplus of landless people who were forced to leave rural areas to work as poorly-paid labourers in factories during the Industrial Revolution. Consequently, the land of England became increasingly concentrated in the hands of a few elite.

Sendón (2009) focused on the impacts of historic republican policies and the Peruvian Agrarian Reform Law of 1969 on people’s livelihoods in Peru. The Agrarian Reform Law made provision for the state to expropriate land from the richer Creole landowners and to transfer it to peasant communities. However, this law did not recognise and understand livestock mobility since communities were given lands that were not used by herders for grazing and as a result their grazing area became disconnected. Fernandez-Gimenez (1999) also investigated how historical formal and informal institutions from the Qing Dynasty in 1691 until 1990 affected land use patterns of Mongolian pastoralists. She shows how changes in administrative boundaries, tenure and regulatory institutions have transformed and constricted the grazing patterns of herds. In spite of these changes in livestock management, adequate institutions were developed to facilitate flexibility in mobility patterns. However, many government policies around the world still do not promote pastoral mobility since traditional farming practices have been viewed as backward and unproductive, leading to overgrazing and environmental degradation (Lamprey, 1983; Sinclair and Fryxell, 1985).

Policies implemented during colonial times in the developing world were based on the commercial ranching model developed in the early part of the 20th century in the United States using carrying capacities, fencing and destocking to manage grazing lands (Sayre and Fernandez-Gimenez, 2003). These management strategies were based on the assumptions that grazing systems are in equilibrium, pastoral systems are degrading and that the 'Tragedy of the Commons' narrative (Harding, 1968) reflects a socio-economic reality (Rohde et al., 2006). Rohde et al. (2006) show that even in the current era, post-colonial grazing policies in southern Africa that were implemented to rectify past policies are still based on these underlying assumptions.

The ranching model of grazing management has failed because policy makers often do not understand indigenous rangeland management (Rohde et al., 2006), nor do they appreciate that equilibrium systems seldom occur in arid and semi-arid regions (Behnke et al., 1993). In African drylands where equilibrial systems operate, heavy grazing has been found to be interrelated to soil erosion and woody shrub encroachment when grasses are over consumed (Coppock, 1993). However, this is just one of a few examples of equilibrial systems in African rangelands, which are governed more by non-equilibrium conditions (Oba et al., 2000; Vetter, 2004). Mobile pastoralism is a key strategy to access variable grazing resources in non-equilibrium environments (Behnke et al., 1993; Niamir-

Fuller and Turner, 1999). Recently, African governments which include Mali, Burkina Faso, Mauritania and Guinea have adopted mobile pastoralism in state policies (Hesse and Thébaud, 2006; de Jode, 2010) whereas other governments still persist with policies that have proven ineffective in drylands.

Investigating the historical changes in the pastoral landscape is important to understand how the political environment has influenced land use practices. The objectives of this study are:

- To assess and discuss the impacts of legislation from five different political eras in South African history on the geography of pastoral mobility in the Leliefontein communal area. These are the Dutch colonial era (1652-1805); British colonial era (1806-1909); Union of South Africa (1910-1947); Apartheid era (1948-1993); and the democratic era (1994-present)

- To examine and discuss the scientific and other foundations on which various legislation was based

- To assess and discuss the positive and negative implications of legislation for mobile pastoralism in the region

Before addressing these objectives, I will use the published literature to describe the pre-historic practices of the indigenous Khoekhoe pastoralists before the permanent arrival of the colonists in 1652.



### 3.2 Livestock management in pre-colonial Namaqualand

The San (Bushmen) who were hunter-gatherers were the original inhabitants of South Africa (Catling, 2008). Khoekhoe pastoralists are assumed to have arrived in southern Africa about 2000 BP with domestic livestock (Smith, 1992). From 2000 years ago, Khoekhoe herded sheep in small numbers in Namaqualand (Webley, 2007) and sufficient archeological evidence exists from 1800 BP to show that they were highly mobile pastoralists (Sadr, 2008).

In historical records, Africa is portrayed as a dark, barbarous and degraded continent by Europeans (Kelso, 2010). The Khoisan[8] peoples were also regarded as savages by seafarers who passed the Cape *en route* to the East before the 17th century. Nevertheless, the Portuguese and Dutch were comfortable to trade for cattle and sheep owned by the indigenous peoples. During the colonial times from 1652 onwards, these people were still regarded as uncivilised and violent beastlike men and heathens (Byrnes, 1996; Frere, 2010). However, these views of Khoisan societies were culturally biased since Europeans found it difficult to accept indigenous peoples as equals (Abrahams, 1994). Derogative and racist descriptors toward the indigenous peoples were also used by Europeans to assert their superiority over local people, justify land grab and influence colonial policy makers (Kelso, 2010). These distinct European views of the life of the Khoisan are also indicative of the relationship of indigenous groups to power and authorities. During the colonial periods, Europeans argued that only they knew what is best for South Africa and thus controlled almost every aspect of the lives of the Khoisan peoples (Kelso, 2010).



The Nama speaking groups within the Khoekhoe in the Kamiesberg Mountains farmed with cattle, sheep and goats and sometimes hunted wild animals. Their farming practices entailed following seasonal transhumant patterns between upland areas in summer and lower altitudes near the coast or the Bushmanland grasslands in winter (Webley, 1986). The grazing system of pre-colonial Nama-pastoralists was enforced by a clan council consisting of the elders in the clan (Webley, 1986). Fines were imposed if farmers did not follow the grazing system. The chief (traditional leader) would consider the number of herds already in the area and whether the area had sufficient time to rest from the previous grazing cycle before herds were allowed to graze those lands (Webley, 1984). The extent of land belonging to clans was not defined by clear boundaries but to land around key resource areas (Boonzaier et al., 1996). Historical evidence suggests that one clan allowed others to use their land in times of need, through the payment of a small symbolic tribute (Penn, 1986).

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[8] *Khoisan is the collective name that refers to the San and Khoekhoe ethnic groups in South Africa.*

## 3.3 Approach

### *3.3.1 Legislative documentation*

In this study I analysed and discuss only legislation that affected pastoral mobility in Leliefontein since numerous other legislation and amendments were passed but did not affect their herding patterns. Relevant legislation from the 19$^{th}$ to 21$^{st}$ centuries (Table 3.1) included national acts that are specific to rural reserves, racial or indigenous groups, rangeland management and accessibility, land tenure, access rights, centralisation and decentralisation of power.

Copies of the legislation that were not available online were obtained from the Parliament of the Republic South Africa in Cape Town. For additional information on land use in the study area, I searched archival records that included government reports, travel journals, diaries and private correspondence kept in the South African National Library in Cape Town. I also used official minutes of monthly meetings from 1956 to 1966 of the Leliefontein management board and Cape Supreme Court documents (Case No. 87/9050) pertaining to land struggles in Leliefontein.



### *3.3.2 Reconstruction of historical communal area boundaries*

An elderly member in one of the communities who used to farm with livestock pointed out the boundaries of historic grazing areas that were used prior to the erection of boundary fences in the Leliefontein communal area in the 1950s. I mapped these boundaries with a hand-held Garmin etrex (Garmin Ltd, Kansas, USA) GPS receiver. Maps of the grazing areas were produced using ArcView 3.2.

### *3.3.3 Land use practices on the new land reform farms*

As part of the Land Reform Programme of South Africa, five farms were acquired after 1994 for the residents of the Leliefontein communal area. Data on the sizes of camps, tenants of camps on these farms and number of animals they owned were obtained from the farmers themselves, Kamiesberg Local Municipality and unpublished data from MT Hoffman at the University of Cape Town. Stocking rates for camps were calculated by dividing the size of the camp by the number of small and large stock that grazed inside the camp. According to agricultural regulations for the region, one large stock unit (LSU) is equivalent to six small stock units (SSU).

**Table 3.1**: Formal legislation assessed to study the impacts of legislation on the geography of pastoral herding in the Leliefontein communal area.

| **Proclamations and Ordinances** | **Year** |
|---|---|
| Caledon Code | 1809 |
| Ordinance 50 | 1828 |
| **Name of Act** | **Act No. and Year of promulgation** |
| Village Management Act | Act of 1881 |
| Act 10 of 1870 | Act 10 of 1870 |
| Mission Stations and Communal Reserves Act | Act No. 29 of 1909 |
| Fencing Act | Act No. 17 of 1912 |
| Natives Land Act | Act No. 27 of 1913 |
| Natives Trust and Land Act | Act No. 18 of 1936 |
| Population Registration Act | Act No. 30 of 1950 |
| Group Areas Act | Act No. 41 of 1950 |
| Coloured Rural Areas Act | Act No. 24 of 1963 |
| Rural Coloured Areas Act | Act No. 1 of 1979 |
| Rural Areas Act | Act No. 9 of 1987 |
| Conservation of Agricultural Resources Act | Act No. 43 of 1983 |
| Provision of Certain Land for Settlement Act | Act No. 126 of 1993 |
| Local Government Transition Act | Act No. 209 of 1993 |
| Common Property Associations Act | Act No. 28 of 1996 |
| Transformation of Certain Rural Areas Act | Act No. 94 of 1998 |
| Municipal Structures Act | Act No. 117 of 1998 |
| Municipal Systems Act | Act No. 32 of 2000 |
| **Northern Cape Provincial Gazettes** | **Notice No. and Year of promulgation** |
| Kamiesberg Local Municipality Grazing Regulations | Notice 18 of 2002 |
| Kamiesberg Local Municipality Cropping Regulations | Notice 34 of 2003 |
| Kamiesberg Local Municipality Impounding Regulations | Notice 68 of 2003 |



## 3.4 Results

### *3.4.1 Dutch Colonial Era (1652-1805)*

Before the permanent arrival of the Europeans in South Africa, ships passing by the Cape only stopped in order to trade with indigenous Khoekhoe tribes for livestock products and to take on fresh water. In 1652, the Dutch East Indian Company (VOC) under the command of Jan van Riebeeck arrived in the Cape and established a permanent colony to supply passing ships with fresh water and produce (Boonzaier et al., 1996). In 1657, the VOC granted cropping rights to some of its employees, also called free burghers, to produce fresh vegetables to be sold to the company at predetermined prices (Guelke, 1979). On the basis of the system of usufruct rights, which included a payment to the chief, colonists were also allowed by the Khoekhoe tribes to use their traditional grazing lands (Marinus, 1997), which as a result reduced their dependency on meat from indigenous peoples. However, these chiefs did not foresee that grazing rights would become permanent and exclusive to settlers. The Khoekhoe did not view the payment in the same light as Europeans since the Khoekhoe viewed the payment as a customary tribute while the settlers viewed it as a purchase for the land (Archer and Meer, 1995).This misconception, together with the wars between the Dutch and Khoekhoe as well as the small pox epidemics in the early 18$^{th}$ century, which decimated almost 90% of the Khoekhoe population (Byrnes, 1996), meant that the traditional system of land use and governance practices employed by the Khoekhoe in the Cape was destroyed (Marinus, 1997).

However, free burghers became unhappy with the autocratic administration and corruption of the local VOC which owned most of the prime land in the Cape (Byrnes, 1996). As a result, rich free burghers and poorer members of the white community embarked on a trek during the early 1700s beyond the boundaries of the Cape. In 1720, the trekboers expanded their range to the Breede River in the east and the Swartland in the north (Guelke and Shell, 1992). Beyond the boundaries of the colony trekboers had large grazing lands available to them and adopted the livestock management strategies of the Khoekhoe by moving between agro-ecological zones (Van Zyl, 1957; Penn, 1986; Beinart, 2007; Catling, 2008). This transhumant system of management is still used by some white farmers to manage their livestock in the region (Penn, 1986; Rohde et al., 2001; O’Farrell et al., 2007) albeit between different privately owned pieces of land.

In 1750 the first European farmer registered a loan farm[9] in Namaqualand but it is assumed that these areas were occupied by Europeans well before registration (Penn, 1995). Later there was a surge in registration of loan farms in the Kamiesberg area, and in 1761, Leliefontein was registered to a trekboer, H. Beukes (Webley, 1982). Traditional grazing movements, which were reported to be over 100 km in distance (Webley, 1986), became restricted when the first colonists were given grazing concessions in the Kamiesberg. By 1770, the Dutch encroachment onto pastoral lands affected the transhumant patterns of Nama pastoralists to an extent that herds had to move almost daily during dry periods due to forage limitation and the hunger of their big herds (Webley, 1984). In 1772 Leliefontein had been granted to Hermanus Engelbrecht but later that year the Dutch Governor Van Plettenberg revoked the land after he realised that the previous Governor had awarded the land to the Nama[10] chief Jantjie Wildschutt. This was one of the few examples where the colonists recognised the aboriginal land rights of the Nama (Penn, 1995). The governor gave back the land to the Nama in an attempt to stabilise and preserve order on the northern frontier where there was an increase in raids between the Khoekhoe and the expanding trekboer communities (Marinus, 1997).

### *3.4.2 British Colonial Era (1806-1909)*

In the Cape Colony, Dutch rule officially ended in 1806 as a result of the defeat of France by the British during the Napoleonic Wars. Holland had been an ally to France and the region was taken over by the British. Lack of tenure security was a major weakness in the Dutch system of rule and the British passed the Caledon Code of 1809. The Code required every Baster[11] or Khoekhoe person to have a registered place of residence and to obtain permission from the colonial government to move.

When colonial frontiers to the north marked by the Buffels River and in the east marked by the Kat River (Boonzaier et al., 1996) became unstable and volatile due to frontier

[9]Farmland of approximately 2570 hectares in size that were rented out to settler farmers by the Dutch Government provided that they pay an annual fee.
[10]The Nama is the Khoekhoe tribe who occupied Namaqualand.
[11]Basters are people of mixed descent having white and indigenous Khoekhoe or slave parents. Slaves were imported into South Africa from Asia and other parts of Africa by former Dutch and British rulers.

wars, the British Cape government encouraged the establishment of mission stations for the Khoekhoe in order to stabilise these frontiers. The missionaries that arrived in Namaqualand were from German, British and Dutch missionary societies who were sent to Africa to preach the gospel and bring spiritual assistance to the poor communities (Catling, 2008). Missionaries had to regularly report to their missionary societies in Europe on their progress and current circumstances. Missionaries also assisted with education, health care and skills development for Khoekhoe who worked on white-owned private farms (Catling, 2008).

The Nama welcomed the missionaries and sought refuge at mission stations (Sharp and West, 1984) to have some form of land security from the trekboers who had begun to occupy their land (Boonzaier, 1984). The missionaries in Namaqualand were given the right to farm with livestock and introduced the cultivation of vegetables and wheat to supplement pastoralism. The missionaries extended this practice to the indigenous people in an attempt to settle them closer to the mission stations (Boonzaier et al., 1996) as opposed to their nomadic lifestyles.

In 1816 the Leliefontein missionary station was founded and the government recognised the Nama chief (traditional leader) as the manager of the station. Within the station, Nama pastoralists were guaranteed access to some of their ancestral land for which they did not have to pay taxes (Kotze et al., 1987). Due to their migratory lifestyle regular church services could only be held in Leliefontein village from mid-December to the end of March because pastoralists trekked to outstations within the missionary station to evade cold temperatures and prevent livestock from damaging crops (CCP 1/2/1/74). The fact that families moved with their herd also resulted in low school attendances when herds moved to outstations (CCP 1/2/1/74). The lifestyles of the Nama were thus perceived to be an administrative and development problem for the missionaries who wanted to Christianise and control the indigenous people. In January 1825, Barnabas Shaw, the first missionary at Leliefontein, was given the power to manage the station by the government of the Cape Colony at the missionary’s request citing ignorance and incompetence of the Nama chief (Carstens, 1966). Grazing rights through communal land tenure were now given to residents by the missionary (Sharp and West, 1984).

The Caledon Code was overturned in 1828 by Ordinance 50 that gave indigenous people the right to own property and move freely within the colony. However, by this time most of the land had been occupied or privatised by settlers (Kingston, 2001). Since the Khoekhoe were ‘free’ some Khoekhoe immediately applied for land but were refused by the governor, because they applied for land for their entire population in the Cape while tenure was based on individual ownership (Boonzaier et al., 1996). The government did make land available to a Khoekhoe and baster community in Kat River along the eastern frontier. However, this settlement was established to buffer white farmers from attacks by Xhosa tribes who were expelled from their land by the colonists (Boonzaier et al., 1996).

The boundary of the Cape Colony shifted several times as the colonists moved northwards. On 17 December 1847 the territory north of the Buffels River was annexed and the entire Little Namaqualand region was declared as crown land (Carstens, 1966). In 1854, Leliefontein which was 188 009 ha in size at this date (Melvill, 1890) was declared a reserve by the British for the Little Nama (Rohde et al., 1999). On 22 May1854, “Tickets of Occupation”, an institutionalised form of racial classification (Marinus, 1997), were issued to Leliefontein inhabitants. The boundaries of the reserve were incompletely surveyed and white farmers slowly encroached on the mission land, which further constrained herd movements in Leliefontein.

In 1856, two unsurveyed loan farms, Tweerivieren (2 802 ha) and Hoorngaat (2 674 ha) which were bought by the missionaries, were added as part of the Leliefontein reserve (Fig. 3.1) (ACLT 4206/2). These farms were cultivated and some of the produce was sold to supplement the salary of the missionary. On the other parts of the reserve, croplands were cultivated by reserve residents for animal fodder and to provide flour.

Act 10 of 1870 formally recognised the authority of the missionaries and church council that consisted of four members, which included the traditional leader, two community members and the resident missionary as the chairman (Marinus, 1997). During this period, the council formally established a seasonal cycle of grazing and defined the grazing boundaries each year based on land available for grazing in the Leliefontein reserve (Price, 1976). This meant that all the herds had to move away from cultivated lands in winter and in the uplands herds had to move to lower altitudes to escape freezing conditions. Missionaries also moved with pastoralists to the outstations (Fig. 3.1) to continue with their provision of education and health services and preaching the gospel to the community (Price, 1976).

The Village Management Act of 1881, which applied to all areas that were not part of a municipality, replaced the missionary Rev. Henry Tindall (1881-1887) by a white magistrate as chairperson on the church council. By doing so, the colonial government became directly involved in local matters in the reserve (Marinus, 1997). The magistrate, as opposed to the resident missionary, was now responsible for overseeing the list of registered occupiers and for punishing those who violated the laws of the British authority at the Cape (Marinus, 1997). In an attempt to decentralise the control of reserve, it was proposed to Parliament on 21 May 1890 by a Mr. P.B. van Rhyn, a member of the legislative council, that the reserve be subdivided into 75 farms. However, the resident missionary of Leliefontein at that time, Rev. George Robson (1887-1892) wrote a letter dated 13 June 1890 to the Ministerial Department of Crown Lands and Public Works that such a subdivision would decrease the control over land, and would further exclude people from valuable grazing and arable lands (Melvill, 1890).



The perception of increased alcohol abuse by the people in Leliefontein led the government to believe that the council was losing administrative control over the people. In an attempt to exert better control over the people, it was also proposed in a report dated 24 July 1890 to the Commissioner of Crown Lands and Public Works by Mr Samuel Melvill that the extent of land in Leliefontein was too large to administer and proposed to subdivide the land into three sections around the present day villages of Kharkams, Rooifontein and Leliefontein (Melvill, 1890). Mr Melvill, the Second Assistant Surveyor-General was instructed by the Commissioner to investigate the administration and conditions of the reserves in Namaqualand and make recommendations to Parliament. At the time, the eastern side of the reserve around Rooifontein village was demarcated for the use by Basters who had no rights to grazing lands outside of Leliefontein. It was proposed that the lowlands in the western part near Kharkams village be administered separately. The resident missionary who was asked by Mr Melvill to comment on his proposal on the subdivision of land before he wrote to the Commissioner, raised the concern that subdivision would lead to exclusion of people in the uplands from their croplands in the lowlands and those in the lowlands would be denied access to water for livestock in the uplands during summer. The missionary also argued for the need for livestock to move seasonally between the upland and lowland grazing sites to evade unfavourable climatic conditions, protect growing crops, and to make use of the temporal and spatially variability of forage.  He further mentioned that limited arable lands in the reserve, frequent droughts where forage availability declines and the drying up of ephemeral water sources all indicated that the area was not large enough for the people of Leliefontein. The missionary based his opinions on his understanding of the land use management system of the Nama people since he had been residing in the Leliefontein mission station for more than three years (Kelso, 2010). Government officials who supported the proposal spent less time in Namaqualand and did not understand the variability in resources in the region and the need for livestock to track this variability in order to survive. The fact that the missionary opposed the proposal was also because he was sympathetic to the indigenous people and the difficulty to survive in this variable ecosystem (Kelso, 2010). It was thus concluded that the reserve would not be subdivided.

The Mission Stations and Communal Reserves Act, 1909 (Act No. 29 of 1909) was passed to improve management, control the resources and delineate boundaries (Carstens, 1966). This Act also made provision for crown lands to be transferred to the Department of Native Affairs and for them to be managed by management boards. The Leliefontein board consisted of six community-elected councilors known as *korporale* (corporals) who, when elected held office for life; and three officials elected by the Governor of whom one was a representative from the missionary society. The board was under the chairmanship of the resident magistrate. Previously, the traditional leader of the community was a senior member of the church council but the establishment of a new board took the powers away from the traditional leaders and the Church. The main functions of the board were to enforce all the laws, control land and grazing and collect taxes.

### *3.4.3 Union of South Africa (1910-1947)*

In 1910 the Union of South Africa, which united the two British and two Boer[12] colonies, was established. One of the first Acts passed by the Union was the Natives Land Act, 1913 (Act No. 27 of 1913). This Act was adopted to curtail the existence of African peasantry, prevented their accumulation of capital and deprived those who were not regarded as of 100% European descent from buying or hiring land from white farmers. Pressure on African peasantry also emerged from the commercialisation of white agriculture and as a consequence eliminated the competition from black peasants (Bundy, 1988). Fencing and irrigation led to a decrease in the need for African squatter peasants to provide labour. White farmers also realised that they could get more out of their land if they had cheap labour rather than having quasi-feudal relationships with peasants (Bundy, 1988). Eviction of sharecroppers and lessees on white farms was initiated by levying high license fees which led to the transformation of peasants into wage labourers. As a result of these interventions vast numbers of peasants lost their economic independence and their ability to meet their subsistence requirements across large areas of South Africa.

In Namaqualand pastoralists were prevented from using white-owned land when privately white-owned farms were fenced off and a camp system was introduced under the Fencing Act, 1912 (Act No. 17 of 1912). Fencing also began to replace herding as a livestock management option in the Karoo at this time (Dean et al., 1995). Fencing of private farms adjacent to Leliefontein continued until the 1960s since several private farmers did not want to proceed with erecting fences until the Leliefontein management board paid half of the fencing costs (Leliefontein Management Board Unpublished

[12] Boers are Afrikaans speaking settlers of Dutch, German and French Huguenot descent.

minutes). Fencing was perceived to increase the carrying capacity of the veld and improved rangeland condition (Archer, 2002).

The Natives Trust and Land Act, 1936 (Act No. 18 of 1936) restricted 'non-whites' to 13% of agricultural land in South Africa. Reserves for the 'non-whites' were too small for the livestock populations and insufficient grazing lands forced many people to seek employment outside the reserves. Consequently, people staying in the reserves, including Leliefontein, became dependent on remittances sent by those relatives working outside the reserves (Thompson, 1990).

Boundary disputes became the order of the day when farmers started to fence off their land. For example, in 1947 there was a boundary dispute over Pedroskloof farm (ACLT /218/3073). Apparently, the owner wanted to put up the fence in convenient areas because the terrain is rugged. However, the management board did not allow this since it would have resulted in his farm becoming larger and the communal area smaller (Leliefontein Management Board Unpublished minutes). Presently, Pedroskloof farm is fenced and is located between two sections of the communal area (Fig. 3.1). However, the present owner denies pastoralists to cross his land to access some remote areas of the communal area. Pastoralists now have to move over steep mountains on foot together with their livestock to access their land on the other side. There are examples where disputes that were unresolved resulted in the communal land becoming smaller. In October 1887, a boundary dispute between the council and the farm owner of Karagiesfontein occurred. The farmer deliberately moved the boundary beacons on his farm which increased the size of his farm. After an investigation, the farmer was requested by the council to move his beacons to their original positions but refused to do so. The matter was left unresolved and the communal area became smaller as a result (Price, 1976).

During my interviews with pastoralists it was mentioned that land was also lost through various illegal land acquisitions with allegations that some members of the management board sold land to private farmers. I was told about one example what pastoralists call '*riempie sny*' (cutting strings), an illegal sale of land whereby a white farmer paid a member of the board in food and tobacco and in return get a piece of land equivalent to the size of a cattle skin. However, the board member was not told that the farmer would cut the skin into a thin string and then use this to measure out a piece of land. As a result of unresolved boundary disputes and various illegal acquisitions of communal lands, the Leliefontein communal area covers a smaller area in the second half of the 20th century compared to the area surveyed in 1856. Most of the land lost was on the eastern half of the reserve (Fig. 3.1).

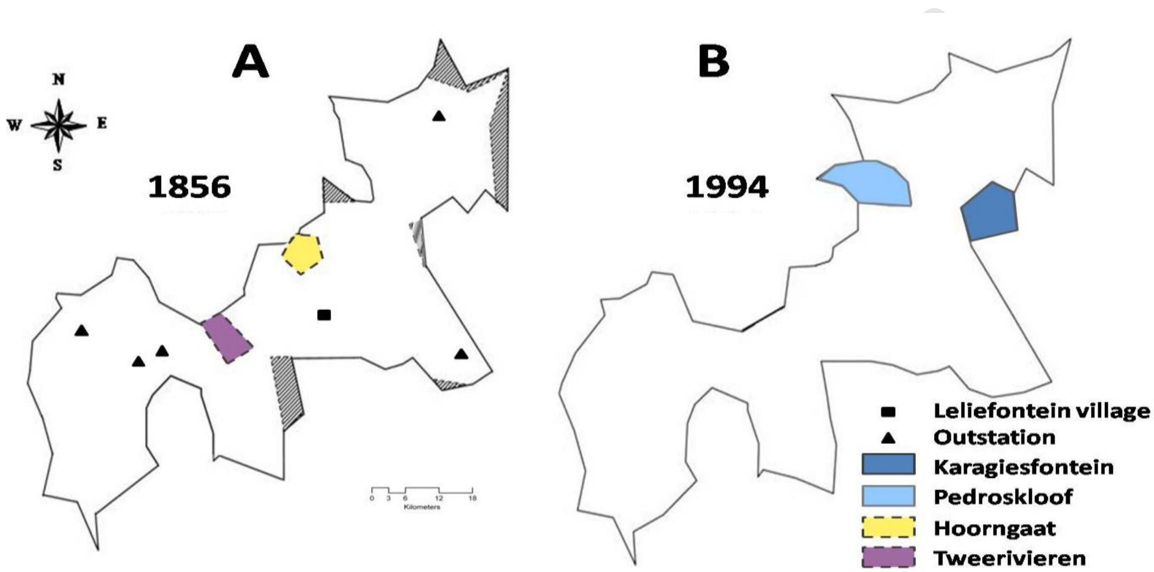


**Figure 3.1**: The boundaries of the Leliefontein Mission Institution in 1856 and the 1994 boundary of the Leliefontein communal area. Map of 1856 was obtained from C.T., A.G., 1538 (1905) and redrawn. The grey areas in map A indicate the land lost by the Leliefontein community between 1856 and 1994.

### *3.4.4 Apartheid Era (1948-1993)*

In 1948 the Nationalist government gained power and starting instituting a more formalised form of racism that was to become known as Apartheid. The Apartheid government introduced the Population Registration Act, 1950 (Act No. 30 of 1950) which classified the South African population into three racial groups, i.e. natives (blacks of Bantu descent), whites and coloured (a person that is neither white nor of Bantu descent). The Nama were classified under the coloured race group. The Group Areas Act, 1950 (Act No. 41 of 1950) confined coloured people to coloured areas. This resulted in retiring coloured farm workers from white-owned private farms in the region, where they had no tenure security to return to Leliefontein with their families and livestock. This caused an increase in human population and less grazing lands available to each household (Rohde et al., 1999).

The Coloured Rural Areas Act, 1963 (Act No. 24 of 1963) was introduced to control, improve and develop rural coloured[13] areas. New management boards[14] were set up to manage commonage user rights and control the number and types of livestock an owner or registered occupier may keep. The Act also permitted management boards to grant special privileges to people from outside the reserve to temporarily graze their animals in Leliefontein. Figure 3.2 shows the number of animals from white private farmers and communal farmers in the region that were illegal, permitted or declined by the management boards to use Leliefontein between 1956 and 1966. A total of 2 230 livestock owned by private farmers that were utilizing the communal area between 1956 and 1966 were illegal. Usually, a fine was imposed on private farmers but some refused to pay. About 11 638 animals were declined access to grazing and were all from private farmers. These farmers were perceived by the management board to have sufficient grazing lands of their own to support their animals. A total of 32 767 additional livestock owned by private farmers and other communal farmers in the Namaqualand area were permitted to graze in Leliefontein between 1956 and 1966.

The greatest numbers of non-resident animals were allowed on the commons in 1959, 1960 and 1966, which were all below average rainfall years. It is unclear why animals from private farms were allowed onto the communal area in these years since forage is usually limited during drier years. One reason might be that the management board would get additional income through the payment of grazing fees and could use the money for other services within the communal area. The board might have also perceived that there would still be sufficient forage and water available to the resident livestock population.

[13] According to Act No 24 of 1963, a coloured person is any person who has been classified as a member of the Cape coloured, Malay, Griqua or other coloured group for the purpose of Act No. 30 of 1950.
[14] These management boards consisted of 10 members. Six members were elected by the community, three appointed by the Minister of which one may be recommended by the Missionary Society, and a magistrate or a person appointed by the Minister to be chairman of the board.

Another reason might be that the board was forced by the apartheid authorities to allow more white farmers onto the communal area during these periods. Leliefontein is the best watered area in the region and has numerous wetlands which are valuable grazing areas for livestock and could bring animals through these dry periods.

The Coloured Rural Areas Act, 1963 also made provisions for the introduction of betterment schemes dividing the land into discrete land use zones (Marinus, 1997). This included the division of the reserve into surveyed residential and agricultural zones. This Act thus forced pastoral families who stayed in the veld to move to existing villages. Management boards formalised *skikkingslyne* (boundary lines) to delineate winter and summer pastures thus ensuring that at least some parts of the rangeland are seasonally rested. Each village had its grazing lands and pastoralists moved between seasonal pastures (Fig. 3.3). Seasonal grazing areas were unfenced but some areas had barriers (Fig. 3.4) which restricted the movement of donkeys.

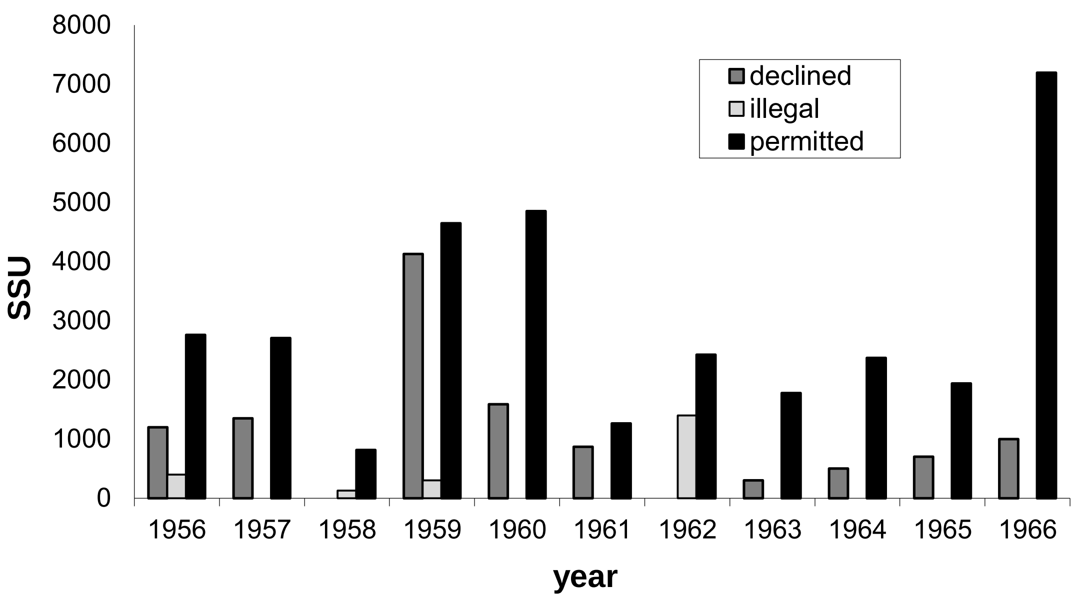


**Figure 3.2**: Number of small stock belonging to white farmers and farmers from other commonages in Namaqualand that were declined, illegal or permitted in the Leliefontein communal area between 1956 and 1966 (Leliefontein Management Board Unpublished minutes).

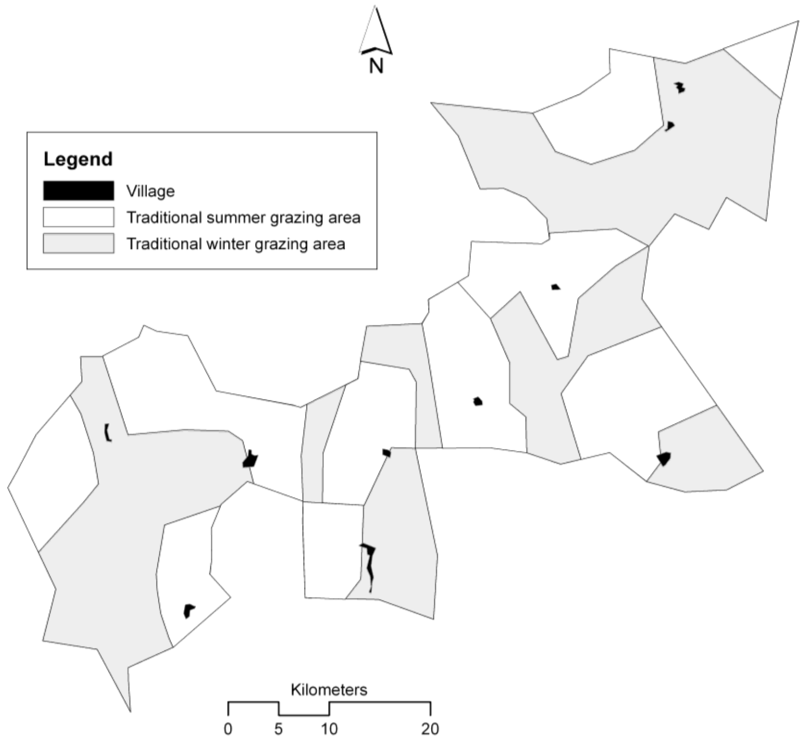


**Figure 3.3**: Seasonal grazing areas for each of the 10 villages in the Leliefontein communal area before the implementation of economic units in 1984.

**Figure 3.4**: Remnants of structures used as seasonal grazing boundaries in the Leliefontein communal area before the implementation of economic units in 1984.

The management board chose a *lynwagter* (linesman) who monitored grazing boundaries and a *skutmeester* (impounding officer) from the community. Through herding, pastoralists would ensure that their animals did not trespass seasonal boundaries. The use of the boundary lines ensured that croplands were protected during the growing season. Animals that trespassed were impounded under local impounding and grazing regulations of the 1950s to 1980s.

In 1984, the reserve was divided into 47 camps or 'economic farming units' (Fig. 3.5). The system of economic units was implemented through the Rural Coloured Areas Act, 1979 (Act No. 1 of 1979). This model of farming on the communal land was introduced to eradicate the perceived backwardness of traditional farming practices that retarded development and caused soil erosion and overgrazing. At the same time this camp system of farming was assumed to increase livestock production and conserve rangeland resources (Kröhne and Steyn, 1991). Thirty units were hired to 38 *bona fide*[15] farmers on a five-year contract with the option to extend the lease for a further five years. Individual farmers or syndicate groups could then have exclusive leaseholds in these camps and be in a better position to use agricultural extension services (Sharp, 1984). Individual leasehold could also increase the possibility of obtaining loans from financial institutions to make improvements on their land (Sharp, 1984).



[15]Persons who are dependent exclusively on farming to sustain their livelihoods (Boonzaier, 1987).

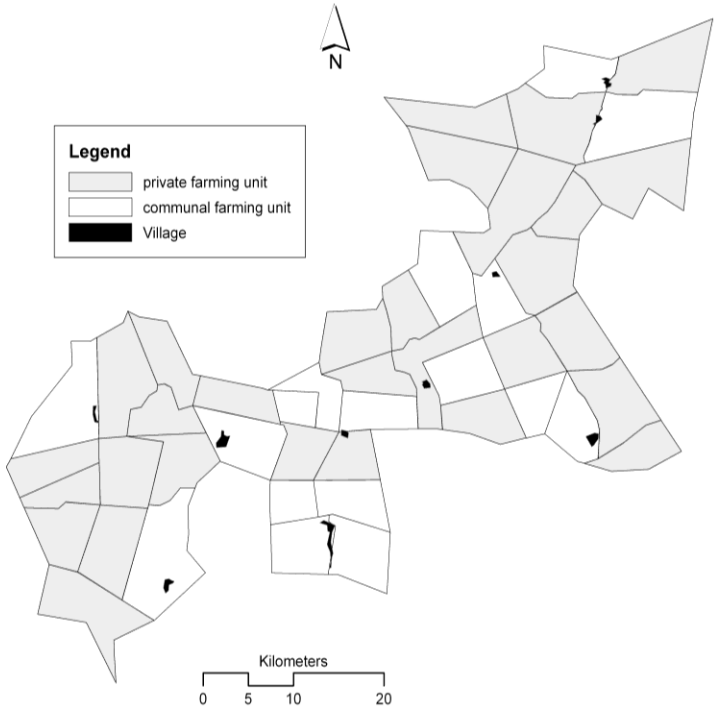


**Figure 3.5**: The distribution of the economic units (camps) that were introduced by the Apartheid government from 1984 to 1988 in the Leliefontein communal area.

The 30 unit's sizes ranged from 1 500 to 6 175 ha depending on local ecological conditions (Archer et al., 1989) and the average size of a unit was 3 440 ha. The remaining 17 camps which were 57 734 ha in total were used by 720 livestock owners (Cape Supreme Court, Case No. 87/9050). Economic units were implemented in all the villages except Paulshoek because pastoralists applied too late for exclusive grazing rights. In 1985, three camps in Paulshoek village were rented out to individuals but the other pastoralists never moved off the land they were supposed to vacate.

In 1984, four pastoralists took the Minister of Local Government, Housing and Agriculture in the House of Representatives to court on the grounds that the economic units system took away their traditional grazing and cropping rights. This new management system was also unable to accommodate opportunistic movements that allow animals to access key resource areas during unfavourable environmental conditions. During the trial the office of the Minister acknowledged that the 17 camps were overstocked and overgrazed due to the division and restriction of herd movements.

He also mentioned that the condition will deteriorate if the high numbers of livestock continue to graze these camps. On 22 April 1988, the court ruled in favour of the applicants to have the economic units system abolished but not for the above mentioned reasons but because of a few technicalities when the economic units system was introduced. Technicalities being that 18 of the 38 farmers who were granted private camps were not *bona fide* farmers since they had other permanent sources of income. Also, when the entire Leliefontein area was subdivided into 47 units, no provision was made for a residential area, croplands and town commonage for the purposes of a graveyard and future expansion of the residential area.

The economic unit system introduced in 1984 by the Apartheid state was not ecologically rational since most of the camps were heavily stocked (Fig. 3.6). The average stocking rate for the 30 private camps was 1.63 SSU/10 ha (range: 0.22 to 7.05 SSU/10 ha) and communal camps averaged 4.46 SSU/10 ha (range: 1.02 to 7.15 SSU/10 ha). It was argued that to be economically viable camps needed to be between 4 808 and 2 070 ha on veld that was in moderate and good condition respectively (Archer et al., 1989). Since the condition of the range in Leliefontein was assumed to be degraded, a larger unit was needed. Moreover, it would be desirable that the farm be spread over different ecological zones to provide heterogeneity in the grazing resource (Archer et al., 1989). Water and forage resources were scattered which means that livestock still had to move between camps (Boonzaier, 1987). The above requirements were not met and as a result economic development objectives were not met (Archer et al., 1989). Since pastoralists who used communal camps could not move beyond the fences, some lost most of their animals mainly due to a lack of forage and water for their animals (Levy and Ndlakuhlolo, 1985). For example, a pastoralist in Nourivier village who had to use the communal camp had 260 small stock before the economic unit system was implemented and had only 92 animals two years later. Similarly, another pastoralist in the village lost 255 out of his 300 small stock mainly due to a lack of forage in the communal camps (Levy and Ndlakuhlolo, 1985).

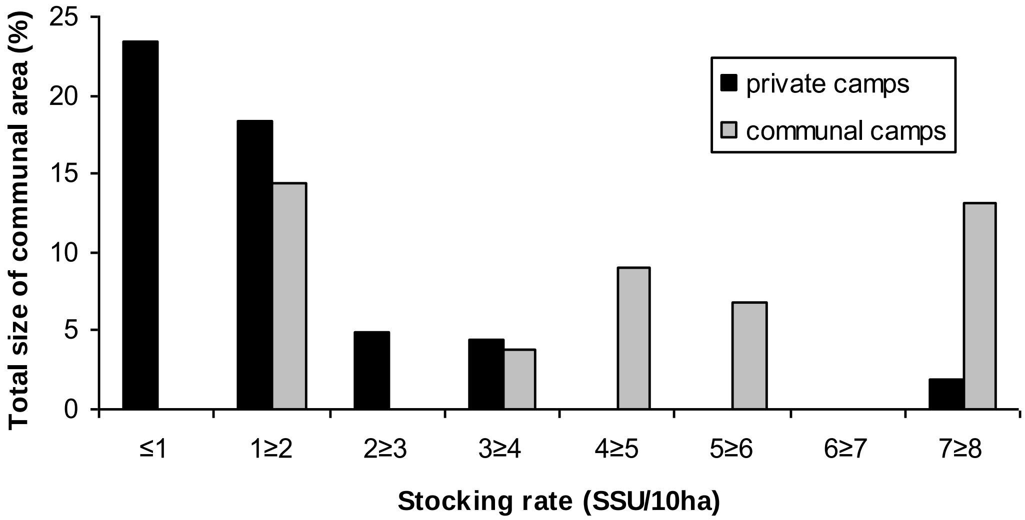


**Figure 3.6**: Livestock densities in private and communal camps during the system of economic units in 1985 in the Leliefontein communal area.

When the system of economic units was abolished by the Supreme Court, the Rural Areas Act, 1987 (Act No. 9 of 1987, House of Representatives) was accepted and Act 1 of 1979 was repealed. Act 9 of 1987 stipulated that about 1 010 703 ha of communal land in Namaqualand be held in trust by the responsible Minister and residents had to apply for grazing rights. Most pastoralists did not apply for rights to the land and its resources (Links[16], pers. comm.). Pastoralists, who kept livestock during this period, mentioned that they did feel the need to apply to use rangeland resources since it had been theirs traditionally for centuries. They further mentioned that user rights should be restored to everyone who previously by birth had rights to use the communal area and that access should not be restricted to the few individuals who could afford to pay grazing fees. However, regardless of these objections by pastoralists, new boards of management[17] were given the power to publish grazing regulations to control and manage stock in Leliefontein.

[16] *Neels Links was the chairperson of the Leliefontein Local Transitional Council and is currently a regional leader of the Khoisan Council in the Kamiesberg region.*

[17] *These boards consisted of a minimum of eight members or as many as the Minister may determine for an area. The members are elected by the community or appointed by the Minister.*

### *3.4.5 Democratic Era (1994 - present)*

In 1994, the first democratic elected government came into power which marked the beginning of the abolition of colonial and segregationist policies. In terms of the Local Government Transition Act, 1993 (Act No. 209 of 1993), management boards were replaced by local transitional councils to control and administer the communal land in Namaqualand. The Leliefontein Local Transitional Council consisted of nine members representing civil society and administered Leliefontein from 1995 until 2000 when the Kamiesberg Local Municipality were formed. To address historic inequalities and limited access to land, Act No. 9 of 1987 was abolished and land reform through the Provision of Certain Land for Settlement Act, 1993 (Act No.126 of 1993) was implemented. Land reform in South Africa includes the redistribution of land, restitution for those who lost their land after 19 June 1913 and tenure reform of communal land.

The Transformation of Certain Rural Areas Act (TRANCRAA), 1998 (Act No. 94 of 1998) was the first comprehensive legislation to reform communal land tenure in South Africa (Wisborg and Rohde, 2004). TRANCRAA aims to transfer land ownership of 23 'coloured rural areas' that were administered through the Rural Areas Act, 1987. TRANCRAA was implemented in six rural areas of Namaqualand (Fig. 2.4) from January 2001 to January 2003. In November 2002 to January 2003, referenda over land ownership were held and people voted on three ownership alternatives which include a Common Property Associations (CPA) in terms of the CPA Act, 1996 (Act No. 28 of 1996), a municipality or a choice that may include trust ownership and individual title (Wisborg and Rohde, 2004). Four communities voted for a CPA and another community did not want to take part in the referendum. The Leliefontein community is the only community who voted for the land to be transferred to a municipality. In 2008, the Kamiesberg municipal council requested from the Minister of Land Affairs that the transfer of land should be accompanied by a grant to repair and maintain the infrastructure on the communal area. A decision on the grant has yet to be agreed upon by the Minister and thus land has not been transferred.

Regulations in terms of the Municipal Structures Act, 1998 (Act No.117 of 1998) and the Municipal Systems Act, 2000 (Act No. 32 of 2000) made provision for communal grazing land to be controlled by the Kamiesberg Local Municipality. Through these two Acts, the municipality promulgated grazing regulations in 2002 (Notice 18 of 2002), cropping regulations in 2003 (Notice 34 of 2003) and *skutregulasies* (impounding regulations) in 2003 (Notice 68 of 2003). Grazing regulations take into account community rules and sets of regulations that had been in use since the application of Act No 29 of 1909. Regulations make provision for control of grazing access, for stock numbers on the communal areas to be limited according to the Department of Agriculture's stocking rates for the region and resting certain grazing areas perceived to be overgrazed. According to Conservation of Agricultural Resources (CARA) Act, 1983 (Act No. 43 of 1983) the Department of Agriculture exercises control over South Africa's natural agricultural resources. However, there is very little cooperation between the Department of Agriculture and the local municipality with regard to the management of natural resources and infrastructure in Leliefontein. The Department of Agriculture also lacks the capacity to visit Leliefontein regularly and give agricultural advice to pastoralists. As a result, not all CARA regulations are implemented.



Cropping regulations lay the legal foundation for the allocation and management of croplands in Leliefontein. There were 559 croplands and food gardens surveyed in 2002 by the Department of Land Affairs. This amalgamated to a total size of 23 049.8 ha or 12% of the Leliefontein communal area. From 1996 to 2009, 66 croplands were used on average annually. Traditionally, croplands were regarded as open grazing areas after the crops were harvested but recently, some croppers have fenced off their cropping units for exclusive use. This resulted in less forage available to other herds during the dry season, fragmentation of the grazing lands which restrict herd movements and the fact that herders do not have to move their stockposts seasonally to avoid crop damage (Chapter Four).

Impounding regulations allowed for any animal to be impounded if unattended in public or residential areas or found causing damage to croplands and vegetable gardens. The impounding regulations were suspended in 2003 by the Kamiesberg Local Municipality due to a lack of capacity to enforce the regulations and legal complications arising from the actions of some pastoralists. Legal complications arose from the failure of the municipal to appoint impounding officers when pastoralists started to impound each other's animals and animals died while being impounded. This resulted in legal battles between livestock owners and those who impounded the animals. Since the suspension, more crop farmers have fenced off their croplands which include natural rangeland that falls within the boundary of their allotment. The suspension of the impounding regulations is one of the main reasons why cropping has declined over the years (Chapter Four) as croppers are not compensated for the damages they suffer.

Other reasons mentioned by croppers why cropping has decreased in the area include their perceptions that rainfall has decreased and that rainfall patterns have changed over the years. Croppers mentioned that they observed a change in rainfall patterns over the years and the main rainfall events sometimes fall outside the growing period of crops. Croppers are thus reluctant to sow seeds because there might not be sufficient follow-up rains which are crucial for crops to grow. Furthermore, famers raised the concern that there is a lack of skilled people in the communal area who could assist with cropping. Cropping in Leliefontein has also decreased due to the absence of markets to sell their wheat and that people can buy flour at prices cheaper than growing it. Other croppers mentioned that they would cultivate their lands if they could get access to mechanised farming implements and seeds.

Land redistribution[18] in rural areas is addressed through the Municipal Commonage Programme. Currently, the inhabitants of the six former Coloured Rural Areas in Namaqualand have access to an additional 245 550 ha of municipal commonage which was land purchased through the Land Redistribution Program and 372 888 ha of state land (Fig. 3.7) that has been allocated for usage by people living in the coloured rural areas (May and Lahiff, 2007).

[18]This component of the land reform process enables poor and previously disadvantaged people to access land purchased by the National Department of Land Affairs on the open market (May and Lahiff, 2007).

Between 1998 and 2000, five farms totaling 32 627 ha in size were acquired for the people in Leliefontein through the Land Redistribution Programme are part of the Kamiesberg Local Municipality's commonage land. Expansion of municipal commonages is as an attempt by the democratic government to supplement the income and enhance household food security of poor communities by giving people access to more land (DLA, 1997). However, the revised commonage policy of 2002 (DLA, 2002) outlined that land reform farms should also be used as stepping stones for aspiring pastoralists to become commercial farmers. These farms would then provide pastoralists with the opportunity to expand their herds and acquire sufficient skills and capital to acquire their own land which will be subsided by a state grant. State grants were provided through the Land Reform and Agricultural Development (LRAD) sub-programmme of the Land Redistribution Programme that was introduced from 2000 to 2006. This sub-programme aimed to provide people access to land to reduce poverty, promote economic development and promote the emergence of black commercial farmers.

Due to the slow pace of land reform through the 'willing buyer willing seller' approach, LRAD was replaced in 2006 by the Proactive Land Acquisition Strategy (PLAS) where the state (as opposed to the beneficiaries) took the leading role in targeting land for acquisition. Under PLAS newly acquired farms are leased to beneficiaries for a 3-5 year trial period with the option to purchase provided that the beneficiaries have established a satisfactory farming enterprise according to government standards. Until 2012, no land in the Kamiesberg region was acquired through PLAS and thus pastoralists in Leliefontein have yet to benefit from this new strategy.

Many pastoralists especially wealthier individuals (Lebert and Rohde, 2007) grabbed the opportunity and moved onto the land reform farms on the eastern side of the Leliefontein communal area (Fig 3.8). Most of the poorer pastoralists were excluded because they could not pay the high grazing fees in addition to paying their herder. Some poorer pastoralists also returned with their animals to the old commons due to transport constraints which prevented them from visiting their livestock regularly. Drought and the lack of infrastructure on the land reform farms also influenced their decisions to return to

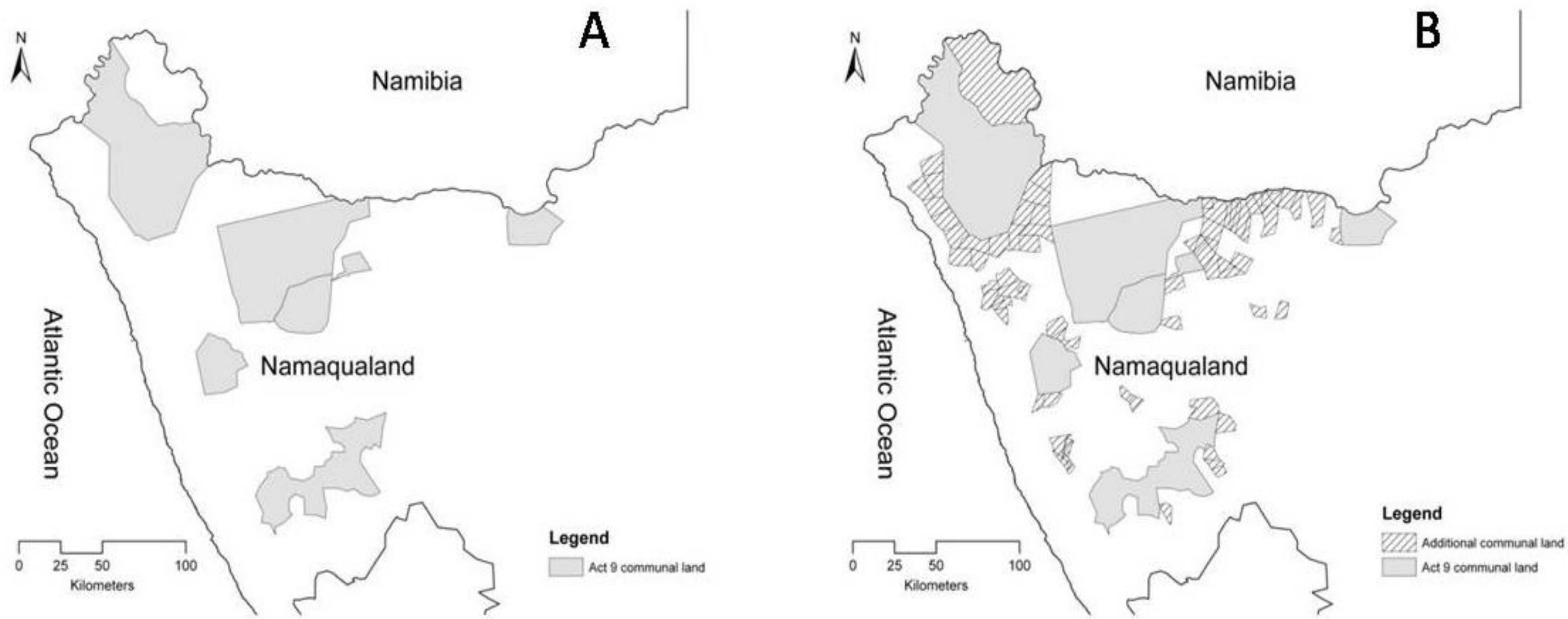


**Figure 3.7**: Locations of communal areas in Namaqualand before (map A) and after (map B) the implementation of South Africa's Land Reform Policy. The Land Reform Programme aims to transfer 30% of agricultural land into black ownership by 2014.

the old commons. Better resourced pastoralists have motorised transport to move their animals to the farms and visit them regularly. They also have other sources of income to pay their grazing fees and to supplement their farming activities in times of need (Lebert and Rohde, 2007).

By 2004, 42 or 9% of the total number of farmers on the old commons had access to the land reform farms. Municipal Grazing Regulations of 2002 state that a livestock owner who is entitled to keep stock on the land reform farms may not keep any stock on the old commonage. However, removing better-resourced pastoralists from old commonage land permanently would create more space for remaining herds but this could lead to job losses since they employ local herders on the old commonage and on the farms several herds range freely (Rohde et al., 2001).

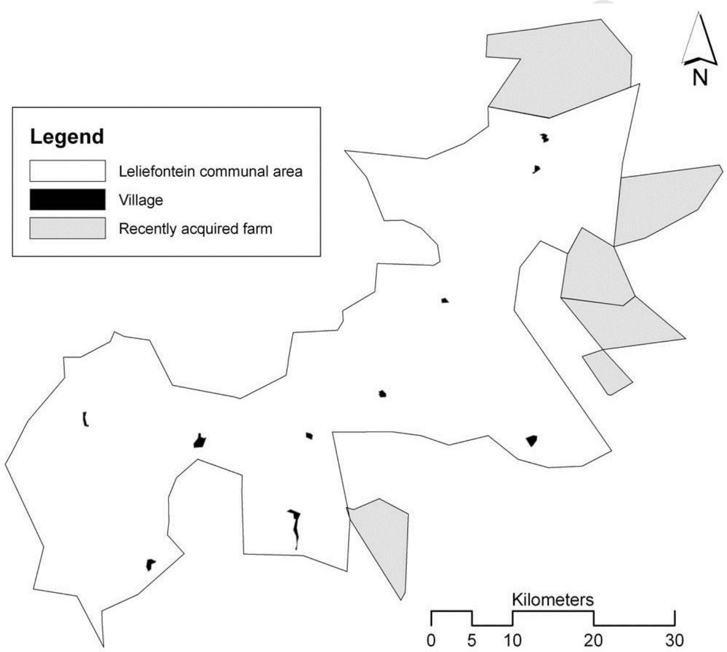


**Figure 3.8**: The locations of the land reform farms acquired by the Department of Land Affairs through the Land Reform Programme for the people of Leliefontein.

In 2003, four land reform farms were overstocked at more than 1 SSU/10 ha (Lebert, 2004). In 2007, there was an increase in grazing density on Tweefontein farm and some camps became heavily stocked (Figs. 3.9 & 3.10). Pastoralists said that they wanted to grow their herds and did not want to sell when they gained access to the farm.

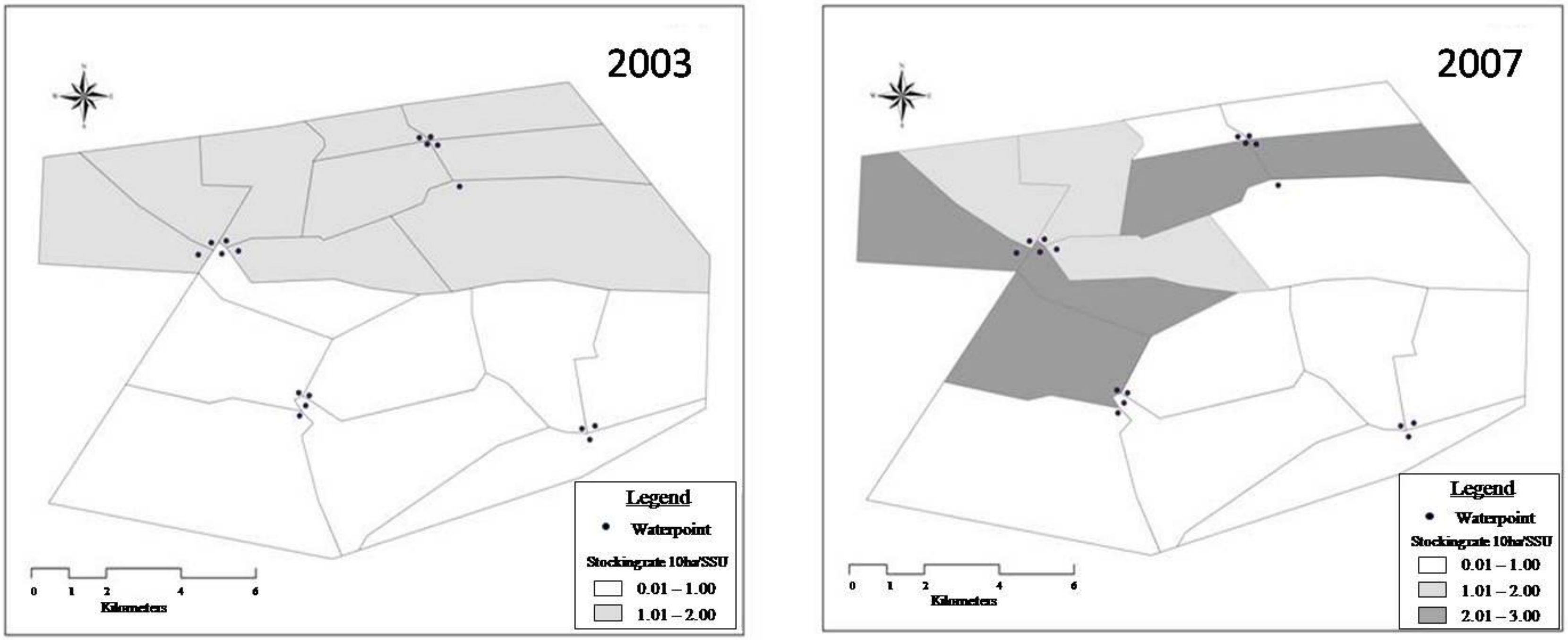


**Figure 3.9**: Spatial distribution of grazing densities during 2003 and 2007on Tweefontein Farm which was acquired for the people of Leliefontein through the Land Reform Programme.

Another reason for an increase in the grazing density is that on the farm of Tweefontein, 11 pastoralists were given access in 2003 and 17 in 2007. More pastoralists used the farm in 2007 because not all applications were processed in 2003 by the municipality.

An increase in the number of pastoralists meant that no camp could be rested from grazing. This was against the Department of Agriculture's (DoA) proposed management system for the farm but the demand for land was too great as people wanted access to land that they were denied from by previous governments. The Leliefontein commonage committee and the local municipality determined who and how many farmers should graze the camps. DoA had little involvement in the allocation process mainly due to the lack of human capacity. In 2011, DoA and the commonage manager proposed to the municipal council that some camps should be rested due to overgrazing. The decision has yet to be made but that would mean that some people will be deprived of grazing lands.

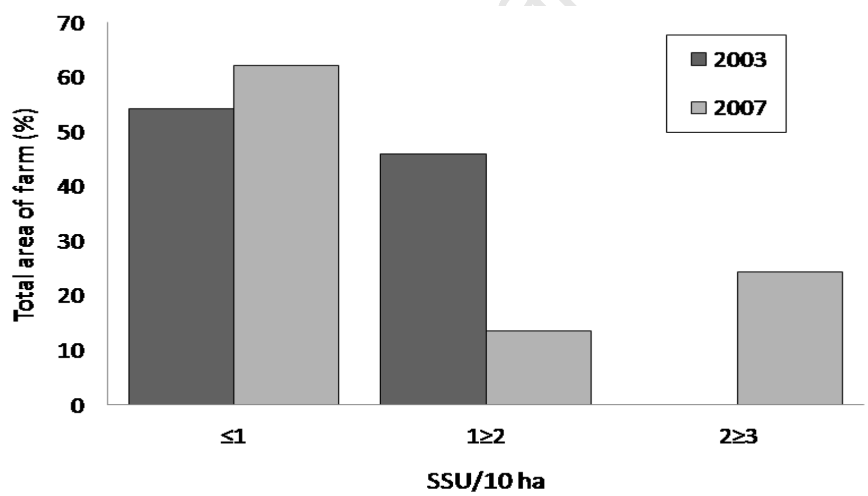


**Figure 3.10**: Proportions of the Tweefontein farm grazed at different grazing densities during 2003 and 2007.

### 3.5 Discussion

During the Dutch rule in South Africa, legislation was implemented as a control mechanism and to occupy land previously inhabited by indigenous people. Land dispossession continued under the British who formally mapped the boundaries of the Leliefontein communal area. As a result of land dispossession, pastoral routes became shorter (Fig. 3.11) and indigenous people lost access to traditional grazing areas. The

British controlled the communal areas through indirect rule using the missionaries to implement the colonialist policies. The fencing of boundaries between private farms and the communal areas was started during the Union of South Africa and pastoralists were no longer able to move long distances to access grazing resources outside the communal area.

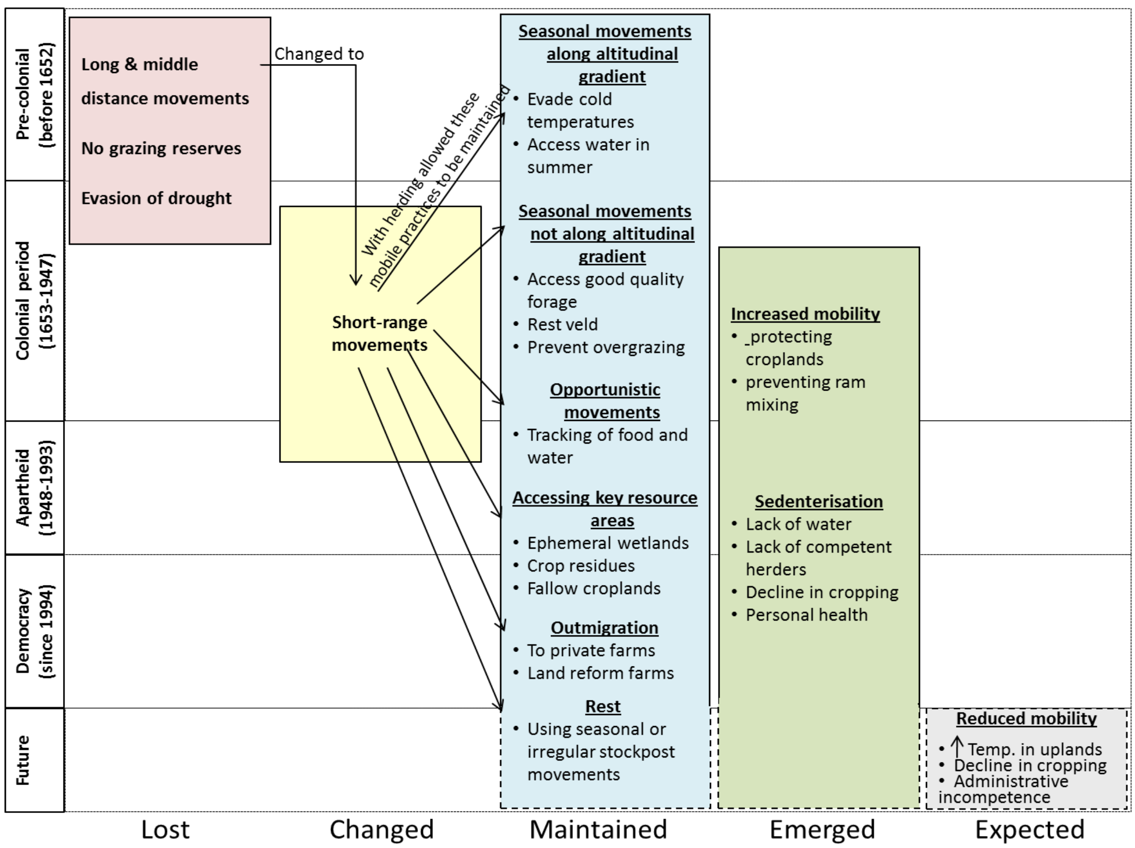


**Figure 3.11**: The evolution of mobile practices in a variable and spatially constrained pastoral system in South Africa[19].

During the apartheid era coloured people were confined to coloured areas which resulted in an increase in households and less grazing lands available to each livestock owning household (Rohde et al., 1999). In 1984, the communal area was divided into economic units based on a commercial model of farming to promote economic development and prevent further environmental damage perceived to be cause by traditional farming practices. This system of privatisation did not achieve its initial objectives but instead it

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[19] *Aspects of pastoral mobility that were maintained and emerged when the Leliefontein communal area became smaller and spatially constrained are discussed further in Chapters Four to Six.*

increased stocking densities and restriction of herd mobility. The economic unit system was poorly designed and was based on faulty scientific theories (Rohde et al., 2006). These theories still form the basis of the current South African commonage policy.

### *3.5.1 What science underpins South Africa's commonage policy?*

The practices promoted by the democratic government in the commonage policy of South Africa are a continuation of previous legislation and is also similar to land policies in other post-independence countries in Africa. In these countries developmental discourses, which were not often based on scientific evidence were used to formulate policies (Abel and Blaikie, 1989; Homewood, 2008). In South Africa, Botswana, Lesotho and Zimbabwe, policies which favour privatisation of communal or tribal land are based on the equilibrium theory that is applied to vegetation dynamics, the perception that pastoral systems are degraded and the 'Tragedy of the Commons' narrative (Abel and Blaikie, 1989; Rohde et al., 2006).

The equilibrium theory as it is applied to rangeland dynamics is informed by Frederick Clements' linear plant succession model (Sayre and Fernandez-Gimenez, 2003). This theory assumes that a rangeland has a carrying capacity based on rainfall and biophysical characteristics that determine its primary production (Vetter, 2005). It further assumes that vegetation succession and grazing pressure are in equilibrium with each other (Westoby et al., 1989). Heavy grazing will push vegetation to an early successional or pioneer stage whereas light or no grazing will allow the vegetation to move towards to a climax community (Wilson & Macleoid 1991; Vetter, 2005). Managing rangelands based on the equilibrium theory promotes the use of conservative stocking rates as determined by fixed carrying capacities for the land to prevent overgrazing. Destocking schemes, an orientation towards market production and improved breeding have also been introduced to modernise communal areas (Sayre and Fernandez-Gimenez, 2003). Many interventions to modernise pastoral practices in arid and semi-arid areas have failed (Oba et al., 2000; Behnke, 2008) often because the ranching model used was designed for use in wetter or less variable environments (Kirkbride and Grahn, 2008).

In arid and semi-arid regions where the coefficient of variation (CV) in rainfall is more than 30% non-equilibrial factors tend to operate (Ellis et al., 1993). In non-equilibrium systems, density independent factors such as rainfall as opposed to density-dependent, grazing pressure are the most important drivers of vegetation dynamics (see Vetter, 2005). Rainfall in semi-arid areas is spatially and temporally variable causing variability in primary production (Vetter, 2005). Livestock numbers are regulated by environmental fluctuations and seldom reached densities that are high enough to affect vegetation dynamics (Ellis and Swift, 1988). Policies which encourage the use of conservative stocking rates may not result in overgrazing during dry periods but will result in undergrazing during good rainfall years and could result in a loss of potential income for pastoralists (Ellis and Swift, 1988; Campbell et al., 2006). Opportunistic stocking rates[20] are thus recommended in variable environments (Campbell et al., 2006). Moreover, in semi-arid environments pastoral mobility, as opposed to paddocking which restricts livestock movements, is considered ecologically rational when resources are variable (Niamir-Fuller and Turner, 1999).



Most researchers agree that land degradation is a reality (Ward et al., 1998; Abel and Blaikie, 1989; Vetter, 2005) but there is no consensus on what constitutes degradation and what its causes are. Some argue that changes in vegetation composition and structure, loss of plant cover or bush encroachment constitute degradation (Hoffman, 2003) while others argue that these are shifts into alternative vegetation states as described by the state and transition model of rangeland dynamics (Westoby et al., 1989). Other researchers hold the position that only a change in vegetation which is irreversible that is, it has moved beyond it bounds of resilience, should be classified as degradation (Abel and Blaikie, 1989). Natural scientists also regard soil erosion and nutrient depletion as indicators of land degradation (Hoffman, 2003; Scholes, 2009) whereas others consider degradation as a decrease in secondary production over time (Behnke and Scoones, 1993).

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*[20] Opportunistic stocking rates occur when animal numbers are regulated by livestock keepers usually in response to environmental conditions. During unfavourable conditions such as drought when there is a lack of food and water, farmers may sell their animals although the low selling cost often discourages sales. During good rainfall periods when forage is abundant, livestock keepers are inclined to buy in animals to boost production.*

Warren (2002) says that a single measure of degradation is too simplistic since biophysical change can have different consequences at different context. For example, land users assess degradation at local scale and might only classify an area as degraded if it affects their livelihood but at larger scales the effects might be masked by the success of an agricultural system (Warren, 2002). Scholes, (2009) argues that for an area to be regarded as degraded, we should look at whether there has been a decrease in the amount of ecosystem services provided, which results in a loss of natural capital. Rangelands provide various ecosystem services such as natural products and medicinal plants to pastoralists as well as fodder and water to their livestock (Shackleton et al., 2008). However, these ecosystem services might become degraded from poor management practices such as overgrazing and poor livestock policies. For example, in Namaqualand overgrazing resulted in a significant reduction in the cover of palatable perennial plants and an increase in annual and unpalatable plant cover (Todd and Hoffman, 1999, 2009; Anderson and Hoffman, 2007). Consequently, these changes in the ecosystem could lead to a loss in ecosystem services in the future.

Traditional pastoral practices which are often associated with heavy grazing have been assumed to cause land degradation (Lamprey, 1983; Sinclair and Fryxell, 1985; Miller, 2000). In these systems destocking is proposed to improve rangeland condition and improve livestock productivity (Abel and Blaikie, 1989). However, it is argued that there is no link between herbivory and land degradation (Scoones, 1995b). This is corroborated by research in Namibia where no difference was found in livestock impacts on soil and vegetation between communal and private farms in Namibia even at higher human and livestock densities in the communal areas (Ward et al., 1998). These authors argue that in variable environments rainfall masks the impacts of grazing and that rainfall is the main driver that recharges the systems after suffering from heavy grazing pressure.

The 'Tragedy of the Commons' narrative (Hardin, 1968) assumes that access to communal resources is open and unregulated; farmers keep livestock for economic reasons and they would rationally want to maximise their personal gains from these resources. Since all users act in this rational manner, the common resource is overused and this might lead to the destruction of the environment.  Policies for communal or tribal land thus promote the allocation of grazing areas to specific groups of people so that the owners bear all the costs of environmental degradation (Abel and Blaikie, 1989).

The 'Tragedy of the Commons' narrative has been challenged as a useful way to view land use practices in many pastoral systems around the world (McCabe, 1990; Peters, 1994; Ward et al., 1998). In Leliefontein it was found that the communal rangeland is not open for all and pastoralists usually graze in certain areas and do not graze in areas that have been traditionally used by others even though they have a right to do so (Marinus, 1996; Debeaudoin, 2001, Allsopp et al., 2007). Livestock numbers in Leliefontein are regulated to ensure that more animals are able to survive drought periods (Debeaudoin, 2001). Moreover, livestock keeping in Leliefontein (Debeaudoin, 2001) as in other pastoral systems (Hassan et al., 1998; Homewood, 2008; Siegmund-Schultze  et al., 2012; Ainslie, 2005; 2013) is not profit driven but is used mostly for subsistence reasons as well as traditional and cultural practices.

Pastoralists do not always want to maximise their personal gains from communal resources since they regularly help each other by sharing their farming knowledge (Samuels, 2006), which are important to maintain social networks (Marinus, 1996). In Paulshoek village, there are seven identifiable networks amongst 26 pastoralists that are based on kinship ties and co-operatives (Marinus, 1996). Social networks are important to help pastoralists to cope with changes in the pastoral system, promote economies of scale, prevent conflict and in times of need when they need access to good quality forage (Turner, 1999b; Mwangi 2003 cited in Galvin, 2009; Galvin, 2009). In Niger, social networks are also important for resident pastoralists to access additional labour to assist with herding duties during the wet season (Turner, 1999b). In Leliefontein, social networks are important to access to information on the condition of the rangeland from other herders (Debeaudoin, 2001) and extended kinships and provide pastoralists' families with employment opportunities in urban areas, which would provide pastoralists with additional sources of income through remittances (Rohde et al., 2003).

The basis for promoting commercially-oriented rangeland practices in communal areas within the municipal commonage policy is thus not supported by scientific evidence but on theories which have been refuted in many parts of the world.

### *3.5.2 What are the implications of promoting leasehold tenure on commonage land?*

The commonage policy of 2002 (DLA, 2002) emphasises the additional role of land reform farms as 'stepping stones' for emergent[21] black farmers to become commercial farmers. However, the system of promoting emerging black farmers to become commercial farmers has not been successful in South Africa. Emerging farmers encounter practical constraints such as lack of access to markets which prevent them from entering main stream commercial agriculture (Senyolo et al., 2009). They also have constraints regarding access to land, infrastructure and financial support since they do not have title deeds to the land and thus cannot use it as collateral (Senyolo et al., 2009). Moreover, the land that they occupy is mostly not economically viable due to its limited size (Martens, 2009).

In Namaqualand, the commonage policy has failed to assist the poor (Rohde et al., 2006) because pastoralists seldom have sufficient capital and farm assets to become commercial farmers (Anseeuw and Laurent, 2007). Moreover, farming credit is only granted to full-time farmers with long-term farming experience. This is not feasible since rarely do we find full-time farmers even in the commercial farming sector in South Africa. Commercial farmers in Namaqualand engage in non-farm income activities such as having other professions or additional activities to supplement their income from farming. It was found that pluriactivity is also necessary on land reform farms in order for the stepping stones system to be successful since it would ensure sufficient income to the household and development of the farming unit (Anseeuw and Laurent, 2007).

[21] Emerging farmers in South Africa are regarded as smallholder farmers, who were previously excluded from the mainstream agricultural economy and include beneficiaries of land reform programmes (Senyolo, 2009).

The Tribal Grazing Land Policy of 1975 in Botswana which allowed for the creation of leasehold ranches for larger cattle herds on former tribal lands had similar implications as South Africa's commonage policy. In Botswana, the policy resulted in conflicts over former communal lands, widened the gap between rich and poor farmers (Rohde et al., 2006) and showed negative rates of return (Malope and Batisani, 2008). During the 1960s to 1980s, traditional Maasai lands were divided into group ranches to modernise and improve livestock production and protect the environment (Kimani and Pickard, 1998; Kipuri and Naikuni, 2008). Ranching led to inequitable access for pastoralists to grazing land and water and the subdivision of ranches reduced the ability of livestock to access vegetation heterogeneity due to restrictions of herd movement (BurnSilver and Boone, 2003).



The LRAD grant in South Africa was too small to purchase large and economically viable livestock farms (Martens, 2009). This resulted in groups rather than individuals purchasing the land which created a communal farming system where often the poorest members are marginalised in the decision-making processes (Lahiff, 2007). In the political arena in South Africa, Benjaminsen et al. (2006) argue that the reason why the system of 'stepping stones' on the land reform farms remains unchallenged even though it is unsuccessful is because it serves political interest. These interests include the emergence of black commercial farmers and reversing the racial land ownership profile created by apartheid and previous legislation. However, deracialising commercial agriculture is not sufficient to change the status quo of South Africa's agricultural landscape (Cousins, 2007).

In order for land reform beneficiaries to be successful commercial farmers, more focus should be placed on agrarian reform. Cousins (2007) argues that agrarian reform could be achieved if the state played a central role in land and agrarian reform, devoted sufficient resources to land reform and acknowledged the contributions of smallholder production to the rural economy (Cousins, 2007). There should also be an active participation of beneficiaries of agrarian reform in processes of policy making, planning and implementation (Cousins, 2007). Achieving agrarian reform might then improve pastoralists' access to markets, finances, good infrastructure and information, which are the aspects needed to become successful commercial farmers (Senyolo et al., 2009).

Since colonisation, legislation introduced in communal areas has not promoted and supported mobile pastoralism. It is no surprise that since Namaqualand was governed by the Dutch, there has been little compliance with the legislation by Leliefontein pastoralists. Firstly, legislation passed before democracy in 1994, discriminated against the indigenous people and they might have viewed those laws as forms of oppression. After 1994, non-compliance continued and arguably even increased because people had high expectations of equality and greater access to resources during the new South Africa. Pastoralists mentioned that there is a deliberate withholding of information regarding the TRANCRAA process so people are confused about their rights to the land and their land use options.



Presently, municipal grazing, cropping and impounding regulations are poorly implemented. There is a lack of capital in the local municipality to employ people to enforce these regulations. Furthermore, there is a lack of capacity in municipal officials who do not understand how these regulations should be implemented and how to respond to the breaching of rules. An example exists whereby a local farmer was ordered by the municipal council to vacate a community ram camp which he occupied. Seven years later, the farmer still uses the ram camp to graze his herd. Moreover, the fact that few people pay rent for croplands or grazing fees has resulted in the municipality giving less attention to land use in the communal area. The possibilities of lawsuits especially against those who wrongfully impound livestock are also why the impounding regulations are not enforced. However, pastoralists in Leliefontein do not contest the political legitimacy of these regulations and understand that they are based on traditional practices and norms of the community. Therefore, the only concern is the lack of enforcement by the municipality.

Legislation on the new farms cannot be implemented due to a shortage of human resources and limited operational budgets as well as the lack of cooperation between community structures, DoA and the local municipality. The commonage committee, which consists of elected officials from the ten villages, the municipality and DoA was established to co-manage the land reform farms and to move away from the top-down approach of communal land management. However, most of the elected officials who are part of the decision-making processes are there for their self-interest (Lebert and Rohde, 2007). In addition to the lack of capacity and resources, the commonage committee is also unwilling to enforce rules because it is not in their best economic benefit. As a result, stocking rates are not adhered to and the elite members of the community gain the greatest benefit from the municipal commonage programme (Lebert and Rohde, 2007).

Some governments have started to embrace mobile pastoralism in state policies (de Jode, 2010). In Mongolia, policies implemented during 2003 and 2006 aimed to restore customary institutions and common property management of natural resources. Traditional range management strategies such as increased transhumance, improved access to pastures and greater control over key resources were implemented which resulted in improved range condition (WISP, 2008). A decrease in poverty amongst pastoral households was also observed due to tourism initiatives and greater access to markets (WISP, 2008). In Tanzania, the Wildlife Policy of 1998 acknowledged the roles mobile pastoralists play in conserving biodiversity by protecting wildlife and their habitats (WISP, 2008). However, from 1999 onwards, the government reconsolidated their central control over tourism and conservation. The activities of pastoralists and wildlife became segregated and pastoralists are now restricted in their access to traditional grazing resources (Ngoitiko et al., 2010).



In other countries such as in Kenya, the subdivision of communal lands into group ranches by government to promote privatization in an attempt to improve production and conserve the environment can be seen as a policy in contrast to those that promote mobility. The further subdivision of group ranches resulted in pastoral mobility being constrained which in turn increased overstocking. However, in order to improve herd mobility, pastoral households have engaged in collective actions which include pasture sharing agreements and strengthening traditional norms so that herds can move between grazing areas which have become fragmented through land tenure changes (BurnSilver and Mwangi, 2007). This re-aggregation suggests that in variable environments such as Kenya, pastoralists need to be mobile and appropriate policies should be in place to promote mobility. In South Africa, current policies also need to be aligned to support mobile pastoralists (Vetter, 2013). These policies should be informed by scientific understandings of pastoral systems that have been rigorously tested and reviewed as well as the management practices of pastoralists. Such policies might then assist pastoralists in overcoming their constraints and help them to meet their farming objectives.

# Chapter Four[22]

## Temporal mobility patterns of livestock keepers in semi-arid communal rangelands of Namaqualand, South Africa

**Abstract**

In arid and semi-arid environments, pastoralists use herd mobility to manage resource variability. When grazing areas become modified, however, herd mobility needs to change and adapt to the new environment. In this study, I investigated what drives herd mobility and how the temporal mobility patterns of pastoral herds changed between 1997 and 2006 in the spatially constrained Leliefontein communal area in Namaqualand. I conducted semi-structured interviews with about 300 pastoralists and agro-pastoralists from 10 villages in the communal area. Herd size and the frequency of herd movements varied significantly amongst the herds in the different villages. Although several herds moved out of the commons onto recently acquired land reform farms to increase their flexibility of herd movements, about 80% of herd movements still occurred within village boundaries. Pastoral mobility in Leliefontein is complex and is influenced by environmental, agricultural, social and personal factors that operate at both herd and village levels within the pastoral system.

### 4.1 Introduction

Arid and semi-arid ecosystems are characterised by unpredictability in rainfall and variability in grazing resources. Such environments pose great risks and uncertainty for animal husbandry (Behnke and Scoones, 1993), and people and their livestock have to adapt to these conditions. One way of adapting is to coordinate their activities with the spatial and temporal availability of resources. Pastoralists around the world have managed to sustain livestock in variable environments for millennia by adopting these approaches (Fernandez-Gimenez and Swift, 2003).



[22] *A large component of the data presented in this chapter has been published in Samuels et al. (2008).*

In drylands where non-equilibrium factors mostly drive vegetation dynamics (Vetter, 2004), pastoralists use herd mobility to manage resource variability (Bovin, 1990**;** Agrawal, 1993; Coppolillo, 2000; Fernandez-Gimenez, 2000; Hendricks et al., 2005). Mobility is seen as an ecologically rational means to ensure maximum use of limited resources (Niamir-Fuller, 1999b; Adriansen, 2003), a risk avoidance strategy (Swallow, 1994) and a strategy that maximises digestible nutrient intake during growing seasons (Western, 1982). Mobility is usually in the form of nomadic movements in search of better forage and water (Sieff, 1997) or seasonal transhumant patterns between dry and wet season pastures (Adriansen, 2003), geomorphological zones (Schareika, 2001), from higher to lower elevation during the cold seasons (de Weijer, 2007) or between different latitudinal areas (Dwyer and Istomin, 2006).

Even though mobile pastoralism contributes significantly to the Gross Domestic Product (GDP) of numerous developing countries around the world (Davies and Hatfield, 2007), its sustainability is not promoted in government policies (Niamir-Fuller, 2008). Mobile practices are also under pressure from long droughts, encroachment of other land uses, especially cropping, due to increases in human population (de Weijer, 2007), and disease control policies (Niamir-Fuller and Turner, 1999). An inadequate supply of infrastructure, the breakdown of customary hierarchies, famine and wars have also led to a decrease in mobility (Niamir-Fuller and Turner, 1999).

This chapter investigates changes in the mobility patterns of pastoralists in the Leliefontein communal area between 1997 and 2006. Pastoralists in this area are spatially constrained and represent the situation of many pastoralists in Africa and the rest of the world in modern times where herd mobility has become increasingly restricted. The study also investigates the key drivers of change in the pastoral system from a social and environmental perspective. Understanding the socio-economic drivers of pastoral mobility is crucial to better manage livestock and prevent environmental degradation (Baker and Hoffman, 2006).

In this chapter I asked the following key questions:

1. What is the nature of herd mobility patterns in the Leliefontein communal area?
2. What drives herd mobility in the spatially constrained Leliefontein communal area?
3. How have herd mobility patterns changed between 1997 and 2006 and what are the drivers of this change?

Mobile pastoral systems are often described in general terms. This study analyses individual herd mobility from all the herds in ten villages in the Leliefontein communal rangeland. McCabe (1994) points out the lack of detailed information on mobility patterns for specific pastoral communities in contrast to generalised descriptions of land use. This lack of information might have directly contributed to the failure of development projects (Horowitz 1981 cited in McCabe, 1994). This study can also contribute to the development of grazing management policy that takes into account current mobile pastoral systems. An example would be in the development of the Municipal Integrated Development Plans (IDPs) in South Africa which are presently responsible for management approaches within the communal lands.



## 4.2 Methods

Data on stockpost and watering point locations from 1997 to 2006 were collected using a Garmin etrex (Garmin Ltd, Kansas, USA) handheld GPS receiver. A local informant in each village, except in Paulshoek where data already existed, was relied on to show the locations of the stockposts and watering points used by pastoralists during the study period. The informants were selected for their in-depth knowledge of the local farming system. The history of stockpost and watering point usage, reasons for stockpost movements and their stock numbers were obtained through semi-structured interviews with about 300 pastoralists and agro-pastoralists from the 10 villages (Appendix A). Interviews were conducted in the local language, Afrikaans, but notes were taken in English. Stock numbers were also obtained from sources listed in Appendix B.

Fieldwork and interviews were conducted from September 2006 to March 2007. The total number of herds through time presented in this study includes herds that started or went extinct during the study period. The locations and occupation of stockposts and stock numbers for the village of Paulshoek were extracted from a long term livestock database on the Paulshoek farming system maintained by the Plant Conservation Unit at the University of Cape Town. Rainfall data was obtained from the South African Weather Services.

ANOVA was used to test for significant differences in maximum herd size between different herd compositions. When the Kolmogorov-Smirnov normality test failed, the Kruskal-Wallis One Way Analysis of Variance on Ranks test was run using Dunn's method of multiple comparisons (Dunn, 1961). I used maximum individual herd size to determine the number of animals a herder could manage in this variable environment. In Leliefontein, herds with no herders are usually comprised entirely of goats (Samuels, 2006). These goat herds are usually kept close to the village and pastoralists seldom move their stockpost locations. I used t-tests to determine whether the number of stockpost movements of exclusively goat herds was significantly different to herds of other compositions. To test whether larger herds move more often than smaller herds, a regression analysis was used to assess the type and strength of this relationship.

A t-test was used to test for differences in the number of stockpost movements between villages and between years and to test whether there is a difference in the time a herd occupies a single stockpost. When the normality test failed, the Mann-Whitney Rank Sum Test was used. A t-test was also used to test whether there were significant differences in minimum temperatures and the number of frost days during the coldest months (June to August) between stockposts at high and low elevations around the Leliefontein village. Data on minimum temperatures and the number of frost days were extracted from the South Africa Atlas of Agrohydrology and Climatology (Schulze, 1997).

## 4.3 Results

### *4.3.1 Herd management, number of herds and stockposts used*

A total of 256 herds were identified and assessed during the fieldwork period. The number of herds differed between villages (Fig. 4.1). Leliefontein village had the most herds (n=36) whereas the villages on the north eastern boundary of the communal area, Kamassies and Rooifontein had only 12 and 18 herds respectively.

Almost two-thirds (65.4%) of all the herds were comprised of both goats and sheep with a ratio of goats to sheep of about 2:1. About 32% of the herds contained only goats while there were only six exclusively sheep herds. There were significant differences in the median maximum herd size values for all herds comprised of different numbers of goats and sheep ($H=42.293$; $df=2$, $p<0.001$). The median maximum herd size for all mixed herds was 116 and was significantly greater than 61 for goat herds ($p<0.05$) but not different to the median of 91 for sheep herds ($p>0.05$). Median maximum herd sizes between goat and sheep herds were not significantly different ($p>0.05$).

More than half (56.8%) of the herds were managed by the owners themselves. This usually occurred because owners could not afford to employ a herder. Herds managed by hired herders (33.5%) usually had multiple owners and therefore the cost of a herder was shared. From time to time herds were looked after through different arrangements, especially when a herder was fired or left his employment. In such cases, shareholders, family or friends, including women, looked after the livestock temporarily. Sons of owners made up 9.7% of herders but usually only herded animals until such time as they were able to find employment outside the communal areas. In recent years there has been a reduction in the number of local people willing to work as paid herders and herders have been brought in from other communal areas or from private farms.

The number of stockposts used by herds also differed between villages (Fig. 4.1). In Paulshoek, more stockposts were used than in any other village. The number of herds and stockpost used were similar in villages such as Kamassies, Kheis and Rooifontein. Some herds used only one stockpost during the period from 1997 to 2006 whereas other herds used up to 15 different stockposts during this period. Most herds moved between two or more stockposts which were usually erected in areas accessible to motorised transport.

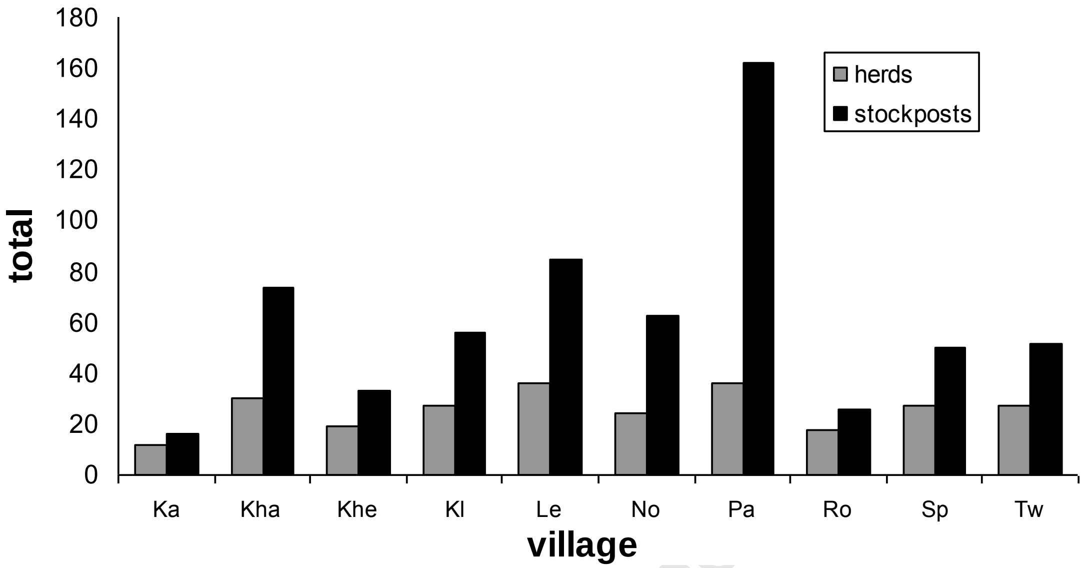



**Figure 4.1**: The total number of herds and unique stockposts used by herds from 1997 to 2006 in the Leliefontein communal area. [Kamassies (Ka); Kharkams (Kha); Kheis (Khe); Klipfontein (Kl); Leliefontein (Le); Nourivier (No); Paulshoek (Pa); Rooifontein (Ro); Spoegrivier (Sp); Tweerivier (Tw)].

### *4.3.2 The number and types of watering points used by livestock in Leliefontein*

The 256 herds investigated used 169 livestock watering points over the period from 1997 to 2006. These included dug wells (40.8%), boreholes (32.0%), springs (17.2%), domestic water sources (5.3%) and dams (4.7%). Boreholes are powered by wind, grid electricity or solar panel-generated electricity. Hand or diesel powered pumps were also used to extract water from boreholes. Almost half of the boreholes in the communal area were not working in 2006 and the rest were in a poor condition (e.g. reservoirs and water troughs were leaking). Infrastructure has been installed by various state departments over the years, but maintenance plans have seldom been developed. Currently this is the responsibility of the local municipality but due to their limited financial resources and management capacity, they do not maintain watering points. Livestock owners sometimes fixed broken boreholes themselves. Where water table permits, shallow wells are dug and maintained by local livestock keepers. The data showed that these dug wells are the most commonly used water source in the Leliefontein communal area.

### *4.3.3 What is the nature of herd mobility patterns in Leliefontein?*

Since 1997, there were 1 832 stockpost movements in total within all the villages (Table 4.1). There were significant differences in the number of stockpost movements between villages (t=4.98; df=9; $p<0.01$). There were 512 stockpost movements by pastoralists in the Leliefontein village alone but in Kamassies, Kheis and Rooifontein there were less than 100 stockpost movements for these three villages together (Table 4.1).

According to the TRANCRAA (Act No. 94 of 1998), any pastoralist who has a birthright or has been residing in Leliefontein before 02 November 1998 has the right to put up a stockpost anywhere within the communal area except on someone else's rented cropland. However, one would expect conflict to arise but pastoralists in Leliefontein usually go to great lengths to avoid conflict. The respect for other people's traditional grazing lands and strong social cohesion in the community has resulted in little conflict over grazing lands. Access to grazing lands in Leliefontein is different to the mobile pastoral system of the Maasai in Tanzania where user rights are not transferred inter-generationally within families. User rights to the Ngorongoro conservation area in Tanzania are only granted through acceptance of membership in the community by village elders (Galvin et al., 2008). Although most pastoralists in Leliefontein moved within their village commons (80.4%) some also moved between village commons (15.9%). In a minority of cases, herds also moved onto the recently-acquired land reform farms (2.9%) and adjacent private farms (0.8%).



**Table 4.1**: The locations of stockpost movements from 1997 to 2006 in the Leliefontein communal area. [Kamassies (Ka); Kharkams (Kha); Kheis (Khe); Klipfontein (Kl); Leliefontein (Le); Nourivier (No); Paulshoek (Pa); Rooifontein (Ro); Spoegrivier (Sp); Tweerivier (Tw)].

| **Destination** | **Ka** | **Kha** | **Khe** | **Kl** | **Le** | **No** | **Pa** | **Ro** | **Sp** | **Tw** | **Total** | **Total %** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Within village boundaries | 2 | 215 | 27 | 57 | 267 | 288 | 252 | 4 | 174 | 187 | 1473 | **80.4** |
| Across village boundaries | 1 | 6 | 0 | 0 | 241 | 4 | 5 | 22 | 2 | 11 | 292 | **15.9** |
| Land reform farms | 6 | 0 | 3 | 0 | 4 | 23 | 8 | 9 | 0 | 0 | 53 | **2.9** |
| Private farms | 0 | 0 | 1 | 0 | 0 | 3 | 10 | 0 | 0 | 0 | 14 | **0.8** |
| **Total** | **9** | **221** | **31** | **57** | **512** | **318** | **275** | **35** | **176** | **198** | **1832** | **100** |

Between 1998 and 2000, five land reform farms were acquired for the communities of Leliefontein through the Land Reform Programme of South Africa. These farms were acquired as a direct consequence of the government policy to redress the unequal distribution of land in South Africa with the majority being in the hands of white farmers. The Land Reform Programme aims to transfer 30% of agricultural land in South Africa to previously disadvantaged people by 2014. The land reform farms are divided into paddocks (locally referred to as camps) and a single paddock could be given to more than one herd. Paddock sizes on these farms range between 126 and 2 199 hectares.

Pastoralists in Leliefontein are only allowed to move onto private farms if they reach agreements with commercial farmers. The terms of the agreements entail repaying the commercial farmer through labour (labour tenancy) or transferring 50% of the pastoralist's newborn lambs to the farmer. Through the 50:50 agreement the commercial farmer often gives pastoralists access to his veterinary services and good quality rams to service pastoralists' stock.

Between 1997 and 2006, 187 out of the total of 256 herds moved their stockposts at least once whereas 69 herds did not move at all (Fig. 4.2). The owners of a herd and not the herders make the decisions on where and when to move a stockpost. Eighty seven herds moved less than five times between 1997 and 2006. Fifty four herds moved between 16 to 20 times and only 14 herds moved more than 20 times during this period. Due to differences in the stockpost movements between herds, the average time period that a single herd occupied a stockpost varied significantly ($t=4.58$; $df=0$; $p<0.001$). On average, pastoralists in Kamassies village occupied a single stockpost for approximately five years (Fig. 4.3). Pastoralists in Rooifontein and Klipfontein villages occupied a single stockpost for almost 40 months. Pastoralists in the upland villages of Leliefontein, Nourivier, Paulshoek and Tweerivier occupied a single stockpost for less than a year. The average stationary time for herds in Kheis was similar to Kharkams which had more movements (Table 4.1) because four of the nine herds that moved in Kheis were only constituted in August 1998.

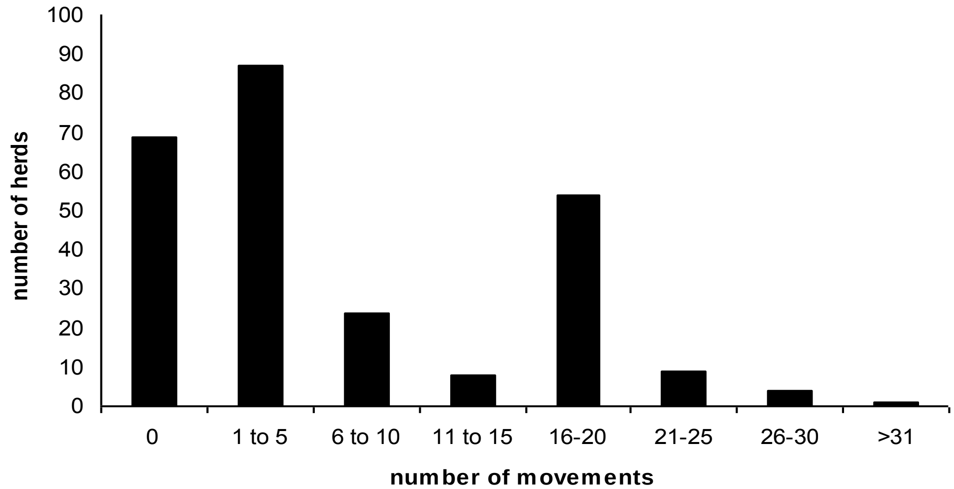



**Figure 4.2**: The number of stockpost movements (n=1832) by all herds (n=256) from all 10 villages between 1997 and 2006 in the Leliefontein communal area.

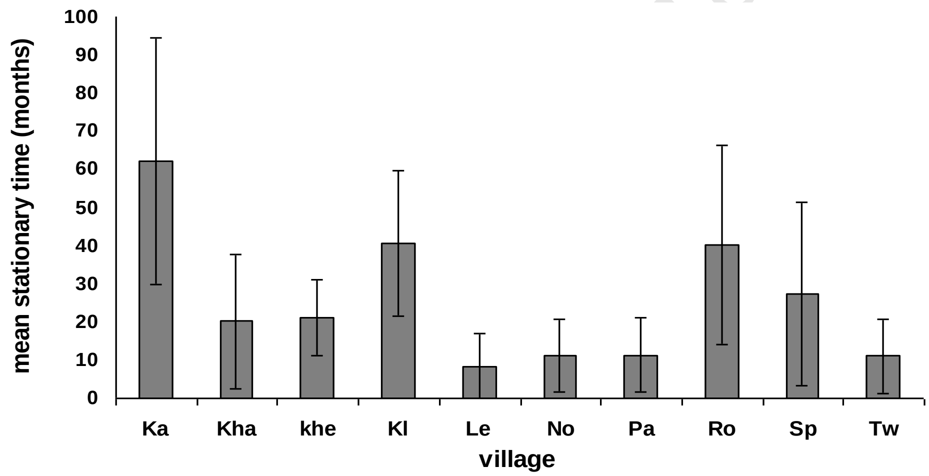



**Figure 4.3**: The mean stationary time (±std. dev.) for herds at any stockpost from 1997 to 2006 for the 10 villages located in the Leliefontein communal area. Key to villages follows Table 4.1.

The average number of stockpost movements per year made by all the herds combined between 1997 and 2006 was 188, and ranged from 166 to 205 movements (Fig. 4.4). There was a significant difference in annual stockpost movements between years ($t=10.888$; $df=9$; $p<0.001$). Average monthly stockpost movements for all ten villages combined exhibited a bimodal distribution pattern (Fig. 4.5). Monthly stockpost movements peaked during the wetter months from April to June and during the hotter months from October to January each year.

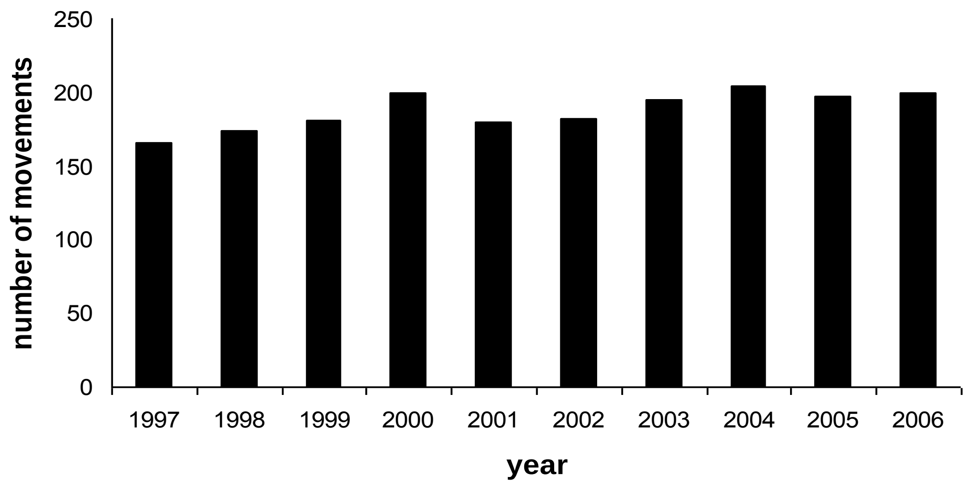



**Figure 4.4**: Number of stockpost movements per year of herds from 1997 to 2006 in the Leliefontein communal area.

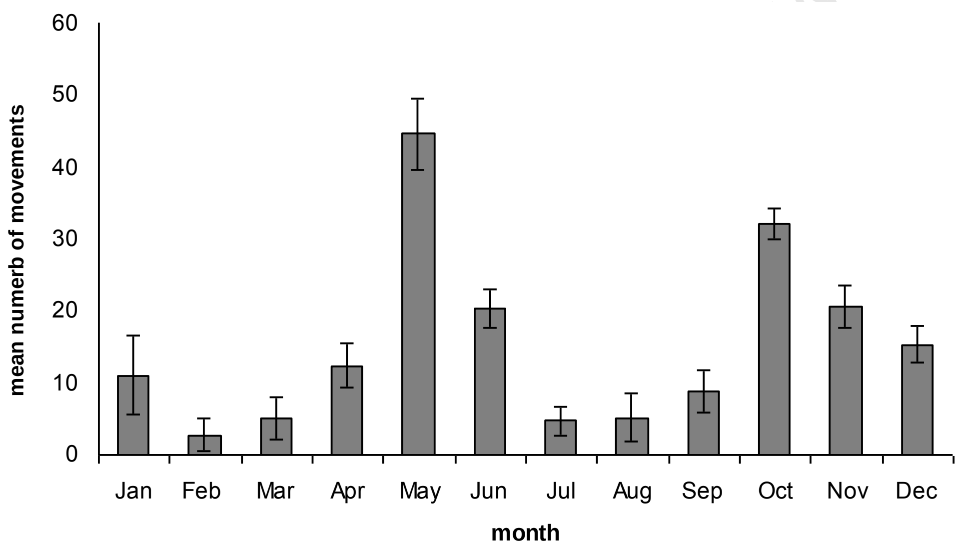



**Figure 4.5**: Average number of stockpost movements per month (±std. dev.) in the Leliefontein communal area from 1997 to 2006.

### *4.3.4 What drives herd mobility in the spatially constrained Leliefontein communal area?*

The decision to move a stockpost is based on a range of both social and environmental drivers which differ between different villages (Table 4.2). For example, pastoralists in and around the Leliefontein village moved regularly from the higher elevations in the winter months to avoid cold temperatures. Pastoralists avoided the cold because of the fear that their animals would develop pasteurellosis and die. Since temperature decreases by 0.7 $^{0}$C for every 100 m decrease in elevation, by moving to lower elevations farmers in Leliefontein were able to avoid some of the colder winter temperatures of the highlying regions. According to the South African Atlas of Climatology and Agrohydrology (Schulze, 1997), the median minimum temperatures for June to August for the areas where stockpost are moved from in winter by Leliefontein pastoralists are 3.0 to 3.8 $^{0}$C respectively. The median minimum temperatures for the same months for areas to which they moved lower down the elevation gradient were 4.0 to 5.0 $^{0}$C respectively. This reflects a significant difference in minimum temperatures between these two locations for June ($t=1125.0$; $n=39, 43$; $p<0.001$); July ($t=1080.5$; $n=40, 44$; $p<0.001$) and August ($t=1153.0$; $n=39, 43$; $p<0.001$). There was also a significant difference in the number of frost days in the winter months between these two locations ($t=2054.0$; $n=39, 43$; $p<0.001$).

The number of stockpost movements was positively related to herd size ($r^2=0.082$; $p<0.001$) as well as to herd composition ($H=16.714$; $df=2$; $p<0.001$). Mixed herds moved significantly more than herds comprised only of goats ($p<0.05$) but not more than herds that were comprised only of sheep ($p>0.05$). Herds comprised only of sheep also moved more frequently than herds comprised only of goats ($p<0.05$).

The owners of the 69 herds that had not moved in the ten year period provided a range of personal and environmental reasons why they did not move (Table 4.3). Some owners had more than one reason why they decided not to move their stockposts. Half of the reasons given by the owners were personal reasons that related to proximity to the village, family and health issues as well as to the absence or unavailability of herders. Environmental reasons given by herd owners included proximity to water, good quality forage around the stockpost and that the number of herds and animals within the herds were too few to cause trampling. Some pastoralists did not move because they wanted to remain close to their croplands. The absence of cropping in certain areas also meant that some pastoralists did not have to move.

**Table 4.2:** Reasons provided for stockpost movements within the Leliefontein communal area during the period 1997 to 2006. Only 1633 reasons for the 1832 stockpost movements are listed. Only reasons for 125 of the 275 movements in Paulshoek were provided by the database and 24 reasons could not be accurately obtained from the interviews.

| Reason | Within village boundary | Across village boundary | Total |
|---|---|---|---|
| **Environmental** | | | |
| Temperatures too cold during winter | 91 | 122 | 213 |
| To prevent trampling through stockpost rotation | 178 | 21 | 199 |
| Poor range condition at previous location | 39 | 0 | 39 |
| To be closer to a good water source for animals | 37 | 0 | 37 |
| Better range condition in certain areas | 35 | 2 | 37 |
| Abundance of toxic plants in certain areas | 23 | 0 | 23 |
| Presence of parasites in certain areas | 3 | 0 | 3 |
| To move away from predators that killed lambs | 3 | 0 | 3 |
| To move away from river during heavy rains | 2 | 0 | 2 |
| Stockpost too wet in winter | 1 | 0 | 1 |
| No water for the herder at previous location | 1 | 0 | 1 |
| The landscape is flatter at previous location | 1 | 0 | 1 |
| | **415** | **145** | **560 (34.3%)** |
| **Agricultural** | | | |
| To move away from cultivated fields | 370 | 4 | 374 |
| To graze one's crop residues | 147 | 6 | 153 |
| To be closer to one's croplands | 5 | 0 | 5 |
| To move after one has harvested his crops | 4 | 0 | 4 |
| | **526** | **10** | **536 (32.8%)** |
| **Personal** | | | |
| To be closer to one's own village to go home at night | 22 | 130 | 366 |
| To return to the permanent summer stockpost | 274 | 0 | 274 |
| To join another herd | 41 | 6 | 47 |
| To be closer to the village for family occasions | 26 | 0 | 26 |
| Owner wants to be on his own | 16 | 0 | 16 |
| To be closer to the village due to ill health | 2 | 0 | 2 |
| To be closer to the village during lambing season | 1 | 0 | 1 |
| | **383** | **136** | **519 (31.8%)** |

| | | | |
|---|---|---|---|
| **Social** | | | |
| Too many herds in one location that might result in conflict | 11 | 0 | 11 |
| Animals in herd graze in the village | 4 | 0 | 4 |
| To be closer to schools | 1 | 1 | 1 |
| Stock theft | 2 | 0 | 2 |
| | **17** | **0** | **18 (1.1%)** |
| **Total** | **1340** | **292** | **1633 (100%)** |

**Table 4.3**: Reasons given by pastoralists for remaining stationary during the study period.

| **Reason** | **Count** |
|---|---|
| **Environmental** | |
| Stockpost is close to a good water source | 18 |
| Range condition is still good around current stockpost | 10 |
| No overgrazing since only few herds present in the area | 7 |
| The herd size is too small to cause trampling | 4 |
| | **39 (40.2%)** |
| **Agricultural** | |
| Owner wants to remain close to his croplands | 5 |
| One could keep animals from grazing crops | 2 |
| There was no cropping in the area | 2 |
| | **9 (9.3%)** |
| **Personal** | |
| Herder is close to the village to go home at night | 25 |
| Owner wants to remain in the place where he grew up | 8 |
| Herd has no herder | 8 |
| Herder's health is too poor to move | 7 |
| Herder's entire family stay at current stockpost | 1 |
| | **49 (50.5%)** |
| **Total** | 97 |

## 4.4 Discussion

This study identified several different herd mobility patterns across different temporal scales during the study period from 1997 to 2006 in the Leliefontein communal area. This suggests that there is heterogeneity in livestock management amongst pastoralists in the spatially constrained communal area and that they face different sets of constraints as livestock keepers. It has previously been shown that different pastoralists in Leliefontein have different perceptions about the environment based on their personal and very local ecological knowledge (Samuels, 2006) and thus they might also manage their herd differently based on their specific sets of criteria for assessing rangeland condition.

### *4.4.1 What is the nature of herd mobility patterns in Leliefontein and what drives these patterns?*

In the Leliefontein communal area, seasonal movements were along altitudinal gradients as well as horizontally across the landscape. Seasonal movements are used by pastoralists all over the world to move livestock between seasonal grazing areas (McCabe, 1983; Niamir-Fuller, 1999b; Touré, 2004; Adriansen, 2008). As in other pastoral systems (Dyson-Hudson and Dyson-Hudson, 1980; Hudson, 1980; Niamir-Fuller, 1999b; Turner, 2003; Kerven et al., 2004), vertical movements in Leliefontein are also used to evade unfavourable climatic conditions. In the study area, pastoralists from Leliefontein village moved mostly just before the start and immediately after the onset of the cold season. In this village, pastoralists move to lower altitudes onto the Tweerivier village commons to escape low temperatures during winter in the uplands. The pastoralists in the Tweerivier in turn move to the southern parts of their commons to accommodate pastoralists from Leliefontein village who settle in the northern parts of the Tweerivier commons.

There is no formal institution regulating inter-village movements between Leliefontein and Tweerivier pastoralists. Movement patterns up and down the altitudinal gradients of the Kamiesberg in response to winter and summer temperatures were evident before the colonists occupied Namaqualand (Webley, 2007). Pastoralists say that they maintain these traditional movement patterns to ensure that their livestock survive the cold winter temperatures. This mobile system is maintained due to good social cohesion in the two communities. In 2011, concerns were raised about stockpost locations of pastoralists from Leliefontein village that graze the croplands of Tweerivier farmers. This issue was resolved when the two communities met and agreed that Leliefontein pastoralists should not grazed on other people's croplands even if no crops are grown during the winter season.

Seasonal movements also occurred when herds moved away from growing crops but these movements were not always along an altitudinal gradient. Dryland cropping was the reason for 32.8% of the movements within the Leliefontein communal area. Dryland cropping occurs mostly in the Leliefontein, Nourivier, Kharkams, Tweerivier, Spoegrivier and Paulshoek villages and is the main reasons why stockposts in these villages are moved. This study and the findings of Baker and Hoffman (2006) show that livestock keepers in Leliefontein move their stockposts away from growing crops to prevent crop damage. We know from studies in other areas (Bayer and Waters- Bayer, 1989; Homewood, 2008; Chonco, 2009) that this practice is typical of many mobile pastoral societies. After harvesting in November and December in Leliefontein, herds move closer to croplands to graze on crop residues which may have much higher nutritional value than natural vegetation at the same time of year. Arable lands are considered key resource areas for livestock during dry seasons in other pastoral systems in South Africa (Bennett et al., 2007; Chonco, 2009) and elsewhere when natural vegetation becomes scarce (Scoones, 1995a; Baba and Magadi, 1998; Kerven et al., 2004; Homewood, 2008) and when livestock need to be kept in good physical condition. Pastoralists in Leliefontein and elsewhere (Schareika, 2001) keep their animals in good physical condition to improve breeding success and to enable them to survive the dry season.

It is assumed that overgrazing is the main cause of degradation in the communal areas (Lamprey, 1983; Fryxell and Sinclair, 1985). Several studies in the Kamiesberg have shown that cover of palatable perennial shrubs and succulents has declined as a result of high grazing pressure, particularly on the lowlands and around watering points and villages (Todd and Hoffman, 1999, 2009; Anderson and Hoffman, 2007). These impacts of overgrazing in the Kamiesberg can result in rangeland degradation if the changes are irreversible after several decades. However, overgrazing should not only be attributed to poor livestock management practices but also to overcrowding on the commons. Overcrowding occurs when many herds use the same grazing area such as when herds congregate around limited water sources during the dry season when the survival of herds depends on access to water. This is different to poor livestock management when an area is continuously grazed although pastoralists have an option to move.

Pastoralists in Leliefontein and other mobile pastoralists (Western, 1982; Behnke, 1999) usually attempt to prevent trampling and overgrazing by resting certain parts of the rangeland and moving away from overutilised areas when water is freely available. In the study area, about 12% of the movement of stockposts were undertaken to prevent the impact of trampling around stockposts. This was mentioned more frequently by pastoralists in Kharkams, Leliefontein and Tweerivier villages where stockpost density was highest. There is no government regulation for herd movements in the communal area and pastoralists decide to move on their own. This is because pastoralists in general are well aware of erosion and vegetation degradation problems that could emerge if they remain stationary for long periods (Behnke, 1999).

Opportunistic movements, which are characteristic of other mobile pastoral systems (Sieff, 1997; Solomon et al., 2006; de Weijer, 2007), occur in all of the Leliefontein villages, especially when range condition is poor around the stockpost being used at the time. During drought, when the availability and quality of forage generally decreases, many pastoralists in Leliefontein temporarily move their stockposts to areas that are largely undergrazed and have good dry forage (Samuels et al., 2007). Movements at irregular intervals in Leliefontein also occur as a result of overcrowding and predators that force herds to move to other areas. Other studies have demonstrated that disease outbreaks and banditry (McCabe, 1994) and conflict (de Weijer, 2007) are additional factors that determine both short and long term animal movements.

In most mobile pastoral systems, grazing reserves are often accessed to make use of the abundance of dry forage especially during droughts (McCabe, 1994; Behnke, 1999; Oba, 2001; Fernandez-Gimenez and Swift, 2003). However, there is no land available in the Leliefontein communal area to be set aside as grazing reserves due to the limited size of the communal area. Chapter Six shows that some areas, particularly mountainous areas are not grazed at all because these areas are largely not accessible to livestock. Therefore, herds might have to rely on these undergrazed areas to provide their animals with good quality dry season forage.

The introduction of various government policies in the 1960s and 1970s and the shift away from subsistence to a cash economy (Rohde and Hoffman, 2008) forced many families to settle in the villages where previously they were scattered throughout the rangeland at various stockposts. People became accustomed to village life and presently only a few families stay with herders at stockposts. However, several herders frequently move closer to their villages so that they are able to visit their families in the village. It was found that herds in the study area also move closer to the village for family occasions during the Christmas and Easter holidays, or for weddings and burials that could occur at any time of the year (Baker and Hoffman, 2006).



During dry periods, when forage and water are generally more limited on the commons, some pastoralists migrated in and out of the commons to increase their mobile range and have access to better grazing resources. In Leliefontein, seven pastoralists reached verbal agreements with neighbouring commercial farmers to temporarily use their private land and then to return to the commons when conditions become favourable. Pastoralists in Leliefontein that entered into the 50:50 agreements with adjacent commercial farmers say that it is better to sacrifice half of your lambs than to have no lambs at all which can occur when they remain on the commons during drought periods. Pastoralists may also risk losing more of their breeding stock when they do not move out of the commons during drought. This was observed during the drought period in 2003 in Paulshoek village when some pastoralists lost more than 50% of their breeding stock (Baker and Hoffman, 2006).

Temporary access agreements are also used by herders in Namibia and Ethiopia where they negotiate with neighbouring pastoralists or agro-pastoralists to use their lands for grazing during drought periods (Behnke, 1999; Bogale and Korf, 2009). When water is a limiting factor in Mali, Fulani pastoralists enter into arrangements with neighbouring agro-pastoralists to camp near their fields to be closer to water (Ramisch, 1999). In return, agro-pastoralists get milk and manure from the livestock which they use to improve their crop yields. When the extent of drought occurs at a regional level, some mobile pastoralists in Africa use long distance migrations into neighbouring countries to evade drought conditions (Oba and Lusigi, 1987). These cross-border movements are facilitated in policies from regional blocks such as the Economic Community of West African States (ECOWAS) which consists of 15 member states (de Jode, 2010).

In northern Kenya migrating pastoralists also make agreements with non-pastoralists to allow pastoral herds to graze on their private land (Lengoiboni et al., 2011; Letai and Lind, 2012). These agreements are usually during the dry seasons when animals have to move around to search for dry forage. Pastoralists enter into written agreements with private ranchers in which they set the duration of grazing on the farm and the amount of grazing fees to be paid to the rancher. Private ranchers may negotiate access onto their land through grazing committees who will manage the duration of grazing access, collect grazing fees and solve any disputes. If these rules in the agreement are broken eviction, denial of future access, confiscation or fines are the penalties (Lengoiboni et al., 2011).



### *4.4.2 How have herd mobility patterns changed between 1997 and 2006 and what are the drivers of this change?*

Between 1997 and 2006 the most important changes to the traditional herd mobility patterns that could be identified in the Leliefontein communal area occurred when the land reform farms were opened to pastoralists in 1998. Although pastoralists moved onto the farms primarily to improve their production, an important outcome of the process was an additional option of migration out of the commons. Mostly, pastoralists who were located closer to the land reform farms on the eastern side of the Leliefontein communal area moved onto these farms. During 2003, several pastoralists from villages further away from the land reform farms also moved to the farms to evade drought conditions on the old commons. However, most of the pastoralists returned to the old commons due to water and transport constraints, infrastructural problems and overcrowding on the new land reform farms. Pastoralists who remained on the farms have motorised transport and could afford to travel regularly to their home in the village when they run out of food and other supplies (Lebert and Rohde, 2007).

Another aspect of pastoral mobility that is evolving in Leliefontein is the practice of keeping a 'safe' distance from other herds. Due to overcrowding on the commons, some pastoralists frequently move their stockposts to prevent their neighbours' rams from mixing and breeding with their ewes (see Fig. 3.11). Results from the study period do not show significant effects of this strategy on pastoral mobility but through my interviews I observed that pastoralists are becoming more aware of the potential consequences of mixing rams with ewes during the non-breeding season. Pastoralists in Leliefontein want their lambs to be born in winter when sufficient grazing resources are available. In some herds the rams remain with the herd the entire year and ewes are therefore often impregnated during the winter period and give birth during the dry season when resources are scarce. A pastoralist may also want his own ram to impregnate his livestock to improve the overall quality and hardiness of his next generation of breeding stock. Dangers of ram mixing were not evident during the eras before apartheid since all the rams were looked after by a *ramwagter* ('ram herder') or kept separately from the main herd in a ram camp. However, none of the villages now has a *ramwagter* and only five villages have ram camps which are not always used for the purpose intended. Frequently ram camps are occupied by individuals because of the generally better quality of forage and the lack of grazing management control. In other African pastoral systems this strategy of keeping a 'safe' distance from other herds is used over larger spatial scales to prevent the spread of diseases and pests (Niamir-Fuller, 2000). In Mongolia, herders have watering schedules to prevent herds from mixing (Fernandez-Gimenez, 2002). Similarly, reindeer nomads have a grazing timetable and move their herds quickly through narrow migratory passages so that they do not mix with other herds (Dwyer and Istomin, 2006; Behnke et al., 2011).

During the study period, about 27% of herds did not move at all. This occurred most commonly when there was no cropping in the area where their stockpost was located. Pastoralists in other areas such as the Rendille and Ariaal in northern Kenya also prefer to remain stationary in order to be close to socio-economic and health services (Fratkin et al., 1999). Similarly, in Senegal, some Fulani herders do not want to move and prefer to remain close to their homes since herding is too labour intensive (Adriansen, 2008). Other reasons for not moving a stockpost include affordability, ill health or for other personal reasons. Single owners also preferred not to move when their stockposts were situated close to the village and they were able to go home at night. Many pastoralists also kept small goat herds at permanent stockposts near the village because goats are able to graze unattended. Goats are also preferred because of their resilience to drought and their ability to cope with the rugged terrain which characterises much of the Leliefontein communal area (Samuels, 2006).

When pastoral mobility is reduced due to land fragmentation or herds become stationary, pastoralists risk having a reduction in animal productivity (Wilson and Clarke, 1976; Boone and Hobbs, 2004; Boone, 2007; de Jode, 2010). For example, in western Sudan, calving rates in mobile herds was 25% more and calving mortality was 29% less than that of sedentary herds (Wilson and Clarke, 1976). In Zimbabwe, mobile herds had a greater survival rate than that of sedentary herds during drought periods (Scoones, 1992). However, Baker and Hoffman (2006) found that mobility did not result in an increase in livestock production or a decrease in mortality between sedentary and mobile herds in Paulshoek village in Namaqualand. The fact that pastoralists do not obtain higher animal production rates and that moving a stockpost is costly since one requires labour and transport, might be why sedentarisation of herds is likely to increase in the future.

This study shows that even in a spatially constrained pastoral system where multiple land uses occurs, a range of traditional mobility patterns could still be maintained by pastoralists to manage their livestock. In Leliefontein, pastoralists have adapted their traditional mobility patterns to their spatially constrained environment. They have also developed new patterns of mobility (see Fig. 3.11) which are determined by several environmental, agricultural, personal and social factors that operate at herd and village levels within the pastoral system. Movements due to a range of social factors not only allow pastoralists to benefit by avoiding other herds, but also to maintain some level of social cohesion within the pastoral system. Maintaining social networks in Leliefontein allows pastoralists access to resources and information in times of need and prevents conflict over limited resources in the spatially constrained pastoral system. Even though pastoralists experienced high variability in climatic conditions during the study period, their mobility practices remained relatively stable since only a few herds could temporarily move in and out of the commons.

# Chapter Five

## Spatial distribution of herds in a variable and constrained pastoral area in Namaqualand: the roles of resources and human settlements

**Abstract**

In this study I assessed the spatial distribution of herds and their mobility patterns from 1997 to 2006 in the variable and spatially constrained Leliefontein communal area. In addition, I investigated the role of water, croplands and human settlements on the movement patterns of herds in Leliefontein. There was variability in the spatial mobility patterns of herds across the landscape. Some movement patterns mimic the historical movement patterns of Nama pastoralists before the region was colonised but on a considerably smaller spatial scale. Movement distances between stockposts were up to 12.1 km within and 31.8 km across village boundaries. Movement distances were significantly different between villages but were not affected by herd composition. There were significant differences in monthly stockpost locations in relation to water location and availability between all herd groups. During the wet winter months when the vegetation is full of water and growing, herds move away from formal water sources to areas that are seldom grazed in summer. Herds that are located closer to croplands move away in winter to protect growing crops. In some villages herds were located close to human settlements mostly due to personal reasons and labour requirements for preparing croplands.



### 5.1 Introduction

Livestock farming is the major land use practice in most arid and semi-arid environments. Within these ecosystems, rainfall is unpredictable and variable in space and time. In some years, droughts of varying durations may occur whereas in other years an area might become flooded. Rainfall variability results in patchiness of food and water availability for people and animals occupying these areas (Behnke et al., 2011). In drylands, pastoralists make use of herd mobility to access patchy rangeland resources ((Niamir-Fuller and Turner, 1999) and attempt to optimise the use of available resources within the limitations of water supply in the dry season (Western and Dunne, 1979). Animals derive benefit through mobility because they can obtain optimal physical condition if their energy intake is greater than the energy they spend during grazing. Optimal physical condition is important for breeding success and for survival during the dry season (Schareika, 2001).

Pastoral systems are continually becoming smaller and spatially constrained due to environmental, socio-economic and political factors (Makepe, 2006; de Jode, 2010; Flintan, 2011) and many pastoralist groups can no longer move their animals over long distances into other grazing areas. This is evident in Niger (Turner, 1999a) and Kenya (Kipuri and Naikuni, 2008) where the formation of conservation areas amongst other factors restricts pastoralists from gaining access to traditional grazing resources. Transhumance has decreased in Afghanistan as pastoralists avoid areas of conflict (de Weijer, 2007). In African countries as different as Lesotho and Sudan, mobility patterns of pastoral herds are also affected by the encroachment of crop expansion onto grazing lands (Turner, 2003; Babiker, 2012).



There is a lack of understanding of herd movements within smaller and spatially constrained pastoral systems which characterise much of South Africa (Hoffman and Ashwell, 2001). As traditional pastoral lands are changing, it is important to assess the spatial extent of herd movements to understand how grazing patterns might change over time. As discussed in Chapter Three, the Leliefontein communal area has become smaller in size and pastoralists are restricted in their movements between agro-ecological zones in order to evade unfavourable environmental conditions and to access grazing resources. This chapter will assess how pastoralists in Leliefontein move their herds over spatial scales in their spatially constrained rangeland.

Pastoralists move their herds to an area due to a range of environmental and socio-economic factors (Western and Dunne, 1979; Fernandez- Gimenez, 1999; Baker and Hoffman, 2006; see also Chapter Four). The selection of grazing sites in Niger, for example, was based on the quality and quantity of fodder (Schareika, 2001). Water availability is also critically important for herders in Africa (Bassett, 1986; Coughenour, 1991; Coppolillo, 2000) and Asia (Fernandez- Gimenez, 1999; Kerven et al., 2004) when they relocate their herds during the dry season. Also, the Rendille of Kenya settle small stock camps closer to human settlements for water and to trade with local stores (Fratkin, 1986). In other parts of Asia, the decision of where to establish camps is based on the decision of experienced herders who have in-depth knowledge of the local environment. Decisions are also partially based on the relationship with crop farmers in the area (Agrawal, 1993). In the Paulshoek rangeland in Namaqualand, labour sharing is a major factor since herders locate their stockposts close to each other to provide reciprocal assistance during the lambing season (Baker and Hoffman, 2006).

Previous studies that have assessed movement patterns between grazing sites have mostly focused on pastoral systems where long-range movements occur in combination with short-range movements (Fernandez-Gimenez and Allen-Diaz, 1999; de Weijer, 2007; Behnke et al., 2011). In West Africa long-range transhumant patterns of up to 500 km occur to access better forage and water (Behnke et al., 2011). Behnke et al (2011) described middle distance movements between 15 to100 km to access better resources, to avoid disease areas and for animal safety as well as short-range movements between 3-15 km around villages and watering points. In Afghanistan long-range movements across provincial and state boundaries occur when herds move between seasonal grazing areas (de Weijer, 2007).  Short-range movements also occur when herd sizes are small and the demand for forage is less (de Weijer, 2007).



In this study, I investigate the spatial parameters of pastoral mobility from 1997 to 2006 in the variable and spatially constrained Leliefontein communal area. Over the last two decades the area has been administrated by three different institutions and their different land use policies for the communal area might have affected pastoral mobility over this period. A management council, which was established by the apartheid government, managed the land until 1995. After apartheid, the Leliefontein Local Transitional Council, which consisted of representatives of civil society, took over the administration until 2000 when the Kamiesberg Local Municipality was formed.

Firstly, I assess and discuss the spatial parameters of herd movements between stockposts and identify a typology of movement patterns. Secondly, I investigate the role of water in the spatial management of pastoral herds. In semi-arid areas, the provision of water for animals is important during the dry season when animals might not get sufficient moisture from the vegetation (Bassett, 1986; Fernandez- Gimenez, 1999) or when current boreholes are not functioning (Adriansen, 2008). Thirdly, I assess and discuss the role of croplands in grazing management. Croplands are used as key resource areas for pastoral herds during dry and drought periods (Bassett, 1986; Baba and Magadi, 1998; Bennett et al., 2007). Lastly, I investigate the role that human settlements play in the location of stockposts.

To achieve these objectives, I asked the following questions:

1. How far do herds move between different stockposts?
2. Are there differences in the movement patterns of herds?
3. Have the spatial parameters of pastoral mobility in the study area changed over time?
4. How do water, croplands and human settlements affect the location of stockposts?

## 5.2 Methods

This study was carried out in the Leliefontein communal area. For a detailed description of the study area, see Chapter Two.

### *5.2.1 Data collection*

I collected data on the spatial distribution and movement between stockposts of all the herds in Leliefontein from January 1997 to December 2006. Semi-structured interviews were conducted with pastoralists to determine when and where they move their stockposts (Appendix A). I also asked their reasons for moving or not moving their stockposts. During the fieldwork period, I used a Garmin eTrex (Garmin Ltd, Kansas, USA) handheld GPS receiver to record the locations of stockposts and livestock watering points used by the herds during the study period. A local guide from each village except Paulshoek village was employed to show the locations of stockposts and watering points.

The locations of stockposts in Paulshoek were obtained from an existing database on livestock farming which is maintained by the Plant Conservation Unit at the University of Cape Town. The locations of the watering points in Paulshoek were obtained from Samuels (2006) who conducted a study on daily grazing routes of herds during a drought period in the village. GPS data on human settlements and ram camps[23] were obtained by walking around the perimeter. Data was collected from September 2006 to July 2007.

### *5.2.2 Land use mapping*

All those who rent croplands in Leliefontein were interviewed between September 2006 and July 2009. During the interviews I recorded all the years that the crop farmer used a specific cropland and what the reasons were for not cropping in some years. Croplands were formally mapped in 2003 by a consultant employed by the local municipality. However, during the fieldwork period only a printed copy of the allotment map was available as the original data have been lost. This map was digitised using ArcView 3.2. The cropping season in the communal area usually occurs from May to November each year. In the uplands around the Leliefontein village, however, ploughing may start as late as July depending on the particular seasonal rainfall conditions (too little or too much). Unusually cold temperatures also delay ploughing in some years. Since the cropping season differs between years, I used monthly distances of stockpost locations from croplands from April to represent the non-cropping season and September as the cropping season to analyse the differences in distances between the seasons.

I used ArcGIS 9.3 to map the locations of stockposts, watering points and human settlements. This software was also used to determine how far stockposts are located from watering points, croplands and human settlements as well as the distance that livestock keepers have moved their stockposts.

The average herd size for each stockpost used was determined by adding the number of animals that used a stockpost every month and dividing the total by the number of months the stockpost was occupied. Livestock numbers were obtained from a number of

[23] *A fenced-off area where only rams are kept during the non-mating season from March to October*

different sources (see Appendix B). Monthly livestock numbers for stockposts that were not obtained from these sources were estimated using the percentage change in monthly stock totals for herds from Paulshoek and applied to the other nine villages. The change in monthly livestock numbers in Paulshoek is affected by environmental variables that influence birth and deaths rates, as well as socio-economic variables such as local and market sales (Baker and Hoffman, 2006). These factors also play important roles in regulating animal numbers in all other villages and therefore it is the best available information to use to estimate monthly livestock numbers for the entire Leliefontein communal area.

### *5.2.3 Data analysis*

Univariate analysis of variance was performed using the General Linear Models (GLM) procedure of SAS statistical software version 9.2 to compare the distances moved between stockposts. The Shapiro-Wilk test was used to test for normality (Shapiro and Wilk, 1965). Since distances were not normally distributed, square root or log transformations were therefore used to normalise the data.

Univariate analysis of variance was also performed on stockpost distances from all independent variables assessed using the GLM procedure. The independent variables consisted of the locations of watering points, human settlements and croplands. When normality failed, the sum of squares totals were used to compare the total and average stockpost distances from the independent variables between villages and herd compositions. The student's t-test significant difference was calculated at the 95% confidence level to compare the mean stockpost distances from watering points, human settlements and croplands. A Principle Component Analysis (PCA) was conducted to determine the combined influence of all independent variables and herd size on stockpost locations. A Pearson correlation matrix was used to measure the strength of the linear dependence between the variables that determine stockpost locations. A probability level of $p<0.05$ was considered significant for all statistical tests.

## 5.3 Results

A total of 595 stockposts were used by 256 herds from January 1997 to December 2006. Stockposts and watering points were scattered throughout the communal area but several stockposts were congregated around human settlements and watering points that are mostly located in north-south valleys (Fig. 5.1). There were also areas where there were no watering points and where stockposts were absent. These areas are the mountainous areas which are difficult to access via road. There were 559 demarcated croplands on the commons (Fig. 5.1). Croplands accounted for 23 049.8 ha or 12% of the communal area and their sizes ranged from 0.6 to 302.0 hectares. Croplands occurred mostly in the uplands and midlands since these areas receive more rainfall than the eastern plateau and western lowlands near the coast. In total, 128 different croplands were cultivated between 1997 and 2006 with an average of 66 used per year. On average 3741.7 ha of land demarcated as croplands was used per annum for cropping purposes during the ten year study period.

There were 78 herds or 30% of the total herds that used only one stockpost during the study period (Table 5.1). Of these, 69 herds never moved their stockposts and nine herds moved out of the commons either onto the land reform farms acquired for these pastoralists by the government or onto adjacent private farms. Another 24 herds also moved onto the land reform or adjacent private farms but these herds used more than one stockpost in the communal area during the ten year study period. Of the herds that moved between two or more stockposts, most were found in Kharkams, Klipfontein, Leliefontein village, Nourivier, Paulshoek, Spoegrivier and Tweerivier and rotated mostly between summer and winter stockposts. In Paulshoek, 17 herds used more than three stockposts during the study period and some of these herds seldom moved back to the same stockpost.

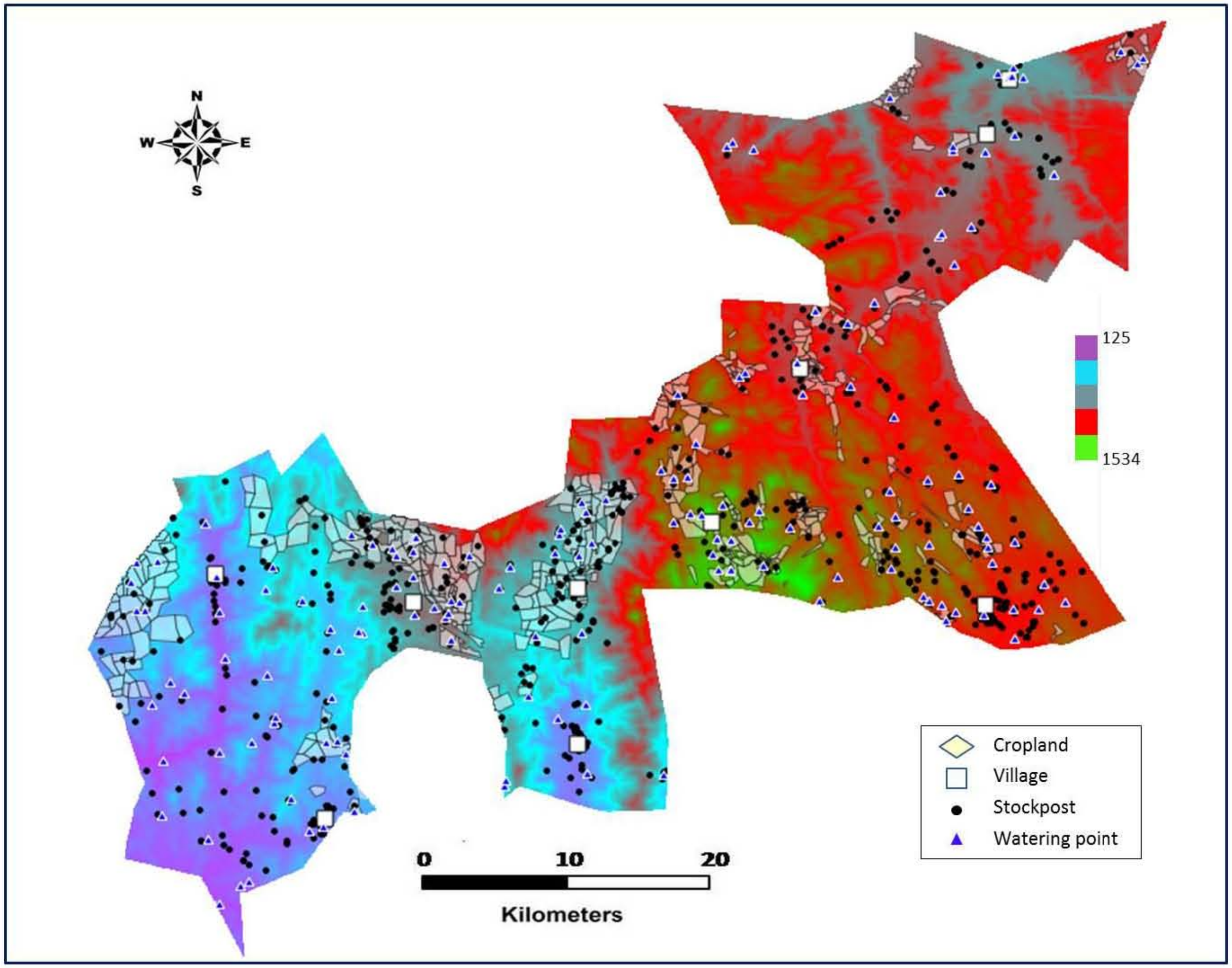



**Figure 5.1**: Digital elevation model (DEM) and the distribution of various land uses in relation to altitude within the Leliefontein communal area.

### *5.3.1 How far do herds move?*

During the study period, the average distance moved between stockpost locations within village boundaries was 4.2 km per move when all herds were considered. The shortest distance moved between stockposts locations was 0.1 km and the furthest was 12.1 km. When considering all the movements per herd for the ten year period, the average total distance moved between stockposts was 47.9 km. The total distance of all stockpost movements within village boundaries was 7372.2 km.

**Table 5.1**: Number of different stockposts used by a herd in each village between January 1997 and December 2006 in the Leliefontein communal area.

| | Number of different stockposts used | | | | |
|---|---|---|---|---|---|
| **Village** | **1** | **2** | **3** | **>3** | **No. of herds** |
| Kamassies | 9 | 2 | 1 | 0 | 12 |
| Kharkams | 7 | 13 | 8 | 2 | 30 |
| Kheis | 10 | 6 | 2 | 1 | 19 |
| Klipfontein | 7 | 15 | 4 | 1 | 27 |
| Leliefontein | 4 | 19 | 5 | 8 | 36 |
| Nourivier | 4 | 11 | 7 | 2 | 24 |
| Paulshoek | 7 | 7 | 5 | 17 | 36 |
| Rooifontein | 11 | 6 | 1 | 0 | 18 |
| Spoegrivier | 9 | 14 | 3 | 1 | 27 |
| Tweerivier | 10 | 4 | 10 | 3 | 27 |
| **Total number of herds** | **78** | **97** | **46** | **35** | **256** |

When pastoralists move their stockposts across village boundaries, the average distance a herd moved was 8.4 km. The minimum distance was 0.9 km and the maximum was 31.8 km. The total distance of all stockpost movements across village boundaries was 1931.1 km. When herds move out of the commons and onto the land reform farms, the total distance that all the herds moved was 677.7 km. The average distance a herd moved between the land reform farms and stockpost locations on the communal area was 12.1 km. The minimum distance was 1.8 km and the maximum was 30.9 km. The total distance of all the stockpost movements in Leliefontein was 9303.4 km during the study period. This excludes the movements by communal herds onto private farms.

There were 14 stockpost movements by seven pastoralists onto seven different private farms during the study period. Four of these movements were during a drought because of the lack of forage on the commons. The abundance and quality of forage during drought on the private farms were perceived by pastoralists to be better than that of the communal area. Other pastoralists moved onto private farms temporarily due to the lack of competent herders to look after their animals. On private farms, pastoralists can take advantage of fenced camps to leave the animals on their own.

Six of these private farms are adjacent to the communal area and one farm is about 100 km away near the town of Springbok. The sizes of the herds that temporarily moved onto private farms ranged from 25 to 255 SSU (Avg. 93 SSU). Five pastoralists returned to the commons during the study period while the remaining two were still on the private farms when the study was conducted. The time spent on the private farms ranged from 3 to 22 months.

ANOVA tests indicate that there were significant differences in the average single (F=3.00, df=9; $p$=0.003) and total (F=4.89, df=9; $p$<0.001) stockpost distances moved by herds from the different villages. The average total distances moved between stockposts by a single herd were the shortest in Kamassies and Kheis (Table 5.2). These two villages had the least number of watering points and herds did not want to move far away from water particularly during the dry season. The average single and total distances that herds from Nourivier moved between stockposts were the furthest when compared to the other villages. In Nourivier, several croppers cultivated their lands during the study period and herds move away from the cultivated fields to prevent crop damages. When herds in Nourivier move away from the croplands most pastoralists establish their stockpost further away on the periphery of the Rooifontein and Paulshoek village commons. The average single (F=0.96, df=2; p>0.05) and total (F=0.90, df=2; $p$>0.05) stockpost distances moved by herds comprised of different proportions of sheep and goats were not significantly different.

**Table 5.2**: Single and total distances of stockpost movements per herd within village boundaries during the ten year study period.

| | | Single distance moved per herd (km) | | Total distance moved per herd (km) | |
|---|---|---|---|---|---|
| **Village** | **No. of herds that moved** | **Mean** | **Stdev** | **Mean** | **Stdev** |
| Kamassies | 2 | 2.3 | 1.0 | 2.3 | 1.0 |
| Kharkams | 23 | 3.5 | 2.1 | 39.2 | 45.0 |
| Kheis | 8 | 2.1 | 2.0 | 7.5 | 7.5 |
| Klipfontein | 20 | 4.1 | 2.8 | 11.6 | 16.6 |
| Leliefontein | 18 | 4.2 | 2.2 | 64.5 | 49.3 |
| Nourivier | 18 | 6.6 | 1.8 | 108.4 | 57.7 |
| Paulshoek | 29 | 3.9 | 1.4 | 41.2 | 49.3 |
| Rooifontein | 4 | 4.8 | 4.1 | 7.8 | 8.8 |
| Spoegrivier | 18 | 4.0 | 3.0 | 47.7 | 61.8 |
| Tweerivier | 14 | 4.7 | 2.3 | 70.0 | 51.6 |
| **Herd composition** | | | | | |
| Mixed herds | 107 | 4.4 | 2.3 | 56.3 | 54.8 |
| Goats only | 42 | 3.5 | 2.3 | 22.9 | 37.6 |
| Sheep only | 5 | 5.2 | 4.2 | 78.0 | 89.4 |

### *5.3.2 Is there a difference in the movement patterns of herds?*

A range of patterns in stockpost movements were detected during the study period and are illustrated in Fig. 5.2. Distances moved between stockpost locations were significantly different between movement patterns ($F=14.28$, $df=7$; $p<0.001$).

**Map 1:** ***Two-way pattern - 39% (n=73)***

Out of the herds that moved between only two permanent stockposts during the study period, 44 herds moved seasonally (twice a year) and 29 herds moved at more irregular times of the year. The movements of the herd in Map 1 were horizontally across the landscape as they moved between their summer stockpost (I) and their winter stockpost (J) annually. The primary reason for moving in winter (May-Jun) is to prevent animals from damaging growing crops. This herd returned to their summer stockpost during Oct-Nov after the crops had been harvested so that the animals could graze on crop residues.

This also gave the winter grazing area the opportunity to rest and encouraged plants to re-grow.

For those herds that moved seasonally, herd size ranged from 15 to 900 SSU. These herds stayed between three to nine months at a stockpost. For herds that did not move seasonally, herd size ranged from two to 450 SSU. Herds that moved at irregular intervals occupied a stockpost for one to 114 months (Avg. 23.9 months) during the study period. Herds that moved seasonally moved an average distance of about 5.4 km while herds that moved at irregular intervals moved about 4.9 km between stockpost locations. Table 5.3 indicates that this difference is significant.

**Map 2:** ***Three-way pattern - 26% (n=48)***

These herds moved between three permanent stockposts for a range of different reasons. For example, the herd in Map 2 (Fig. 5.2) moved away from growing crops near stockpost (G) to stockpost (H) in winter (May-Jun) and returned after harvesting (Nov-Dec) so that the animals could graze on crop residues. During the latter parts of the dry season (Feb-Mar) when forage became scarce, the herd moved to another stockpost (F). The area around stockpost (F) was perceived to have good dry forage since it was rested during the other times of the year.

Out of the herds that used this pattern, 13 moved seasonally and 35 herds moved at more irregular intervals. Herds that moved seasonally stayed between one to nine months at a stockpost whereas herds that did not move seasonally stayed between one to 113 months (Avg. 18.5 months) at a stockpost. The size of herds that moved seasonally ranged from 15 to 521 SSU. This figure was between seven and 258 SSU for herds that moved at irregular intervals. Herds that moved seasonally between stockposts moved about 5.3 km on average whereas herds that did not move seasonally moved about 4.8 km on average (Fig. 5.3). This difference is significant (Table 5.3).

**Map 3:** ***Radial pattern - 15% (n=28)***

These herds had a permanent stockpost and moved to temporary stockposts during winter or other times of the year due to the different reasons for stockpost movements discussed in Chapter Four. For example, the herd in Map 3 (Fig. 5.2) used vertical movements and moved seasonally from its permanent summer stockpost (A) to lower altitudes at the onset of winter (May-June) to escape freezing conditions in the uplands or to move away from growing crops. The specific winter location was largely determined by the number of herds already in that area. A pastoralist would not move his stockpost to an area if he perceived the area to be overcrowded. The herd depicted in Map 3 (Fig. 5.2) had several winter outposts (stockposts B to E) and returned to its summer station during October to November each year.

Sixteen of the herds that moved in a radial pattern moved seasonally and 12 moved at more irregular intervals. Herds that moved seasonally occupied a stockpost between one to eight months and herds that moved at more irregular intervals occupied a stockpost 13 months on average (range: 1 to 80 months). The sizes of herds that moved seasonally ranged from 10 to 301 SSU and 13 to 400 SSU for herds that moved at irregular intervals. Herds that moved seasonally moved about 6.3 km on average and herds that did not move seasonally moved about 4.5 km between stockpost locations (Fig 5.3). This difference in movement distances is significant (Table 5.3).

**Map 4:** ***Opportunistic pattern - 7% (n=13)***

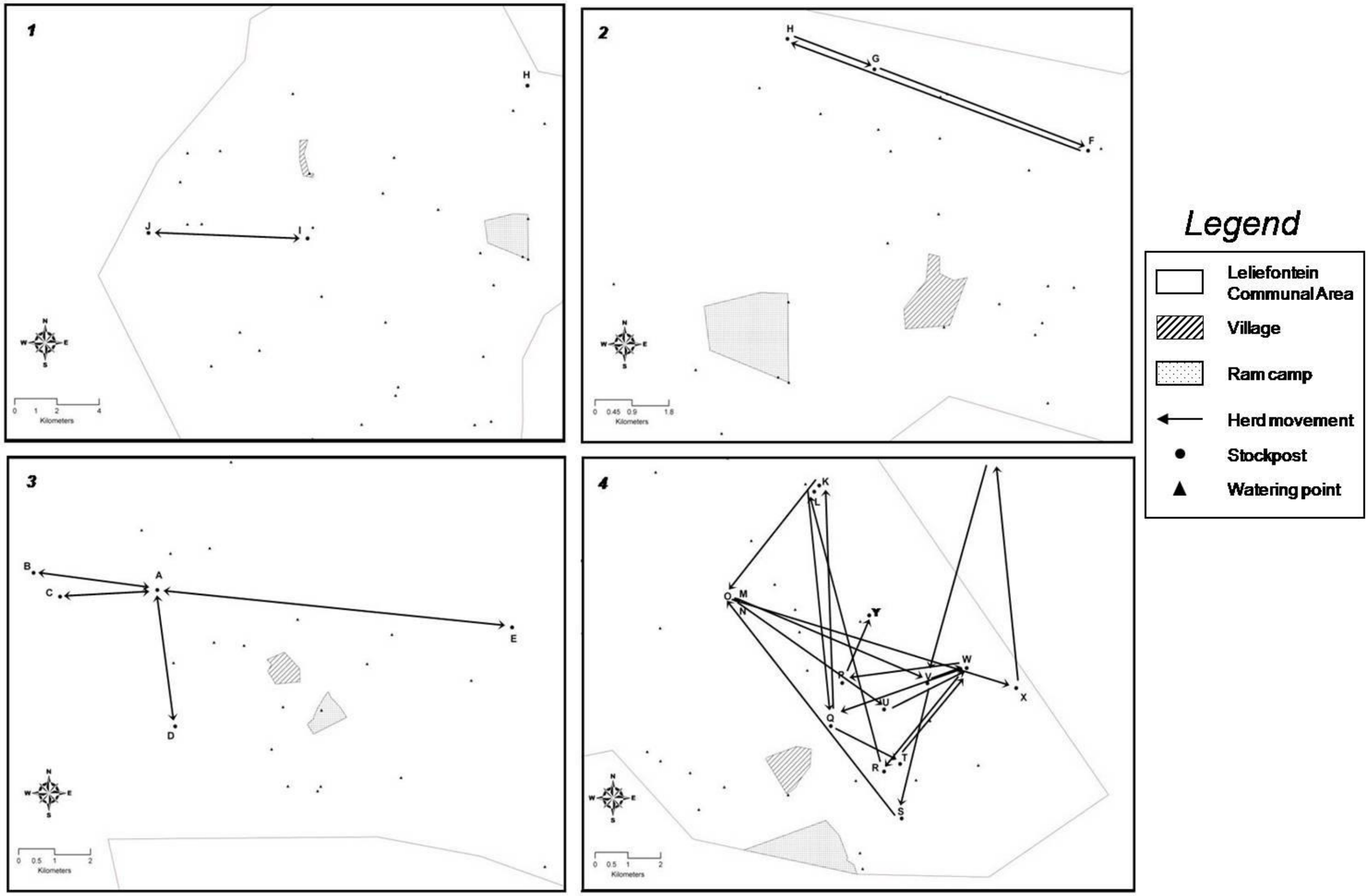
Herds that exhibited opportunistic movement patterns were found mostly in the village of Paulshoek that receives both winter and summer rainfall. This might explain why 17 herds used more than three different stockposts during the study period (Table 5.1). Herds that had opportunistic movement patterns were all mixed herds with an average herd size of 108 SSU (range: 11 to 468 SSU). These pastoralists moved between 0.2 km and 31.8 km between stockposts with an average distance of 6.0 km (Fig. 5.3). On average, these herds moved 18 times during the study period and staying 4.6 months at a stockpost. These herds seldom returned to the same stockpost as illustrated in Map 4 (Fig. 5.2). Movement appeared to be largely opportunistic and herds moved to areas perceived as having the best forage available at that time. Since the Paulshoek commons is located on the boundary between winter and summer rainfall, herds could exploit ephemerals that emerged during winter and grasses that emerged during summer particularly on the eastern boundary of the village. Pastoralists also considered push factors such as poor forage condition, the cultivation of crops, and an inadequate supply of water for livestock when moving to another stockpost. Outmigration was also identified amongst these herds that left the commons during drought periods and returned when conditions were more favourable for livestock.

***Single movements - 13% (n=25)***

There were 25 herds that only moved once during the study period. Twenty of the herds that moved once are located in villages where cropping did not occur. Seventeen of these 20 herds were managed by the owners themselves which might indicate the lack of labour to assist in the relocation of stockposts. The sizes of herds that moved only once ranged between three and 250 SSU.

**Table 5.3**: The average distance moved between stockposts within different movement patterns during the study period in the Leliefontein communal area. Differences between log mean distance values greater than the Least Significant Difference (LSD) value of 0.2 were significant at the 5% probability level.

| Movement pattern | Time of year | Mean distance (m) | Standard deviation | Log mean distance |
|---|---|---|---|---|
| Two-way | Seasonal | 5 426 | 2 863 | 8.5 |
| | Irregular | 4 851 | 4 499 | 8.2 |
| Three-way | Seasonal | 5 269 | 2 935 | 8.4 |
| | Irregular | 4 827 | 3 510 | 8.1 |
| Radial | Seasonal | 6 258 | 3 398 | 8.6 |
| | Irregular | 4 450 | 3 708 | 7.9 |
| Opportunistic | | 6 006 | 4 966 | 8.4 |
| Single | | 4 463 | 4 633 | 7.9 |




**Stockpost locations shown for herd 4 does not include the locations when the herd moved out of the commons

**Figure 5.2**: Different types of stockpost movement patterns that occurred during the study period in the Leliefontein communal area. Map 1 reflects a two-way pattern, Map 2= three-way, Map 3= radial and Map 4= opportunistic pattern.

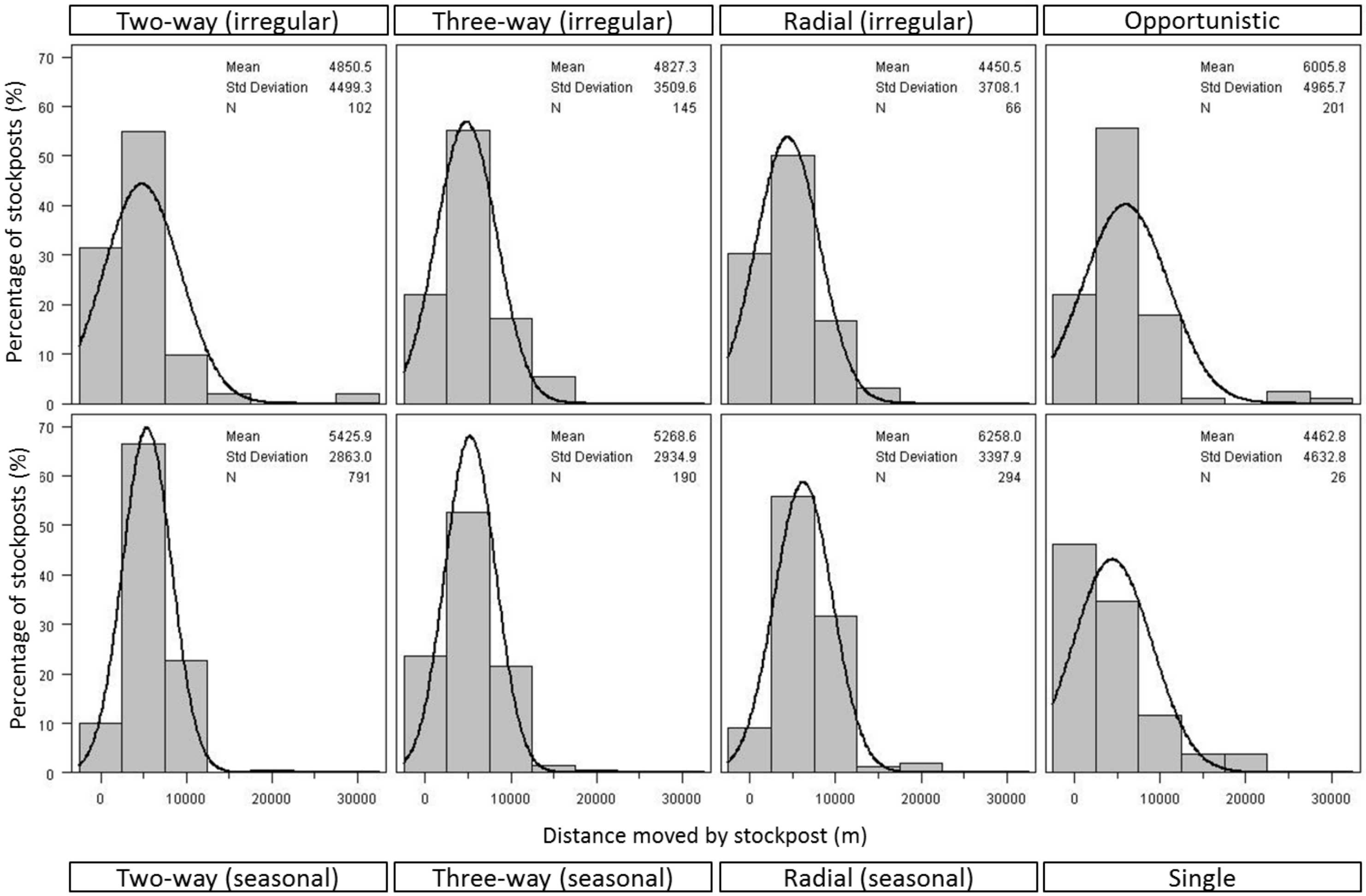



**Figure 5.3**: The distribution of distances moved between stockposts within the different movements patterns identified during the study period from 1997 to 2006 in the Leliefontein communal area.

### *5.3.3 How do watering point locations affect the distribution of stockposts?*

Artificial water sources accounted for most of the drinking points for livestock and of these hand dug wells were the most common (Table 5.4). Water is extracted from boreholes using wind, solar, electrical, diesel or hand pumps. In Leliefontein village, ephemeral springs found in wetlands were the most abundant water source used by the herds. The sizes of dams varied between 0.004 and 10 ha. The four large dams are located in Kheis, Rooifontein, Nourivier and Tweerivier and were built by the Department of Water Affairs during the Apartheid era to provide water services to communities within the Leliefontein communal area. Four smaller dams also exist and were built locally by hand. Because of their size, all dry up during drought periods. Municipal piped water allocated for domestic consumption, which comes from the same basic sources as the livestock water (i.e. boreholes and dams) was used by herds when livestock water sources were depleted or when boreholes were broken temporarily. Municipal water is also used during drought periods and overcast days when solar pumps do not function optimally (Samuels, 2006).

Pastoralists are generally responsible for maintaining wells that are located on their allocated croplands while the municipality is responsible for the maintenance of borehole infrastructure in the general rangeland. However, during the study period it was evident that boreholes were not being maintained. Municipal officials argued that there are no funds to maintain the infrastructure because pastoralists do not pay grazing fees. Pastoralists on the other hand argued that they do not pay grazing fees because the municipality does not provide any services with regard to livestock farming. Some pastoralists say that they cannot pay fees because they are too poor whereas others say that they do not want to pay because others are not paying grazing fees. During my interviews, I found that this impasse has been in existence since the Rural Areas Act (Act 9 of 1987) was introduced which required that pastoralists should apply for grazing rights and pay grazing fees. As a result of this impasse, pastoralists say that there had been an increase in broken boreholes during the study period and that herds are becoming restricted around the few functional boreholes. This was the case in Kheis village where herds congregated mostly around the only functional borehole in the village during the study period.

**Table 5.4**: The types and number of different livestock watering points used by herds during the study period in the Leliefontein communal area.

| | **Borehole** | **Dam** | **Well** | **Spring** | **Municipal** | **Total in village** |
|---|---|---|---|---|---|---|
| Kamassies | 2 | 0 | 4 | 1 | 3 | **10** |
| Kharkams | 6 | 2 | 15 | 1 | 1 | **25** |
| Kheis | 2 | 2 | 3 | 1 | 0 | **8** |
| Klipfontein | 7 | 0 | 7 | 5 | 1 | **20** |
| Leliefontein | 5 | 0 | 3 | 17 | 0 | **25** |
| Nourivier | 8 | 1 | 5 | 0 | 0 | **14** |
| Paulshoek | 7 | 0 | 16 | 2 | 1 | **26** |
| Rooifontein | 6 | 1 | 4 | 0 | 1 | **12** |
| Spoegrivier | 6 | 1 | 8 | 2 | 0 | **17** |
| Tweerivier | 5 | 1 | 4 | 0 | 2 | **12** |
| **Total of watering point type** | 54 | 8 | 69 | 29 | 9 | 169 |

Pastoralists try to establish their stockposts in locations were they could have access to as many watering points as possible in their daily grazing routes. Herds in Kharkams had on average about five watering points within their daily grazing routes whereas herds in Kheis only had access to about two watering points on average (Fig. 5.4). Differences in the amount of watering points within the daily routes of herds in the 10 villages were significant (F=30.20, df=9; $p$<0.001).

Significant differences in stockpost locations in relation to watering points were found between all the herds throughout the year (Annexure 1). Herds in Kamassies remained significantly closer to watering points than herds from all other villages during May to October. Herds that were comprised entirely of sheep were significantly closer to watering points from December to April (Annexure 1).

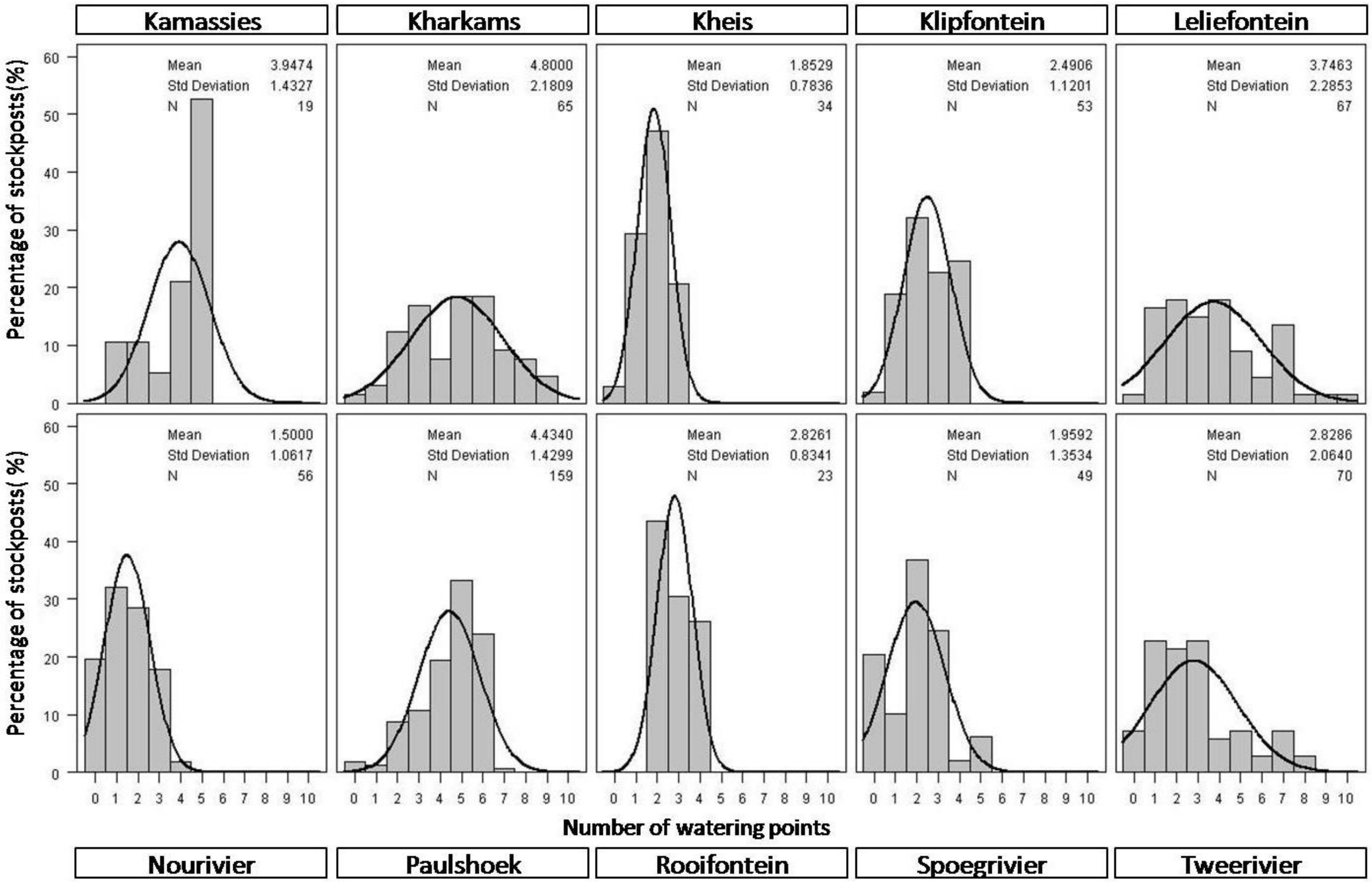



**Figure 5.4**: The distribution of the number of watering points within 2.5 km from stockposts between 1997 and 2006 in the Leliefontein communal area.

Annexure 2 indicates that the annual locations of stockpost from watering points differ significantly between villages ($p$<0.05) except in 1997 and 2006. Herd composition alone did not play a significant role in annual stockpost locations in relation to watering points. When the village and herd composition were considered together, significant differences in the locations of stockposts from watering points were found only in 1999 (F=2.32; df=10; $p$<0.05).

### *5.3.4 How do cropland locations affect the distribution of stockposts?*

Croplands had an important effect on the location of stockposts in all villages where cropping is still practiced. Livestock keepers moved further away from croplands when crops were growing and in Kharkams and Leliefontein village, these differences are significant (Fig. 5.5). Significant differences in stockpost locations in relation to croplands were found between villages for all the different years. No significant difference was found between herd compositions for any year during the study period (Annexure 3).

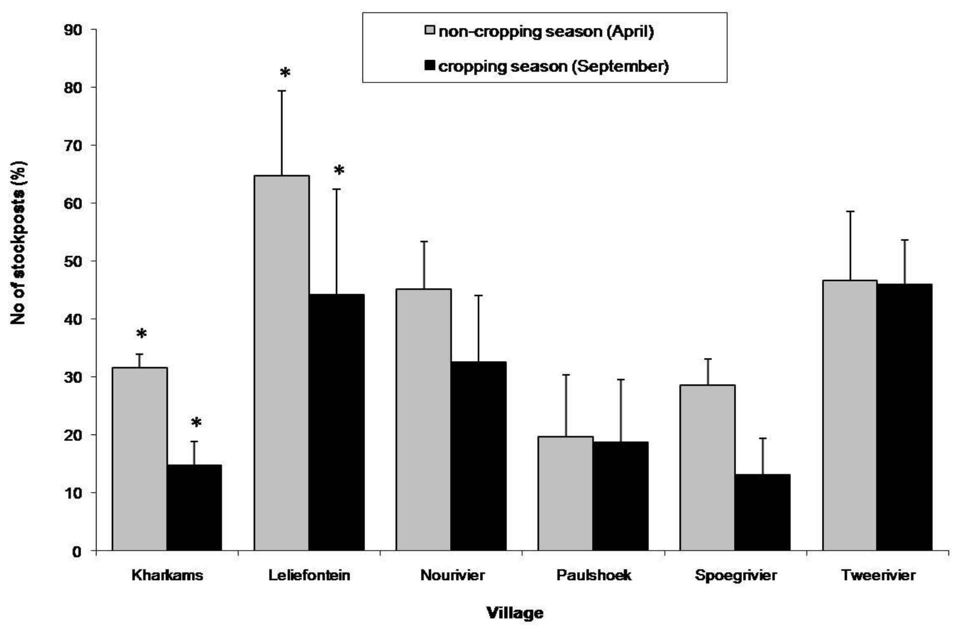



**Figure 5.5**: Number of stockposts located within 1 km of a cropland in April (non-cropping season) and September (cropping season) in the Leliefontein communal area. An * indicates a significant difference (p<0.05) in distances of stockpost locations from croplands between the cropping and non-cropping season in the village.

### *5.3.5 How do human settlements affect the distribution of stockposts?*

There was variability in the distance stockposts were located from settlements. In villages such as Kharkams almost half of the herds were located within 2.0 km from the settlement whereas in Tweerivier, almost 40% of the herds were located 6.0 km from the village (Fig. 5.6). In Kheis, Klipfontein and Kamassies bimodal patterns of distribution of stockposts distances from human settlements could be observed. For example, in Kamassies 42% of stockposts were located within a 2.0 km and 47% were located farther than 6.0 km from the village.

Village and herd composition significantly affected the locations of stockposts in relation to human settlements (Annexure 4). When these factors were considered together significant differences could only be found in selected years. Herds in Kheis were significantly closer to settlements than herds from other villages from March to September. Herds from Nourivier were significantly further from settlements than herds from Kamassies throughout the year except December (Annexure 5). Herds that were comprised entirely of sheep were established significantly closer to settlements than mixed or goat only herds from December to April. Between July and September, mixed herds were significantly further from settlements than herds comprised only of goats (Annexure 5).

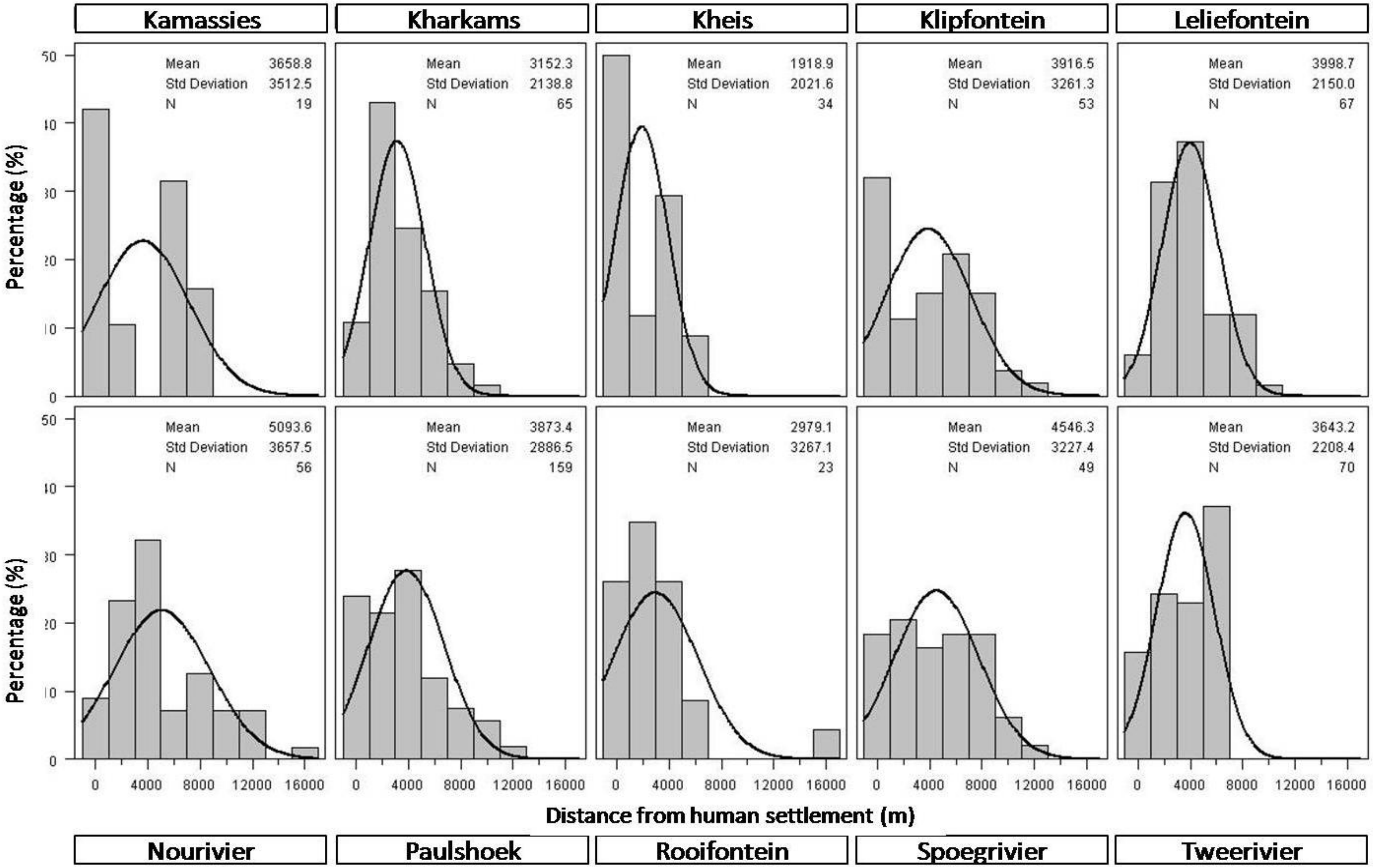



**Figure 5.6**: The distribution of stockposts distances from human settlements between the different villages from 1997 to 2006 in the Leliefontein communal area.

### *5.3.6 What is the combined effect of the variables on the locations of stockposts?*

In Kamassies and Rooifontein cropping did not occur during the study period. In Klipfontein and Kheis only one cropper in each village cultivated his land during the study period. However, these croplands were fenced off which protected the crops from livestock. In these four villages, where cropping did not play a role in the grazing patterns of herds, stockposts were further away from the village and were mostly located where herds could have access to several watering points (Fig. 5.7). Average herd size and distance to village were significantly positively correlated ($\rho=0.425$, $n=194$, $p<0.05$) (Table 5.10). Thus, the larger the herd, the further they are from the village. There was also a significant positive relationship ($\rho=0.180$, $n=194$, $p<0.05$) between herd size and distance to water.

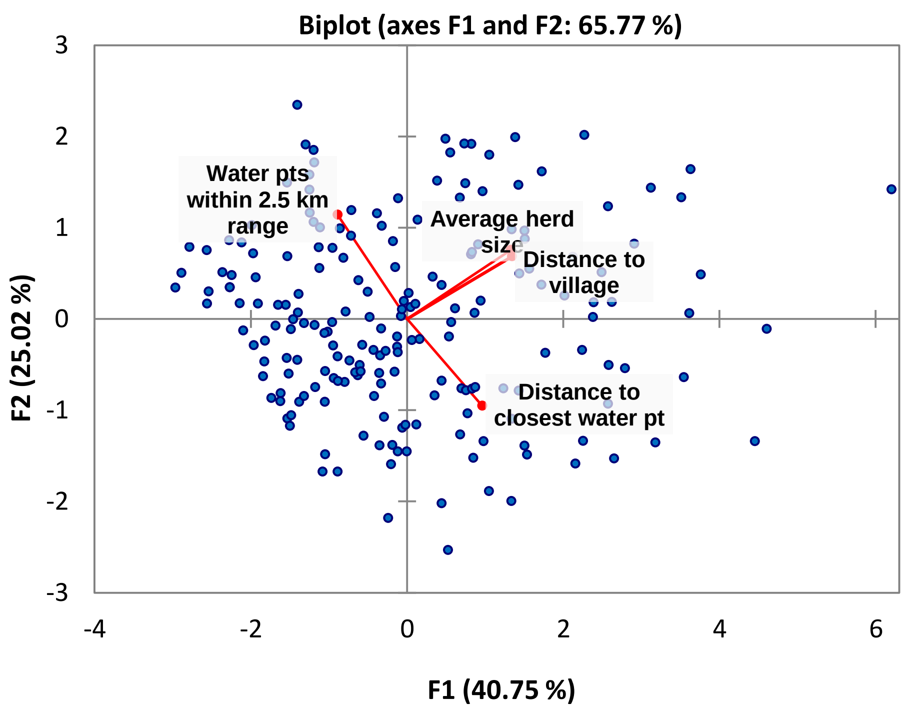



**Figure 5.7**: Principal component analysis of the distribution of stockposts in relation to variables that affected stockpost locations in the four villages where cropping did not play a major role in the grazing patterns of herds during the study period in the Leliefontein communal area.

**Table 5.10**: Pearson correlation matrix of variables that affected stockpost locations in the four villages where cropping did not play a major role in the grazing patterns of herds during the study period in the Leliefontein communal area.

| Variables | Average herd size | Distance to closest watering point | Distance to village | Watering points in 2.5 km range |
|---|---|---|---|---|
| Average herd size | **1** | **0.180** | **0.425** | -0.105 |
| Distance to closest watering pt. | **0.180** | **1** | 0.139 | **-0.204** |
| Distance to village | **0.425** | 0.139 | **1** | **-0.165** |
| Watering points in 2.5 km range | -0.105 | **-0.204** | **-0.165** | **1** |

Values in bold are different from 0 with a significance level alpha=0.05

During the non-cropping season in the six villages where cropping could affect livestock management, most stockposts were also located where herds have access to several watering sources (Fig. 5.8). Distance to water and village and average herd size were significantly negatively correlated with the number of watering points in a 2.5 km radius[24] from a stockpost (Table 5.11). It was recorded during this study that some herders watered their animals in the village using domestic water and this explains the significant negative correlation between distance to water and village to the number of watering points in a 2.5 km range. There was a significant positive relationship ($\rho=0.300$, $n=261$, $p<0.05$) between average herd size and distance to village. Herds closer to the village were thus significantly smaller than herds that were located further from the village. Herds closer to the village were usually looked after by the owners themselves who mostly stayed in the village.

During the cropping season in the six villages most stockposts were located further away from human settlements and in areas where herds were close to their croplands and water and therefore had options to several water sources (Fig. 5.9). Distance to water and village and average herd size were significantly negatively correlated with the number of watering points in a 2.5 km radius (Table 5.12). The correlation between average herd size ($\rho=0.350$, $n=313$, $p<0.05$) and distance to water ($\rho=0.199$, $n=313$, $p<0.05$) was

[24] *An estimated daily average grazing distance of herds (including those larger than 500 SSU) from stockposts in Namaqualand based on (Samuels et al., 2007).*

positive and significant to distance to village. Distance to water and cultivated cropland was positive and significantly (ρ=0.159, n=313, p<0.05) correlated.

**Table 5.11**: Pearson correlation matrix of variables that affect stockpost locations during the non-cropping season in the six villages where cropping occurred during the study period in the Leliefontein communal area.

| Variables | Average herd size | Distance to closest watering point | Distance to village | Watering pts. in 2.5 km range | Distance to closest uncultivated cropland |
|---|---|---|---|---|---|
| Average herd size | **1** | 0.114 | **0.300** | **-0.176** | 0.008 |
| Distance to closest watering pt. | 0.114 | **1** | 0.039 | **-0.402** | 0.070 |
| Distance to village | **0.300** | 0.039 | **1** | **-0.342** | 0.064 |
| Watering points in 2.5 km range | **-0.176** | **-0.402** | **-0.342** | **1** | -0.085 |
| Distance to closest uncultivated cropland | 0.008 | 0.070 | 0.064 | -0.085 | **1** |

Values in bold are different from 0 with a significance level alpha=0.05



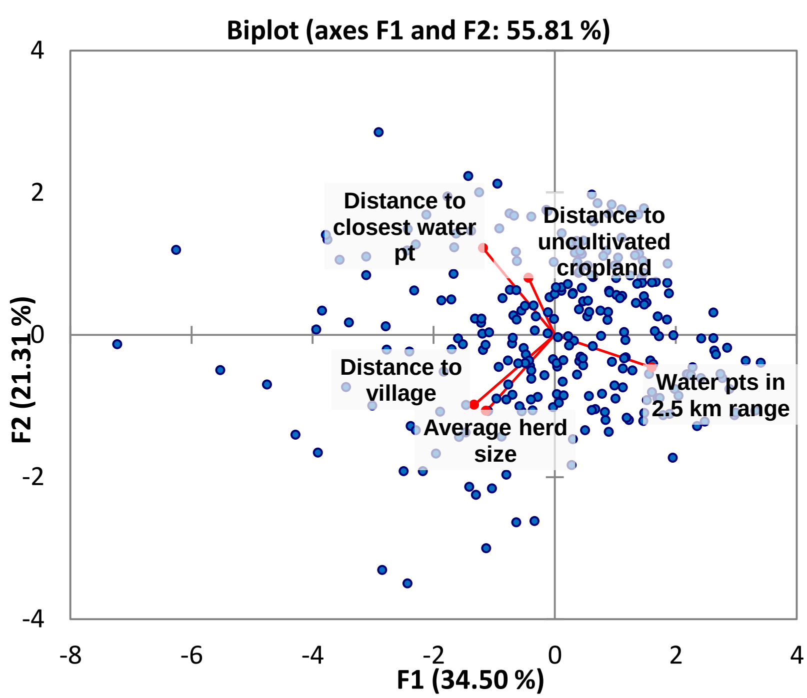



**Figure 5.8**: Principal component analysis of the distribution of stockposts in relation to variables that affect stockposts locations during the non-cropping season in the six villages where cropping occurred during the study period in the Leliefontein communal area.

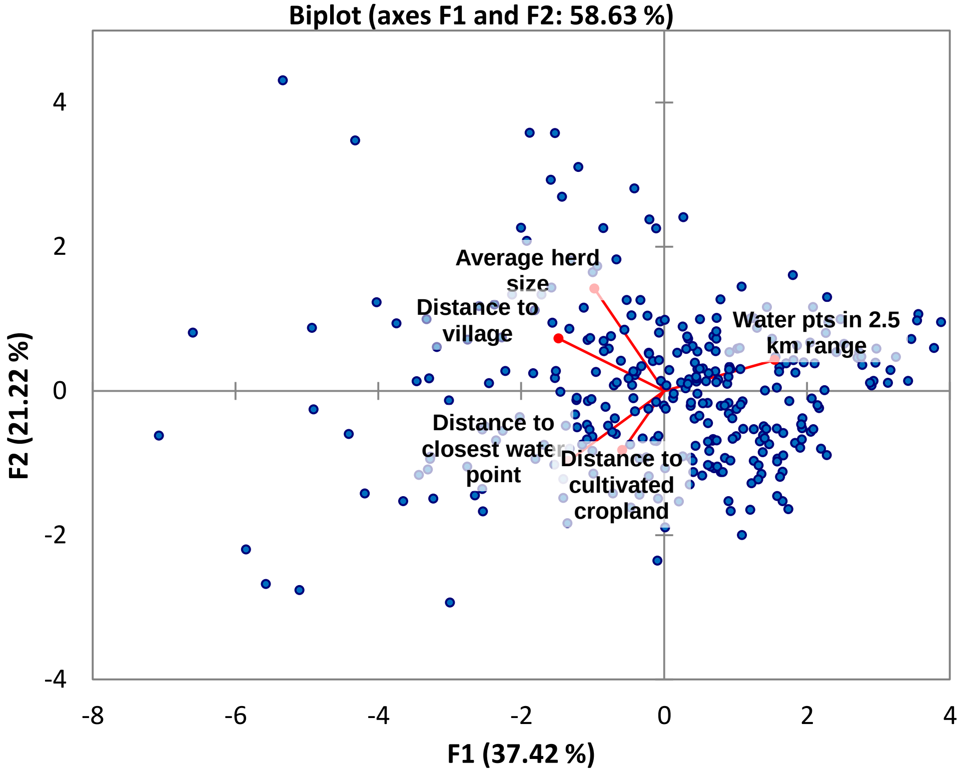



**Figure 5.9**: Principal component analysis of the distribution of stockposts in relation to variables that affected stockposts locations during the cropping season in the six villages where cropping occurred during the study period in the Leliefontein communal area.



**Table 5.12**: Pearson correlation matrix of variables that affected stockpost locations during the cropping season in the six villages where cropping occurred during the study period in the Leliefontein communal area.

| Variables | Average herd size | Distance to closest watering point | Distance to village | Watering pts. in 2.5 km range | Distance to closest cultivated cropland |
|---|---|---|---|---|---|
| Average herd size | **1** | 0.085 | **0.350** | **-0.125** | 0.038 |
| Distance to closest watering point | 0.085 | **1** | **0.199** | **-0.451** | **0.159** |
| Distance to village | **0.350** | **0.199** | **1** | **-0.396** | 0.106 |
| Watering points in 2.5 km range | **-0.125** | **-0.451** | **-0.396** | **1** | -0.064 |
| Distance to closest cultivated cropland | 0.038 | **0.159** | 0.106 | -0.064 | **1** |

Values in bold are different from 0 with a significance level alpha=0.05

## 5.4 Discussion

### *5.4.1 How have spatial parameters of pastoral mobility changed over time?*

The current size of the grazing areas for pastoralists in Leliefontein is much smaller than in the pre-colonial era and pastoralists have had to adapt their mobility patterns by moving over shorter distances between stockposts. During the pre-colonial era, the grazing areas of Nama pastoralists were large enough for transhumance over long and middle distances into other agro-ecological zones (Penn, 1986; Rohde and Hoffman, 2008). People could have moved more than100 km to the Sandveld near the coast in the west in winter to avoid cold conditions in the Kamiesberg uplands and also to make use of available marine resources to augment their diet (Webley, 1986). They could also have moved in the opposite direction to the fringes of Bushmanland in the east in times of drought in the west (Webley, 1982) or during the summer months when rain usually falls in this region. There is also evidence that Nama pastoralists moved long distances north to the Orange River or south to the Olifants River when forage became scarce in the Kamiesberg region (Rohde and Hoffman, 2008). Presently, long distances movements within the communal area are no longer possible but shorter movements still allow the herds to engage in some form of seasonal and opportunistic movements as well as outmigration during drought periods (Chapter Four). Since the distance between stockposts is short, pastoralists move their animals on foot and take one day or less to move between stockposts.

In a spatially constrained pastoral area, such as in Namaqualand, it is less labour intensive and less costly to relocate herds than in larger mobile pastoral systems and thus deciding to move in Leliefontein might not be such a difficult option. However, it is sometimes difficult to access labour to assist as those who could help; especially the youth expect to be paid. Pastoralists do not always have the means to pay those who assist them with relocating their stockposts. Elsewhere in semi-arid Africa, it has been reported that moving livestock is labour intensive since some herders are known to walk for up to 600 km to reach desired markets (Little et al., 2001). Other pastoral groups such as the Raikas in India embark on migratory routes for up to 1 500 km which last for about seven months (Agrawal, 1993). Pastoralists in several European countries today use motorised transport to move livestock over long distances to overcome some of the challenges in moving their herds (Baena and Casas, 2010; Thevenin, 2011). However, these costs are sometimes covered by the state since transhumance practices provide tourism opportunities for local municipalities (Pardini and Nori, 2011).

The majority of pastoralists in Leliefontein moved between the same stockposts. This practice informally defines their rights to certain grazing areas. Preferential access to these grazing areas is often based on the historical locations of families within the shared commons in the 19th and early 20th centuries before they were relocated and aggregated in villages (Marinus, 1996). Stockposts in the study area were located relatively close to each other and this resulted in an overlapping of grazing areas between herds.

Overlapping grazing routes, however, rarely led to conflict over resources. Samuels (2006) found that pastoralists respected each other's grazing area and did not guide their animals in a specific direction if another herd was already grazing in that area. In other mobile pastoral systems, social relationships are also maintained to reduce conflict over limited resources and to access inter-territorial grazing lands (Waller and Sobania, 1994; Behnke, 1999; Ramisch, 1999; Galvin, 2009). Maintaining social ties might be another reason why there was no conflict over resources in this spatially constrained pastoral system. Pastoralists in Leliefontein often congregate and meet at watering points where they share knowledge and food which maintain these social ties (Samuels, 2006).

### *5.4.2 Effects of watering points on stockpost locations*

The introduction of boreholes for agricultural purposes in Namaqualand in 1845 (Walton, 1998) and elsewhere (Western, 1982; Bassett 1986; Sonneveld et al., 2009) influenced the settlement patterns of herds. During this study herds were located close to water during the dry season and moved further away when water was more abundant during the wet winter season. Livestock congregation around permanent and reliable watering sources during the dry season is found within many other arid mobile pastoral systems (Bassett, 1986; Smith and Metelerkamp, 1995; Behnke, 1999; Shazali and Ahmed, 1999). Since the area is small, herds in Leliefontein do not have to travel far distances daily to reach water and can use their energy to search for better forage. In larger pastoral systems, as in West Africa, the physical constraints of accessing water that is located far from livestock encampments are sometimes overcome by transporting water to livestock. As a result, animals are able to conserve their energy and use it to access better pastures (Adriansen, 2008).

The high number of watering points (including those that are seasonal) in some villages of the Leliefontein communal area, resulted in pastoralists locating stockposts in areas where they had access to several watering sources within their daily grazing orbit around stockposts. This allowed herds to have several grazing routes where they could visit different vegetation types and still be able to water their animals on a daily basis (Samuels, 2006). Such access to several watering sources daily even during the dry season is not as prevalent in most other pastoral systems where large herds often have to walk far and over a long time period to reach a water source when water cannot be transported to them (Behnke, 1999; Adriansen, 2008).

Herds in Nourivier, Spoegrivier, Kharkams and Leliefontein village were furthest away from watering points during the winter period. During winter the vegetation, and particularly the succulent component is full of water and provides enough moisture for animals. This enables pastoralists to move their herds to areas where there is no permanent watering source. By moving to these winter grazing areas, pastoralists allow the vegetation around the areas closer to permanent watering sources to rest. This practice is similar to other pastoral systems where herds move further away from permanent watering sources during the wet season to distant areas that are usually undergrazed during the dry season (Western, 1982).

### *5.4.3 Effects of cropping on the locations of stockposts*

Results from this study show that cropping in the smaller and spatially constrained Leliefontein communal area could be regarded as a promoter of pastoral mobility in several villages since herds have to move away from growing crops in winter. In other transhumant systems, cropping has also been an important influence on herd movement in order to protect maturing crops (Homewood, 2008). In contrast, in several other mobile pastoral systems, rain fed and irrigated agriculture has led to a reduction in pastoral mobility by narrowing and blocking migratory routes and preventing access to grazing resources (Shazali and Ahmed, 1999; Turner, 2003; Babiker, 2012; Dongmo et al., 2012).

After the harvesting of crops in the Leliefontein communal area, herds usually returned to their summer locations to graze on crop residues. This is similar to mobile pastoral systems elsewhere in South Africa (Bennett et al., 2007) and Africa (Bassett, 1986; Scoones, 1995a; Baba and Magadi, 1998; Homewood, 2008) where croplands provide livestock with high quality forage during the dry season. However, in Leliefontein, fallow croplands have an additional benefit as they act as key grazing sites for livestock during winter. Pastoralists prefer guiding their herds to fallow croplands due to the abundance of ephemerals that emerge after good rains. Pastoralists regard ephemerals as good quality forage and allow their animals to graze the flowers which they perceive to stimulate milk production in lactating ewes (Samuels, 2006). Additional benefits of croplands have also been reported in West Africa, where fallow croplands are preferred grazing sites for livestock when savanna grasses become lignified (Bassett, 1986).

As a result of the small size of the grazing area available to herds in Leliefontein, livestock will graze the crops if left unattended (Baker and Hoffman, 2006). The fact that most herds investigated in this study are located farther away or moved away from croplands during the growing season indicates that pastoralists still adhere to traditional norms that regulate land use. Moving away from growing crops is a traditional practice and can be regarded as an effective way of protecting unfenced croplands. When herds move away from croplands there is no need for croppers to fence off their land to protect their crops from livestock. However, during the study period, not all the herds moved away from growing crops in winter. Consequently, some croppers suffered crop damages from unmanaged herds which are not looked after by herders during grazing periods (Samuels, 2006). During farmer interviews it was often mentioned that there is lack of competent herders in Leliefontein to look after livestock during the grazing period to protect growing crops. Therefore, some croppers have fenced off their land since they are often not compensated for the damages they suffer. The fencing off of croplands by some croppers, however, has led to the exclusion of pastoralists from grazing sites. Traditionally, all croplands have been regarded as open to livestock when crops are not growing.

Due to the usually poor returns from cropping there has been a steady loss of skills and fewer people are expected to cultivate their allocated croplands in Leliefontein in years to come. When an area is not cultivated, herds no longer have to move away from croplands during the growing season. This contraction of cropping area is fundamentally different to the circumstances in many other parts in Africa where cropping is expanding into the rangelands and the need for more labour to practice cropping has resulted in less labour available to look after livestock (Turner et al., 2005). A balance thus needs to be maintained between the amounts of cropping that could occur in pastoral systems without compromising the mobile existence of pastoralists. In a spatially constrained grazing area, too much cropping will take away valuable grazing lands and cramp livestock herds on the remaining parts of the rangelands. An absence or a decline in cropping, on the other hand, may result in pastoralists opting not to move away from croplands and lead to a decline in seasonal mobility. This could lead to overgrazing of some areas which might result in a depletion of palatable plants and in an increase in unpalatable plants in the study area (Anderson, 2008). Overgrazing also removes vegetation cover which exposes the soil to erosion.



### *5.4.4 Effects of human settlements on stockpost locations*

During this study it was found that the location of stockposts close to human settlements in the Leliefontein communal area often occurred as a result of social and personal circumstances. The perceived lack of competent herders to look after livestock also resulted in several herds being looked after by the owners themselves. In some villages investigated in this study, herds were located close to human settlements so that herd owners could be at home with their families at night. Before people settled in villages from the 1940s onwards, the entire family usually stayed with the herder at the stockpost and would then move with the herder to other stockpost locations (Rohde and Hoffman, 2008). The current circumstances of herders in Leliefontein are similar to those in other pastoral systems where some owners prefer paying younger herders to look after livestock and not go on transhumance themselves so that they could remain at home and look after their shops and other business interests (Adriansen, 2008).

In Leliefontein some herds also established themselves closer to the village in winter so that family members could assist with milking and '*stutwerk*' (placing kids with their mothers to drink milk) in the morning before the adult herd leaves the stockpost. In other mobile pastoral systems, herds are located closer villages in winter because labour is needed for other activities such as weeding of crops (Sanford, 1983a). Thus the need for labour is an important driver of herd mobility in pastoral systems especially during the winter season.

Some pastoralists settle their herds close to their homes in the village due to personal health constraints (Baker and Hoffman, 2006). This might be because in Namaqualand, the average age of herders is about 55 years old with the oldest herders over 70 years old (Hendricks, 2004; Samuels, 2006). In Namaqualand, being a herder is not attractive to the younger generation since it is labour-intensive and the financial reward is far less than what it is for other occupations. Young people in Leliefontein say that they do not want to suffer (financially) like their parents (Swarts and Aliber, 2013). In Italy for example, the ageing pastoral population is addressed by using migrants from Africa and other parts of Europe to look after animals (Pardini and Nori, 2011). During my interviews, I found that few herders were from other regions in Namaqualand but usually young people find the modern city life more attractive than being a pastoralist (Swarts and Aliber, 2013).

The spatial extent of pastoral mobility in the study area has changed since the pre-colonial era because pastoralists can no longer move over long distances into other agro-ecological regions. The fact that that they are spatially constrained only allows them to move 4.2 km on average when they move within their village commons and 8.4 km when the move across village boundaries. Pastoral mobility in Leliefontein remains an important way for pastoralists to access resources and is influenced by a number of other socio-economic drivers as well. Decisions to move a stockpost in Leliefontein are complex and are based on the need for farmers and pastoralists to protect their crops during the growing season, to gain access to permanent and reliable watering sources especially during dry periods, to be in close proximity to the village when labour for activities other than herding are needed and to accommodate the varied and often complex personal circumstances of pastoralists. This has resulted in different herd mobility patterns which include outmigration opportunistic and seasonal movement patterns that resemble historic spatial movements of Nama pastoralists in the region.

**Annexure 1**: The monthly average distances (m) of stockposts from livestock watering points for different villages and herd compositions during the study period in the Leliefontein communal area. Differences between square root mean values greater than the Least Significant Difference (LSD) value were significant at the 5% probability level. Keys to villages follow figure 4.1.

| | Village | | | | | | | | | | | | Herd composition | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LSD** | | **Ka** | **Kha** | **Khe** | **Kl** | **Le** | **No** | **Pa** | **Ro** | **Sp** | **Tw** | **LSD** | **Mixed** | **Goat** | **Sheep** |
| | | Mean | 532 | 1039 | 1213 | 1291 | 713 | 804 | 1009 | 916 | 1174 | 1236 | | 1010 | 1101 | 459 |
| **Jan** | **5.8** | Stdev | 417 | 752 | 786 | 651 | 573 | 765 | 659 | 556 | 1065 | 870 | **7.9** | 759 | 758 | 320 |
| | | Sqrt Mean | 21.3 | 30.1 | 32.7 | 34.6 | 24.3 | 25.5 | 29.7 | 28.7 | 31.2 | 32.7 | | 29.4 | 31.0 | 20.2 |
| | | Mean | 532 | 1039 | 1222 | 1289 | 713 | 920 | 1000 | 916 | 1174 | 1249 | | 1022 | 1098 | 459 |
| **Feb** | **5.8** | Stdev | 417 | 752 | 799 | 645 | 573 | 856 | 659 | 556 | 1065 | 859 | **7.9** | 768 | 752 | 320 |
| | | Sqrt Mean | 21.3 | 30.1 | 32.8 | 34.6 | 24.3 | 27.2 | 29.6 | 28.7 | 31.2 | 33.0 | | 29.5 | 31.0 | 20.2 |
| | | Mean | 540 | 1052 | 1247 | 1289 | 713 | 1058 | 980 | 901 | 1174 | 1301 | | 1025 | 1139 | 459 |
| **Mar** | **5.9** | Stdev | 430 | 754 | 803 | 639 | 573 | 962 | 669 | 545 | 1065 | 894 | **8.0** | 771 | 795 | 320 |
| | | Sqrt Mean | 21.3 | 30.3 | 33.1 | 34.6 | 24.3 | 29.2 | 29.1 | 28.4 | 31.2 | 33.6 | | 29.6 | 31.5 | 20.2 |
| | | Mean | 540 | 1025 | 1291 | 1251 | 759 | 1275 | 997 | 922 | 1174 | 1338 | | 1052 | 1148 | 459 |
| **Apr** | **6.0** | Stdev | 430 | 757 | 785 | 633 | 604 | 996 | 690 | 563 | 1065 | 877 | **8.1** | 781 | 793 | 320 |
| | | Sqrt Mean | 21.4 | 29.8 | 34.0 | 34.1 | 25.1 | 32.5 | 29.3 | 28.7 | 31.2 | 34.3 | | 30.0 | 31.7 | 20.2 |
| | | Mean | 540 | 1059 | 1244 | 1257 | 1217 | 1599 | 986 | 885 | 1200 | 1122 | | 1136 | 1168 | 890 |
| **May** | **5.9** | Stdev | 430 | 752 | 781 | 629 | 630 | 1405 | 653 | 568 | 1111 | 776 | **7.2** | 854 | 799 | 587 |
| | | Sqrt Mean | 21.4 | 30.5 | 33.3 | 34.2 | 33.3 | 35.7 | 29.3 | 27.8 | 31.3 | 31.2 | | 31.2 | 32.0 | 28.0 |
| | | Mean | 540 | 1174 | 1197 | 1257 | 1305 | 1648 | 1023 | 885 | 1396 | 1147 | | 1186 | 1227 | 1108 |
| **Jun** | **5.8** | Stdev | 430 | 773 | 738 | 629 | 647 | 1463 | 629 | 568 | 1230 | 806 | **6.8** | 875 | 835 | 854 |
| | | Sqrt Mean | 21.4 | 32.2 | 32.7 | 34.2 | 34.7 | 36.1 | 30.1 | 27.8 | 33.7 | 31.4 | | 32.0 | 32.8 | 30.8 |
| | | Mean | 556 | 1201 | 1197 | 1257 | 1305 | 1666 | 1006 | 885 | 1382 | 1156 | | 1190 | 1222 | 1108 |
| **Jul** | **5.8** | Stdev | 422 | 770 | 738 | 629 | 647 | 1457 | 629 | 568 | 1216 | 795 | **6.9** | 879 | 825 | 854 |
| | | Sqrt Mean | 21.8 | 32.6 | 32.7 | 34.2 | 34.7 | 36.3 | 29.8 | 27.8 | 33.5 | 31.6 | | 32.0 | 32.8 | 30.8 |
| | | Mean | 556 | 1201 | 1212 | 1257 | 1305 | 1680 | 1073 | 927 | 1382 | 1156 | | 1219 | 1221 | 1035 |
| **Aug** | **5.8** | Stdev | 422 | 770 | 729 | 629 | 638 | 1440 | 693 | 549 | 1216 | 795 | **6.5** | 881 | 822 | 838 |
| | | Sqrt Mean | 21.8 | 32.6 | 33.0 | 34.2 | 34.7 | 36.6 | 30.8 | 28.9 | 33.5 | 31.6 | | 32.5 | 32.8 | 29.6 |
| | | Mean | 549 | 1181 | 1276 | 1282 | 1298 | 1590 | 1022 | 927 | 1382 | 1183 | | 1192 | 1223 | 1035 |
| **Sep** | **5.7** | Stdev | 410 | 777 | 778 | 620 | 620 | 1449 | 644 | 549 | 1216 | 824 | **5.7** | 874 | 808 | 838 |
| | | Sqrt Mean | 21.7 | 32.2 | 33.8 | 34.6 | 34.7 | 35.4 | 30.0 | 28.9 | 33.5 | 31.9 | | 32.1 | 32.8 | 29.6 |
| | | Mean | 532 | 1156 | 1246 | 1282 | 878 | 1194 | 1012 | 968 | 1399 | 1214 | | 1099 | 1179 | 801 |
| **Oct** | **5.7** | Stdev | 417 | 775 | 764 | 620 | 624 | 1096 | 628 | 597 | 1197 | 841 | **5.7** | 796 | 815 | 950 |
| | | Sqrt Mean | 21.3 | 31.9 | 33.4 | 34.6 | 27.5 | 31.1 | 30.0 | 29.4 | 33.9 | 32.4 | | 30.9 | 32.0 | 24.9 |
| | | Mean | 532 | 1103 | 1246 | 1302 | 750 | 938 | 975 | 978 | 1399 | 1267 | | 1042 | 1191 | 801 |
| **Nov** | **5.7** | Stdev | 417 | 761 | 764 | 631 | 578 | 843 | 619 | 582 | 1197 | 913 | **5.7** | 768 | 827 | 950 |
| | | Sqrt Mean | 21.3 | 31.1 | 33.4 | 34.9 | 25.0 | 27.6 | 29.3 | 29.6 | 33.9 | 32.8 | | 29.9 | 32.2 | 24.9 |
| | | Mean | 532 | 997 | 1224 | 1320 | 716 | 900 | 948 | 978 | 1186 | 1255 | | 999 | 1138 | 459 |
| **Dec** | **5.6** | Stdev | 417 | 738 | 761 | 624 | 576 | 804 | 627 | 582 | 1059 | 895 | **7.8** | 752 | 763 | 320 |
| | | Sqrt Mean | 21.3 | 29.4 | 33.1 | 35.2 | 24.3 | 27.0 | 28.7 | 29.6 | 31.4 | 32.7 | | 29.2 | 31.6 | 20.2 |

**Annexure 2**: Differences between distances of stockpost locations from livestock watering points between 1997 and 2006 in the Leliefontein communal area.

| Variable | | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Village | F | 1.97 | 2.03 | 2.91 | 3.35 | 3.22 | 2.27 | 2.06 | 2.98 | 3.01 | 1.70 |
| | df | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| | *p* | 0.052 | 0.037 | 0.003 | 0.001 | 0.001 | 0.018 | 0.034 | 0.002 | 0.002 | 0.090 |
| Herd composition | F | 0.13 | 0.30 | 1.02 | 1.04 | 1.68 | 0.93 | 0.39 | 0.03 | 0.10 | 1.86 |
| | df | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | *p* | 0.879 | 0.744 | 0.362 | 0.354 | 0.189 | 0.397 | 0.675 | 0.967 | 0.906 | 0.157 |
| Village & Herd composition | F | 1.25 | 1.10 | 2.32 | 1.84 | 1.73 | 1.18 | 1.20 | 1.20 | 0.96 | 1.28 |
| | df | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | *p* | 0.269 | 0.361 | 0.012 | 0.054 | 0.075 | 0.301 | 0.294 | 0.290 | 0.481 | 0.239 |

Locations of stockposts used in 1997 in Paulshoek village were not available from the livestock database and thus not included in 1997's analysis.

**Annexure 3**: Differences between distances of stockpost locations from croplands between 1997 and 2006 in the Leliefontein communal area.

| Variable | | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Village | F | 3.13 | 6.32 | 4.98 | 3.53 | 5.10 | 2.85 | 3.44 | 2.91 | 13.10 | 4.09 |
| | df | 4 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 |
| | *p* | 0.017 | <0.001 | <0.001 | 0.005 | <0.001 | 0.017 | 0.010 | 0.015 | <0.001 | 0.002 |
| Herd composition | F | 0.09 | 0.31 | 2.22 | 0.86 | 0.51 | 0.94 | 0.07 | 1.69 | 1.02 | 0.25 |
| | df | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | *p* | 0.918 | 0.734 | 0.111 | 0.423 | 0.603 | 0.391 | 0.931 | 0.188 | 0.364 | 0.777 |
| Village & Herd composition | F | 0.51 | 0.22 | 0.52 | 0.66 | 0.88 | 0.99 | 1.68 | 0.83 | 0.53 | 1.00 |
| | df | 6 | 5 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 |
| | *p* | 0.803 | 0.952 | 0.816 | 0.702 | 0.524 | 0.439 | 0.129 | 0.552 | 0.785 | 0.426 |

Locations of stockposts used in 1997 in Paulshoek village were not available from the livestock database and thus not included in 1997's analysis.

**Annexure 4**: Distances of stockpost locations from human settlements in the years 1997 to 2006 in the Leliefontein communal area.

| Variable | | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Village | F | 2.20 | 2.38 | 2.47 | 2.23 | 2.87 | 4.02 | 5.23 | 5.46 | 4.02 | 5.07 |
| | df | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| | *p* | 0.029 | 0.014 | 0.010 | 0.021 | 0.003 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Herd composition | F | 5.63 | 6.89 | 5.45 | 4.32 | 4.65 | 6.43 | 7.39 | 9.31 | 11.40 | 12.89 |
| | df | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | *p* | 0.004 | 0.001 | 0.005 | 0.014 | 0.011 | 0.002 | 0.001 | <0.001 | <.0001 | <0.001 |
| Village & Herd composition | F | 1.27 | 1.36 | 2.18 | 2.19 | 1.41 | 1.36 | 1.35 | 1.82 | 1.90 | 2.05 |
| | df | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | *p* | 0.257 | 0.199 | 0.019 | 0.019 | 0.178 | 0.200 | 0.203 | 0.058 | 0.046 | 0.029 |

Locations of stockposts used in 1997 in Paulshoek village were not available from the livestock database and are not included in 1997's analysis.

**Annexure 5**: The monthly average distance of stockpost locations from human settlements between different villages and herd compositions during the study period. Differences between square root mean values greater than the LSD value are significant at the 5% probability level.

| | | | Village | | | | | | | | | | | Herd composition | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LSD** | | **Ka** | **Kha** | **Khe** | **Kl** | **Le** | **No** | **Pa** | **Ro** | **Sp** | **Tw** | **LSD** | **Mixed** | **Goat** | **Sheep** |
| **Jan** | **11.4** | Mean | 2811 | 2840 | 1779 | 3895 | 3721 | 3303 | 3727 | 3264 | 3839 | 2670 | **15.3** | 3698 | 2639 | 825 |
| | | Stdev | 3466 | 1963 | 1903 | 3295 | 2488 | 2815 | 2653 | 3415 | 3148 | 2015 | | 2675 | 2769 | 821 |
| | | Sqrt Mean | 41.2 | 50.0 | 33.6 | 54.1 | 57.7 | 53.2 | 56.3 | 51.7 | 54.9 | 46.9 | | 56.0 | 43.6 | 25.2 |
| **Feb** | **11.5** | Mean | 2811 | 2839 | 1713 | 3828 | 3812 | 3506 | 3765 | 3263 | 3839 | 2709 | **15.5** | 3747 | 2628 | 825 |
| | | Stdev | 3466 | 1963 | 1905 | 3296 | 2520 | 2965 | 2643 | 3415 | 3148 | 1994 | | 2696 | 2753 | 821 |
| | | Sqrt Mean | 41.2 | 50.0 | 32.7 | 53.5 | 58.4 | 54.6 | 56.6 | 51.7 | 54.9 | 47.5 | | 56.4 | 43.5 | 25.2 |
| **Mar** | **11.2** | Mean | 3609 | 2887 | 1716 | 3876 | 3812 | 3833 | 3770 | 2593 | 3839 | 2661 | **15.3** | 3736 | 2711 | 825 |
| | | Stdev | 3504 | 1956 | 1943 | 3281 | 2520 | 3216 | 2648 | 1680 | 3148 | 1983 | | 2586 | 2873 | 821 |
| | | Sqrt Mean | 43.8 | 50.5 | 32.3 | 54.0 | 58.4 | 57.1 | 56.8 | 47.7 | 54.9 | 47.0 | | 56.4 | 44.1 | 25.2 |
| **Apr** | **11.3** | Mean | 3609 | 2949 | 1662 | 3938 | 3850 | 4183 | 3573 | 2589 | 3839 | 2569 | **15.3** | 3743 | 2709 | 825 |
| | | Stdev | 3504 | 1973 | 1963 | 3319 | 2496 | 3337 | 2654 | 1682 | 3148 | 1933 | | 2623 | 2885 | 821 |
| | | Sqrt Mean | 43.8 | 51.1 | 31.4 | 54.4 | 58.8 | 60.0 | 55.0 | 47.7 | 54.9 | 46.3 | | 56.5 | 44.1 | 25.2 |
| **May** | **10.7** | Mean | 3250 | 2886 | 1860 | 3909 | 4786 | 4739 | 3291 | 2509 | 4209 | 2738 | **13.2** | 3880 | 2903 | 3015 |
| | | Stdev | 3474 | 1948 | 2027 | 3293 | 2033 | 3157 | 2532 | 1676 | 3348 | 1867 | | 2591 | 2910 | 2732 |
| | | Sqrt Mean | 45.8 | 50.5 | 33.9 | 54.3 | 67.3 | 64.5 | 52.4 | 46.9 | 57.8 | 48.6 | | 57.7 | 46.1 | 47.1 |
| **Jun** | **10.7** | Mean | 3250 | 3280 | 1868 | 3909 | 4869 | 5467 | 3199 | 2510 | 4336 | 2384 | **12.7** | 3972 | 2942 | 3363 |
| | | Stdev | 3474 | 2121 | 2012 | 3293 | 1993 | 3728 | 2412 | 1676 | 3439 | 1549 | | 2672 | 3014 | 2761 |
| | | Sqrt Mean | 45.8 | 53.5 | 34.2 | 54.3 | 68.0 | 68.8 | 51.8 | 46.9 | 58.6 | 45.5 | | 58.4 | 46.2 | 50.6 |
| **Jul** | **10.5** | Mean | 3410 | 3252 | 1868 | 3909 | 4869 | 5348 | 3419 | 2510 | 4263 | 2367 | **12.5** | 4066 | 2869 | 3363 |
| | | Stdev | 3438 | 2166 | 2012 | 3293 | 1993 | 3510 | 2437 | 1676 | 3377 | 1528 | | 2667 | 2864 | 2761 |
| | | Sqrt Mean | 47.6 | 53.5 | 34.2 | 54.3 | 68.0 | 68.4 | 54.1 | 46.9 | 58.3 | 45.4 | | 59.3 | 46.0 | 50.6 |
| **Aug** | **10.8** | Mean | 3250 | 3252 | 1810 | 3909 | 4886 | 5362 | 3930 | 2510 | 4263 | 2367 | **12.2** | 4217 | 2874 | 3122 |
| | | Stdev | 3473 | 2166 | 1998 | 3293 | 2552 | 3465 | 2875 | 1676 | 3377 | 1528 | | 2510 | 2853 | 2712 |
| | | Sqrt Mean | 45.5 | 53.5 | 33.5 | 54.3 | 67.8 | 68.7 | 57.6 | 46.9 | 58.3 | 45.4 | | 60.2 | 46.1 | 48.6 |
| **Sep** | **10.9** | Mean | 3250 | 3191 | 1800 | 4014 | 4727 | 5295 | 3908 | 3152 | 4263 | 2281 | **12.4** | 4214 | 2779 | 3122 |
| | | Stdev | 3473 | 2191 | 2015 | 3312 | 2106 | 3252 | 2908 | 3367 | 3377 | 1567 | | 2871 | 2781 | 2712 |
| | | Sqrt Mean | 45.8 | 52.6 | 33.0 | 55.1 | 66.7 | 68.6 | 57.2 | 50.7 | 58.3 | 44.2 | | 60.1 | 44.9 | 48.6 |
| **Oct** | 11.4 | Mean | 2811 | 3228 | 1694 | 4014 | 4013 | 3826 | 3690 | 3093 | 4331 | 2373 | **14.8** | 3838 | 2702 | 1586 |
| | | Stdev | 3466 | 2195 | 1986 | 3312 | 2488 | 2797 | 2892 | 3403 | 3363 | 1562 | | 2784 | 2840 | 2148 |
| | | Sqrt Mean | 41.2 | 52.9 | 31.6 | 55.1 | 60.1 | 57.5 | 55.1 | 49.7 | 58.9 | 45.2 | | 56.9 | 43.7 | 32.8 |
| **Nov** | **11.1** | Mean | 2811 | 3063 | 1694 | 4019 | 3764 | 3130 | 3476 | 3035 | 4331 | 2419 | **14.4** | 3657 | 2665 | 1586 |
| | | Stdev | 3466 | 2088 | 1986 | 3279 | 2559 | 1872 | 2562 | 3333 | 3363 | 1821 | | 2610 | 2840 | 2148 |
| | | Sqrt Mean | 41.2 | 51.6 | 31.6 | 55.3 | 57.9 | 52.7 | 54.0 | 49.4 | 58.9 | 44.9 | | 55.7 | 43.3 | 32.8 |
| **Dec** | **11.0** | Mean | 2811 | 2883 | 1692 | 3950 | 3714 | 2829 | 3415 | 3035 | 3880 | 2671 | **15.1** | 3559 | 2537 | 825 |
| | | Stdev | 3466 | 2051 | 1953 | 3275 | 2522 | 1579 | 2376 | 3333 | 3184 | 1986 | | 2499 | 2749 | 821 |
| | | Sqrt Mean | 41.2 | 49.9 | 31.9 | 54.7 | 57.5 | 50.2 | 54.1 | 49.4 | 55.2 | 47.1 | | 55.1 | 42.2 | 25.2 |

# Chapter Six

## Grazing distribution and pressure in relation to vegetation in a semi-arid communal rangeland in Namaqualand

**Abstract**

The spatial heterogeneity of vegetation in rangelands provides pastoralists with a range of grazing sites to select for their livestock. When herds are spatially constrained there is reduced access to ecological heterogeneity and this may impact negatively on the condition of the grazing resource. In this study, I investigated both the effects of vegetation on the herding strategies used by pastoralists and the impacts of grazing within the six major vegetation types found in the Leliefontein communal area. Results show that in this unfenced pastoral system, the diversity of vegetation types and the variability in forage availability and quality between vegetation types resulted in herds being able to move short distances to reach desired grazing sites. Pastoralists used their indigenous technical knowledge of the life cycles and palatability of the vegetation to move their livestock to areas with highest grazing value for their animals. Pastoralists move their herds to Succulent Karoo vegetation which they perceive to have better forage value than Fynbos affinities during the winter months. During the dry season, pastoralists moved their herds to ephemeral wetlands to access quality forage and water. This study also discussed the applicability of fixed stocking rates in a variable and spatially constrained pastoral system and found that stocking rates varied during the study period which would have allowed livestock to exploit the abundance of forage during the wet season. Due to the movement of herds back to the uplands in summer, overstocking occurred during the recruitment period of most plants within Kamiesberg Granite Fynbos and Namaqualand Granite Renosterveld vegetation. I discuss the long term implications of these movements on the conservation of flora in the study area.



### 6.1 Introduction

African rangelands are characterised by a mosaic of vegetation types (Niamir, 1991). Spatial heterogeneity of vegetation in Africa is affected by gradients in climate (O' Brien, 1993; Scholes et al., 2009), soils (Anderson and Talbot, 1965) and landscapes (McCabe, 1994). Land use (Esler et al., 2006) including grazing (Adler et al., 2001) also affects the spatial heterogeneity of vegetation at a range of scales. Grazing gradients around watering points, livestock camps and human settlements results in vegetation gradients where the most palatable plants occur further away from livestock focal points (Adler et al., 2001; Riginos and Hoffman, 2003; Todd, 2006). Vegetation in areas in Namaqualand where long-term grazing pressure is high has lower perennial cover (Riginos and Hoffman, 2003), an increase in unpalatable and toxic plants and an increase in annuals and grasses (Todd and Hoffman, 1999; 2009). The heterogeneity and patchiness of vegetation creates different grazing sites for livestock in the rangeland. When vegetation is heterogeneous and patchy, grazing distribution will be uneven (Valentine, 2000).

On private farms, various strategies are used to manipulate the distribution of grazing by livestock in the rangeland. These strategies include the use of fences, water point location, location of salt licks and other nutritional supplementation, and shade (Valentine, 2000). Fences are used to separate different vegetation types into paddocks to create homogenous vegetation landscapes. Ranchers usually try to rotate their herds between paddocks in a time frame that prevents selective grazing since livestock are forced to graze on a wider range of plants including less-palatable species (Beukes and Cowling, 2000). Although short duration grazing and non-selective grazing systems are perceived to decrease selectivity these perceptions have not been verified consistently by scientific evidence (McCabe, 1987; Kreuter and Tainton, 1988).



In extensive, unfenced rangeland commons, pastoralists herd their livestock to areas most desired for their livestock species or breeds. These movements of livestock between different habitats have been the focus of many studies (Bailey et al., 2004; Coppock et al., 1986; Low et al., 1981; Scoones, 1995a) and is now regarded as a sophisticated strategy to make optimal use of variable grazing resources (Niamir-Fuller and Turner, 1999; Schareika, 2001), to distribute grazing pressure (Behnke and Scoones, 1993) and to prevent overgrazing and under grazing (Bassett, 1986). To achieve these objectives, pastoralists have to consider that forage quality fluctuates with season and have to move in accordance with this variation. In order to move pastoralists thus need to know their local environment and monitor resources to make informed herd management decisions (Schareika, 2001). For example, herders in Niger have a nutritional programme for their cattle where they move their animals to specific areas in the rangeland based on the availability and quality of forage during specific times of the year (Schareika, 2001). In another example, the Turkana move their animals to higher elevations over long distances to access available herbaceous vegetation during the dry season (McCabe, 1994).

In spatially constrained environments, there is reduced access to ecological heterogeneity (Niamir-Fuller, 1999a; BurnSilver and Boone, 2003) since pastoralists might not be able to access the full spatial variability of vegetation in the landscape. Pastoralists could also lose access to key resources (Scoones, 1991) that are important for the survival of livestock during the dry season (Illius and O' Connor, 1999). In pastoral systems where there is a low input of external food sources herders have to make maximum use of available natural resources to feed their animals.

Chapter Four shows that herders frequently move their stockposts to areas where they perceive forage to be of better quality and where they perceive enough forage is available. In this study, I investigated how vegetation types affected the grazing strategies used by pastoralists during the study period. This study also assessed and discussed the impacts of grazing within the six major vegetation types in the Leliefontein communal area. I asked the following questions:

1. How does the selection of grazing sites by pastoralists affect stocking rates within different vegetation types throughout the year?
2. If the observed stocking rates are indicative of longer term stocking rates, how applicable is the fixed carrying capacity recommendation for the Leliefontein communal area?
3. What may be the conservation implications of different intensities of grazing on the vegetation of the region?

### *6.1.1 Vegetation of the study area*

Six main vegetation types have been identified by Mucina and Rutherford (2006) in the Leliefontein communal area namely; Namaqualand Heuweltjieveld, Kamiesberg Granite Fynbos, Namaqualand Klipkoppe Shrubland, Kamiesberg Mountains Shrubland, Namaqualand Blomveld and Namaqualand Granite Renosterveld (Table 6.1). Using the refined boundaries of these vegetation types (Helme and Desmet, 2006), I examined grazing distribution and pressure within them. Three smaller vegetation types cover less than 2% of the study area (Fig. 6.1) and are not discussed further.

## 6.2 Methods

### *6.2.1 Data modelling*

Monthly livestock numbers for herds in Paulshoek village were obtained from an existing database on animal production that is managed by the University of Cape Town (MT Hoffman Unpublished data). I collected annual livestock numbers from 1997 to 2006 from eight different sources for herds in the other nine villages in the Leliefontein communal area (Appendix B). Monthly stock totals for herds for the other nine villages were modelled as described in Chapter Five.

I calculated the monthly average stocking rate at a specific stockpost by dividing the daily grazing area with the monthly average number of livestock in a herd. The average grazing distance that herds in Paulshoek village graze from their stockpost is approximately 2.2 km (Samuels, 2006) but I used a radius of 2.5 km to accommodate the herds larger than 500 SSU in size found in Nourivier, Kharkams and Rooifontein villages. A buffer of 2.5 km around each stockpost was created which produced an area of 1 964 ha as the daily grazing area of a herd. I excluded daily grazing areas which fell outside the Leliefontein communal area. In total about 15% of the daily grazing areas fell outside the boundary of Leliefontein communal area.

**Table 6.1**: Description of the six major vegetation types found in the Leliefontein communal area.

| **Vegetation type** | **Biome** | **Total size of vegetation type** (Helme and Desmet, 2006) | **Proportion of study area** | **Vegetation features** (Mucina and Rutherford, 2006) |
|---|---|---|---|---|
| Namaqualand Klipkoppe Shrubland | Succulent Karoo | 274 356 ha | 52.3% | Outcrops support an open shrubland dominated by dwarf to medium shrubs (up to 1m tall), flatlands support dwarf or prostrate succulents, areas where runoff collects support tall (1-3m) non-succulent shrubs |
| Namaqualand Blomveld | Succulent Karoo | 130 580 ha | 20.3% | Shrubland dominated by sparse dwarf succulent and ericoid leaf shrubs, geophytes, herbs and low leaf succulents also abundant |
| Namaqualand Heuweltjieveld | Succulent Karoo | 246 717 ha | 11.1% | Low leaf-succulent shrubland with heuweltjies (termite mounds) |
| Namaqualand Granite Renosterveld | Fynbos | 17 147 ha | 6.8% | Dense 1-1.5m shrubland dominated by *Elytropappus rhinocerotis* and asteraceous shrubs, diversity of geophytes |
| Kamiesberg Mountains Shrublands | Succulent Karoo | 35 872 ha | 6% | Tall shrubland dominated by non-succulent and succulent shrubs |
| Kamiesberg Granite Fynbos | Fynbos | 6 432 ha | 1.8% | Sparse medium-tall (1-2 m) shrubland dominated by malacophyllous shrubs |

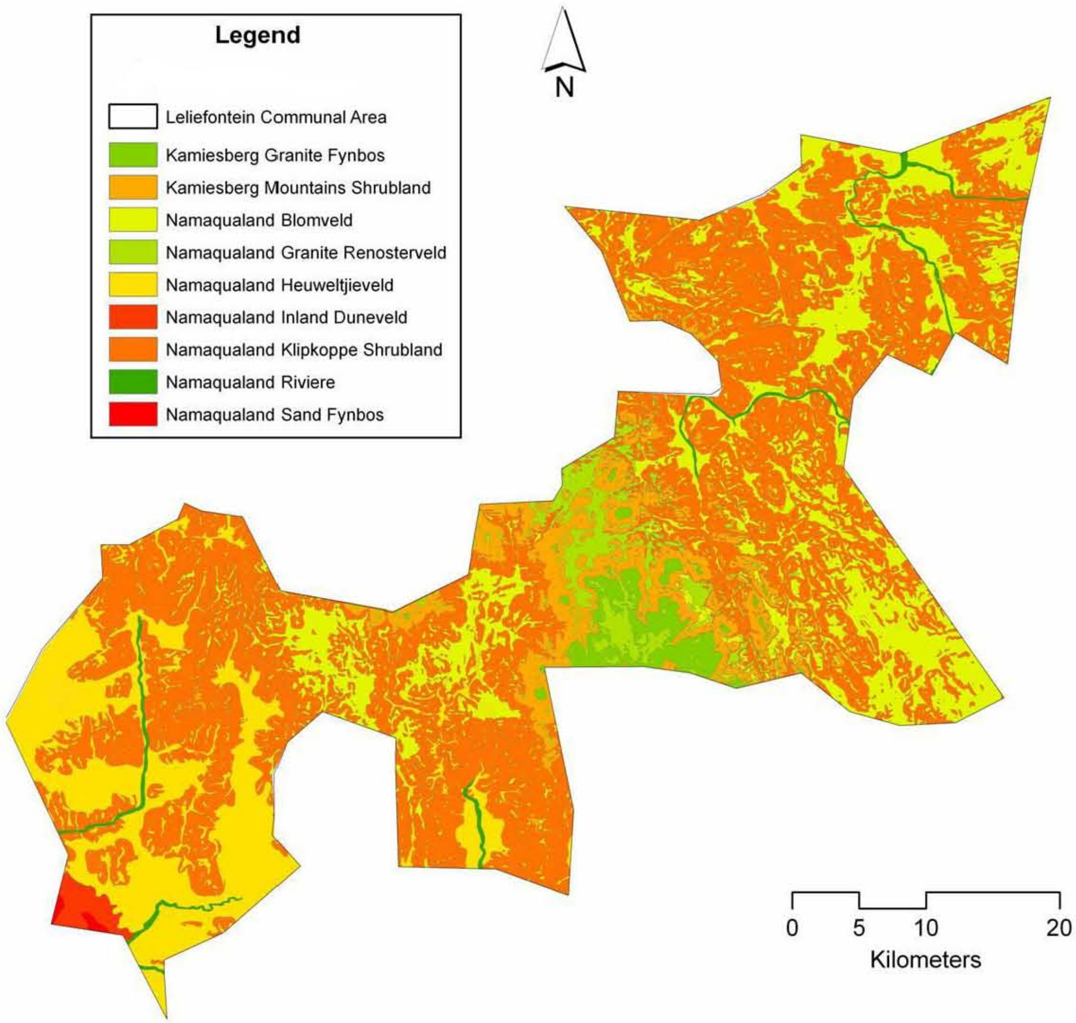



**Figure 6.1**: The distribution of the different vegetation types found in the Leliefontein communal area (Mucina and Rutherford, 2006 as modified by Helme and Desmet, 2006).

Annual stocking rates were calculated as follow:

X = Annual stocking rate at a stockpost

y = size of daily grazing area (ca. 1964 ha)

a = total number of livestock for the months a stockpost was occupied

b = number of months a stockpost was occupied

c = total number of months for the study period (101 months)

$$X = (a/y)(\left(\frac{b}{12}\right)/\left(\frac{c}{12}\right))$$

The Paulshoek database started in August 1998 and thus monthly stock numbers for other villages were only modeled from that month. Livestock numbers from the last five months in 1998 (August to December) were included in the determination of monthly grazing densities and not in the annual grazing densities since data were not available for that entire year. Thus, annual grazing densities were only determined for eight years from 1999 to 2006.

### *6.2.2 Data mapping*

A total of 595 stockposts were used during the study period from August 1998 to December 2006 and their close proximity to each other resulted in overlapping grazing areas. I created 71 separate group shapefiles of non-overlapping grazing areas and projected them as WGS 184 UTM ZONE 34S in ArcGIS 9.3. Group shapefiles were imported into IDRISI as vector files. The output data type of the vectors files were selected as 'real'; the reference systems as 'latlong' and the reference units as degrees. For each of the 71 group vector tables separate vector files with the same spatial parameters were created for the study period as a whole and for each of the eight years and 12 months thus providing 21 time periods in total. The grazing densities for the same months during the study period were grouped and monthly averages were used to construct grazing density maps. The vector files were converted into raster files with 1200 columns and 800 rows. This created a pixel size of 69.63 m X 102.5 m or 0.7137 ha.

The raster files of a particular time period were overlaid on top of each other using the additions option. The final image contained the union of all the information of the 71 group files. This was repeated for all of the 21 time periods of the study. The final raster images were overlaid with a raster image outlining the study area using the multiplications option. The study area image was selected as the Boolean image and the final raster images as the second images. This resulted in a grazing density map with the same boundary lines as the study area map.

Each of the 21 raster images of grazing density was overlaid on top of each of the six of the vegetation types. This created raster images containing the density of livestock for all of the 21 time periods in each of the six vegetation types.

### *6.2.3 Data analysis*

I extracted the grazing density information in IDRISI and created density categories of 0.2 SSU/10ha. The data was imported into MS Excel for analysis. All the pixels with zero grazing density were regarded as ungrazed areas during the study period. Pixels with grazing densities greater than 1 SSU/10 ha were regarded as areas grazed above the recommended stocking rate set by the Department of Agriculture for the region. Pixels with less than 1 SSU/10 ha but greater than zero were regarded as areas grazed below the recommended stocking rate. The average stocking rate per vegetation type was calculated as the sum of all the grazing densities of the pixels divided by the number of pixels in each vegetation type.



## 6.3 Results

### *6.3.1 How is grazing pressure distributed in the Leliefontein communal area?*

Grazing pressure was unevenly distributed during the study period (Fig. 6.2). Grazing density was above the recommended stocking rate of 1 SSU/10 ha in areas mainly around human settlements which indicates that proximity to the village is an important factor in the distribution of pastoral herds in Leliefontein. Other areas were under grazed and some areas were not grazed at all by livestock during the study period. Ungrazed areas were further away from human settlements and included mountainous areas that were inaccessible to livestock. It is also evident that grazing pressure was more even around Paulshoek village where the most stockposts were used during the study period and with many widely-distributed water sources. In villages such as Kamassies and Rooifontein where there are fewer stockposts and watering points, grazing was concentrated mainly around the villages and large parts of the rangeland were not visited by livestock at all.

Annual grazing pressure was also unevenly distributed during the entire study period (Annexure 6). Over the course of the study period, the same areas were consistently overgrazed or grazed under the recommended stocking rate. Large parts in the north of the study area were unutilised by livestock between 1999 and 2006. The distribution of grazing pressure also remained relatively uneven throughout the year. Grazing distribution was more clumped during the dry summer months probably because animals are dependent on artificial water sources (Annexure 7). During the dry season most of the ephemeral springs and wells dug in rivers dry up in the study area. This indicates that animals are dependent on fewer watering points during the dry season. During the winter months, grazing densities were higher because of the additional animals born into the herds during this time of the year. Even though the grazing densities were higher during winter, grazing pressure was more dispersed than in summer since animals might get sufficient moisture from the vegetation and are less dependent on formal water sources. Moreover, herds make use of ephemeral natural pools of water during winter in areas away from artificial watering points and human settlements.



### *6.3.2 How is grazing pressure distributed amongst the different vegetation types in the study area?*

Stocking rates varied between vegetation types and the changes in annual stocking rate followed the same patterns of variation between the vegetation types. Kamiesberg Mountains Shrubland and Namaqualand Klipkoppe Shrubland were grazed on average under the recommended stocking rate throughout the study period. Kamiesberg Granite Fynbos and Namaqualand Granite Renosterveld had the highest grazing pressure of the six vegetation types (Fig. 6.3a). In 2004, the year following the 2002/2003 drought period, all vegetation types and the study area as a whole were grazed at or below the recommended stocking rate. This is because of the high livestock mortality rates recorded during the 2002/2003 drought and the cold and wet period immediately after the drought.

Kamiesberg Granite Fynbos and Namaqualand Granite Renosterveld vegetation had more than half of the areas grazed above the recommended stocking rate for most part of the study period (Fig. 6.3b). These two vegetation types together with Namaqualand Heuweltjieveld had the least amount of area ungrazed by livestock. The area which was ungrazed by livestock was relatively constant over time for all vegetation types. Areas that were ungrazed lack water and are inaccessible to pastoralists via road. This result also suggests that there is not a natural aversion to one or other vegetation type that keeps them ungrazed.

Figure 6.4a shows that between April and October most livestock leave the areas where Kamiesberg Granite Fynbos and Namaqualand Granite Renosterveld vegetation occur. However, when these animals leave these two vegetation types, there does not seem to be another area which gains these animals because there is no sharp rise in stocking rates in the other vegetation types. These two vegetation types are the smallest in terms of size in the study area and there are very few animals on these two vegetation types relative to the other vegetation. Thus, the large change in stocking rates in these two vegetation types is not reflected as a sharp change in the other four vegetation types. Another reason is that the other four vegetation types, which all have Succulent Karoo affinities, are closely associated with each other spatially and it is difficult to differentiate when one or the other may actually be the target grazing area in a particular season.

Kamiesberg Granite Fynbos and Namaqualand Granite Renosterveld vegetation were heavily utilised by small stock from September to mid-April which coincides with the flowering and recruitment periods for most of those plants in these vegetation types (Mucina and Rutherford, 2006). About 55% of the total area covered by Kamiesberg Granite Fynbos and 31% of Namaqualand Granite Renosterveld are found in the Leliefontein communal area. About 21% of the Renosterveld vegetation in the study area has already been transformed by cropping and about 60% of the endemic or near endemic flora is rare or threatened. Therefore, additional heavy impacts from grazing could result in a loss of Renosterveld species in the region. Kamiesberg Granite Fynbos has been identified as a key element in the conservation strategy for the area since it supports at least 29 endemic or near endemic plant species (Helme and Desmet, 2006).

The average herd size during the study period was 84±86 (mean ± std. dev.). By using the size of a grazing orbit of 2.5 km around a stockpost and the recommended stocking rate of 1 SSU/10 ha unit, about 196 SSU could be kept at a stockpost throughout the year. This includes the areas within piospheres around stockposts. Sacrifice zones within piospheres around stockposts, which are characterised by bare ground, have on average a radius of about 50 meters (ca 0.79 ha) in the study area (MI Samuels Unpublished data). During winter, other zones within piospheres are covered with ephemerals which provide valuable forage to animals. Therefore, the small area of sacrifice around stockposts (0.04% of a herd's grazing area) and the fact that valuable forage could still be obtained in winter in other zones resulted in these areas around stockpost not being excluded from the analysis.

Keeping more than 196 SSU at a stockpost without relocating your stockpost during the year, means that the area will be grazed above the recommended stocking rate. Out of 256 herds investigated, 90 of them had a herd size greater than 196 SSU at some time during the study period. This suggests that stockposts need to be relocated at least once a year to prevent heavy grazing. During the study period, there were 1 473 stockpost movements within the boundaries of the communal area.

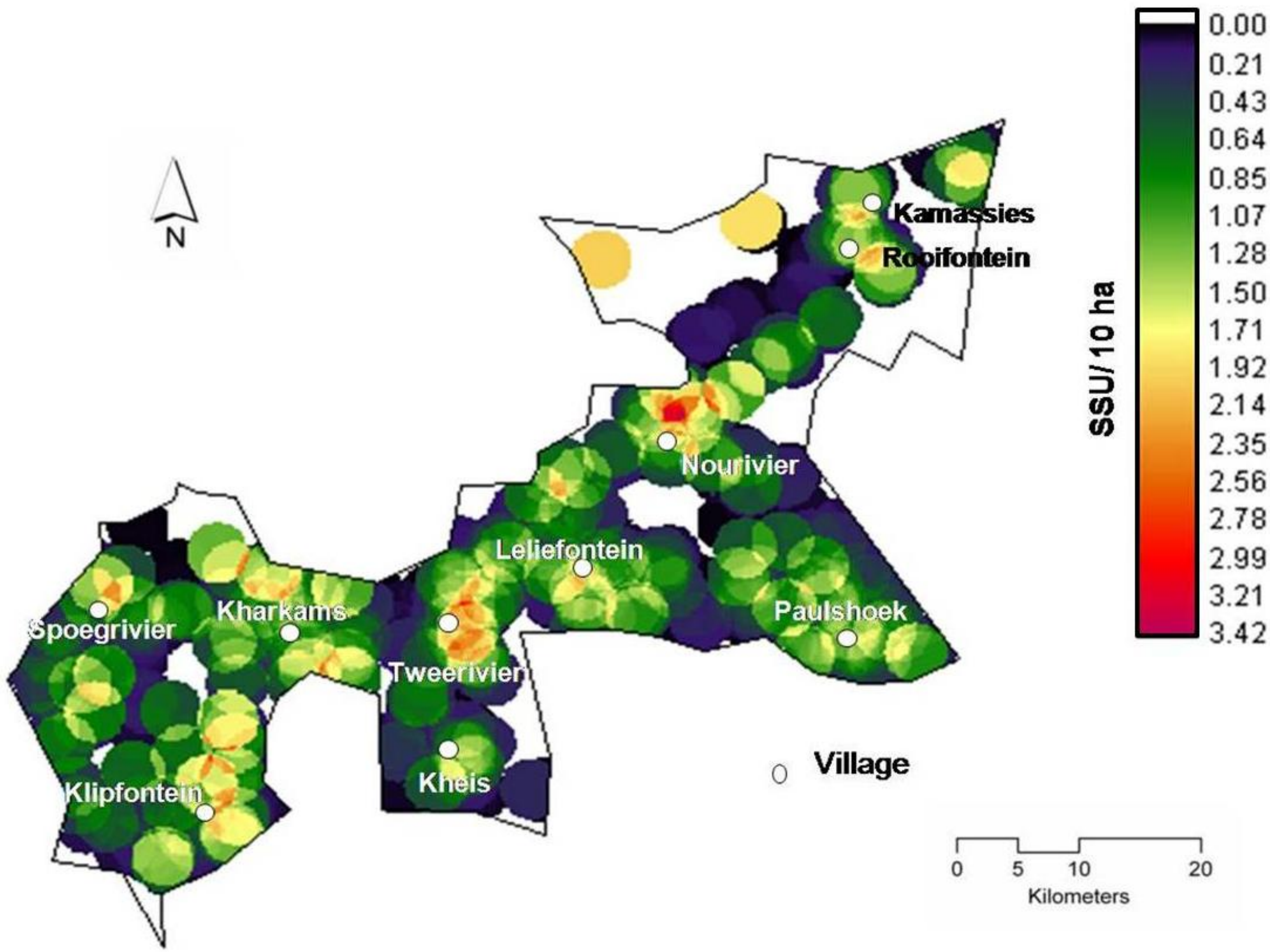



**Figure 6.2**: The distribution of average grazing pressure from small stock for the study period between 1999 and 2006 in the Leliefontein communal area. The white areas represent areas that were not grazed by livestock at all during the study period.

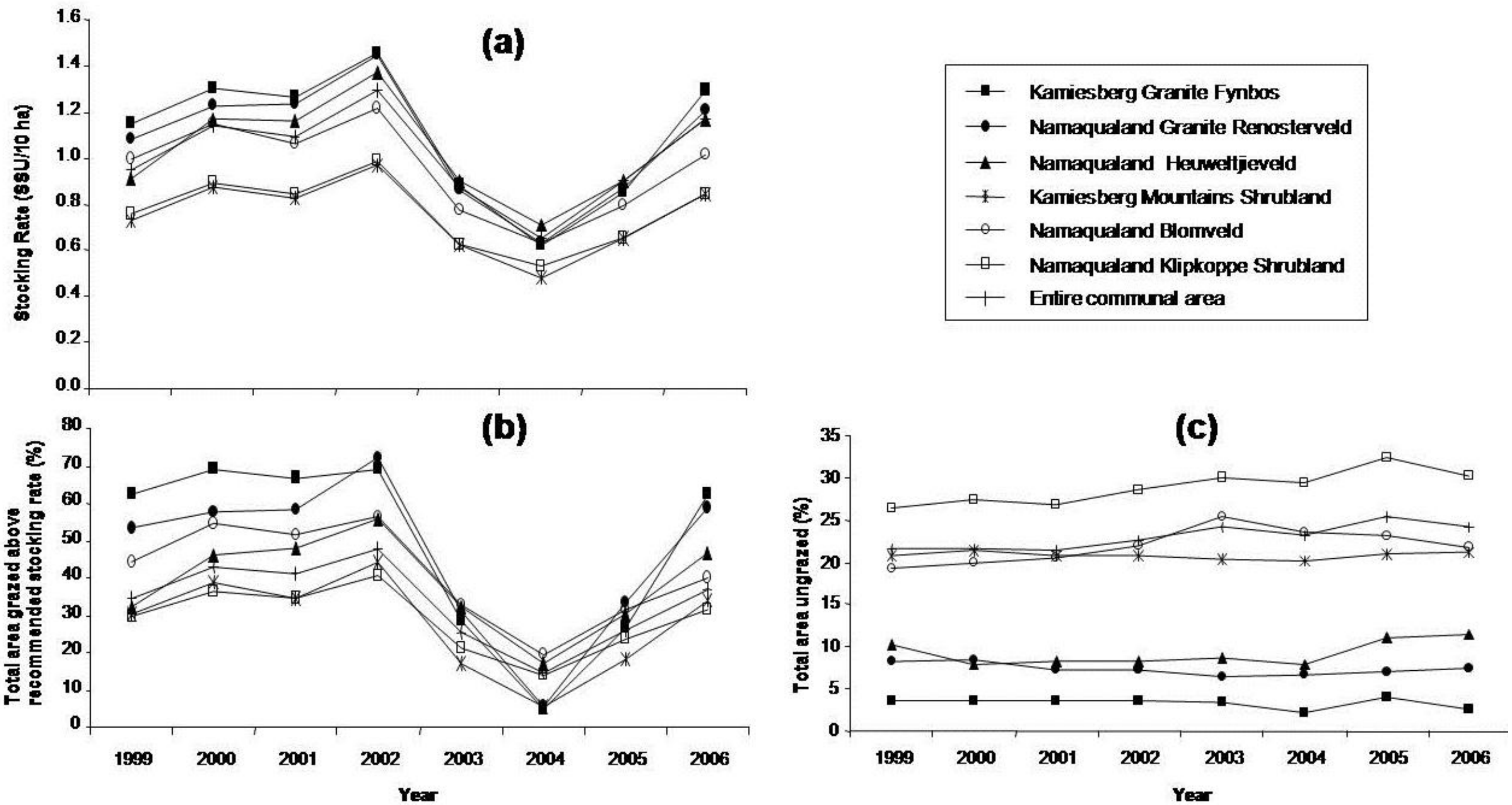



**Figure 6.3**: (a) The annual average stocking rates (SSU/10 ha) (b) total area (%) grazed above recommended stocking rate (c) total area (%) ungrazed by small stock between 1999 and 2006 within the entire communal area and each of the six major vegetation types.

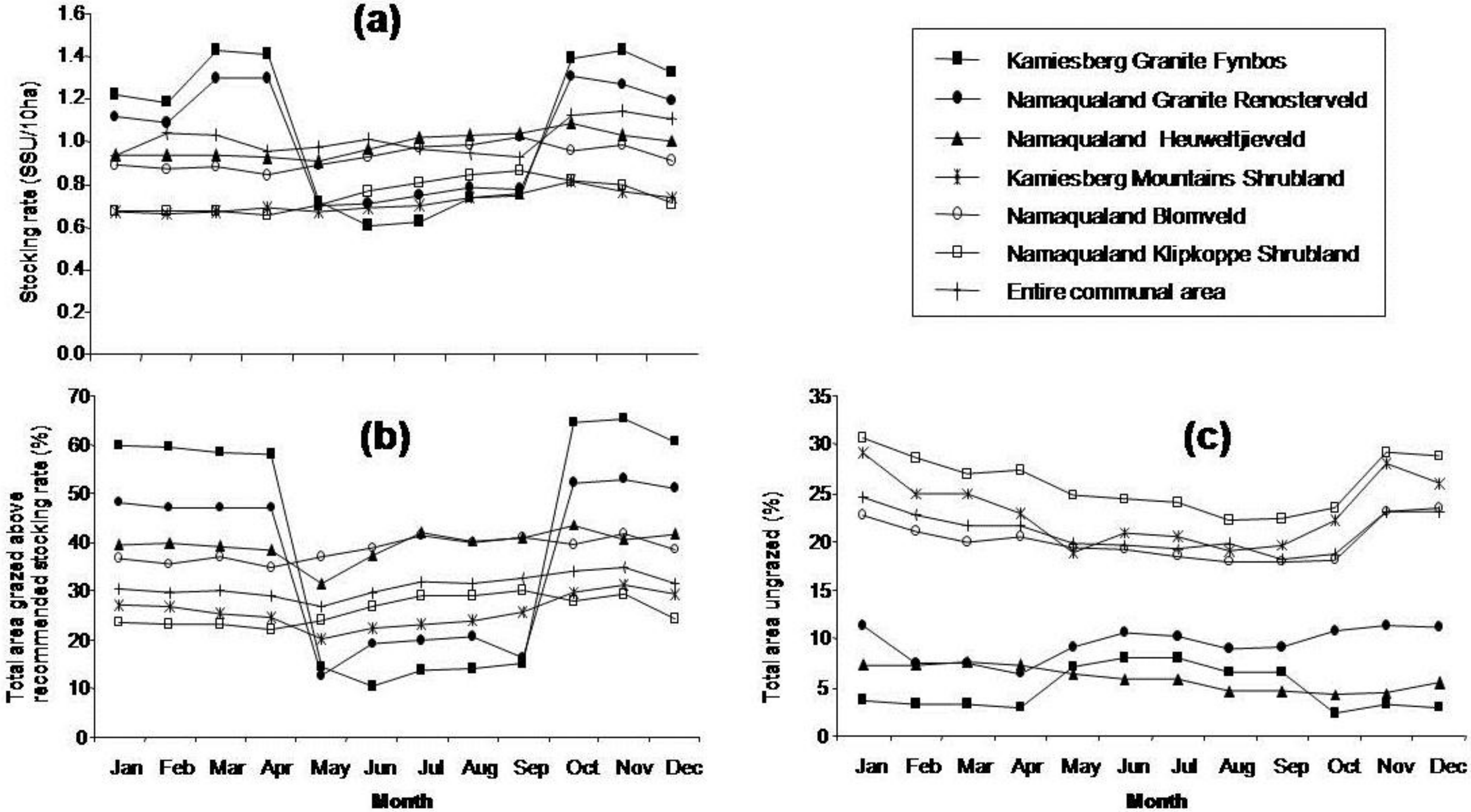



**Figure 6.4**: (a) The monthly average stocking rates (SSU/10 ha) (b) total area (%) grazed above recommended stocking rate (c) total area (%) ungrazed by small stock between 1999 and 2006 within the entire communal area and each of the six major vegetation types.

**Discussion**

Pastoralists in Leliefontein divide their grazing area into different landscape features which include mountainous areas, lowlands, cultivated croplands, fallow croplands, riverine and wetland areas (Samuels, 2006). Most vegetation types in the study area contain all these different landscape features and the locations of stockposts are usually closer to features that pastoralists prefer during a specific time of the year. Preference for specific landscape features by pastoralists is based mostly on their perceived quality of forage and abundance of preferred forage species and water (Samuels, 2006; Allsopp et al., 2007). However, this study could not assess stocking rates within particular landscape features. This drawback results from the basic pixel size of the analysis and the assumption of a fixed circular grazing orbit of 2.5 km around a stockpost. The complex topography in the study area and the close association of vegetation types (Helme and Desmet, 2006) also made it difficult to separate landscape features in a Geographical Information System. Therefore, the discussion is only focused on stocking rates within vegetation types.

### *6.4.1 What are the impacts of grazing within the different vegetation types in the study area?*

Pastoralists move their herds to lower altitudes in winter due to the cold conditions in the uplands. As a result, they have to move along an altitudinal gradient from Kamiesberg Granite Fynbos and Namaqualand Granite Renosterveld vegetation to Succulent Karoo vegetation types. Although the main reasons for moving are cold temperatures and frost periods in the uplands during winter (discussed in Chapter Four), pastoralists also regard the two Fynbos affinities as sourveld and the Succulent Karoo vegetation types as sweetveld. In winter, vegetation classified as sourveld loses its nutritive value (Meissner, 2000) and pastoralists are aware of this change in forage quality. This change in forage value is one of the reasons why pastoralists move their animals to sweetveld which has higher grazing value during winter (Meissner, 2000). However, several pastoralists are reluctant to move unless their animals would adapt to a new area and are less concerned as to whether they would obtain good quality forage for their animals. The survival of animals is the most critical factor in the decision-making of pastoralists but they do acknowledge that accessing good quality forage would keep their ewes in good physical condition for the winter lambing season. As a result of the movements of most pastoralists to sweetveld, lower grazing pressure was recorded for the two Fynbos vegetation types in winter.

The specific grazing area to which pastoralists in Leliefontein move in winter might also depend on whether plants are in flower and if there is a low occurrence of toxic plants (Chapter Four). Pastoralists prefer grazing in areas where there is an abundance of plants in flower. Such areas often include fallow croplands where flowering ephemerals dominate the landscape during late winter and early spring. Pastoralists perceive that the consumption of flowers stimulates milk production in lactating ewes (Chapter Five). This is important to ensure that their newborn lambs and kids are in good physical condition. Areas where there is low occurrence of toxic plants are often preferred by pastoralists as several plant species in the region, if consumed, are known to be fatal to livestock (Samuels, 2006). Livestock mortalities as a result of toxic plants are often higher amongst lambs and kids and, therefore, it is one of the key duties of a herder not to access these areas and to train animals not to graze toxic plants (Debeaudoin, 2001; Samuels, 2006; Salomon et al., 2013). In other mobile pastoral systems, the movement of herds to other grazing areas is also not made unless one or several criteria are fulfilled. Elsewhere in Africa, for example, Fulani pastoralists first move to an area on a temporary basis and will only stay if the forage quality is good and there is a presence of key forage species (Ba, 1982 cited in Niamir, 1991). Similarly, in India, scouts are sent out to evaluate rangeland condition before a pastoral herd is moved to a particular location (Agrawal, 1993).

In Leliefontein, the diversity of vegetation types within the relatively small area creates a mosaic landscape and herds only move on average 4.2 km between stockposts within and 8.4 km across village boundaries (Chapter Five) where they could access forage of higher nutritional value. In other mobile pastoral systems, herds often have to travel up to hundreds (Behnke et al., 2011) even thousands of kilometers as in the case of the Saharan

Tuareg (Homewood, 2008) to reach vegetation types that might be of higher grazing value.

Herds in Leliefontein village are able to graze in several ephemeral wetlands when they move back to the upland areas in summer. Pastoralists say that wetlands provide good quality forage for their animals during summer and hold water longer into the dry season for livestock to drink. Wetlands in the Kamiesberg have been found to contain several indigenous wetland species that are palatable to livestock (Kotze et al., 2010). In other mobile pastoral systems, wetlands have been described as key resource areas that are important for herd survival during the dry season in variable environments (Scoones, 1991). In the Richtersveld National Park, patches of *Cynodon dactylon* grass on the Orange riverbanks provide pastoralists with good quality summer forage (Hendricks et al., 2004). Elsewhere in Africa, Sahelian floodplains provide pastoral livestock with important forage resources during the dry season (Scholte and Brouwer, 2008).

The four vegetation types with Succulent Karoo affinities are grazed at constant stocking rates throughout the year. Since stockpost movements do occur where these vegetation types are distributed, movements are often within the same vegetation type as was found in other parts of Namaqualand (Mussgnug, 1995). Grazing a single vegetation type during the same season indicates that pastoralists do not want to or cannot switch the diet of their animals. Pastoralists say that switching their animals' diet could result in livestock mortalities since the animals are not used to eating those specific plants. In addition, a particular vegetation type might have more grazing areas of nutritional forage (e.g. riverine areas and wetlands) when compared to other vegetation types during that specific season. Other reasons for moving within the same vegetation might be the lack of water, an increase in the abundance of toxic plants in other vegetation types during that specific season or pastoralists might want to rest other vegetation types.

### *6.4.2 If the observed stocking rates are indicative of longer term grazing pressure, how applicable is the fixed carrying capacity recommendation for Leliefontein?*

During this study, grazing pressure varied over space and time. Most vegetation types were grazed above the stocking rate recommended by Department of Agriculture but during and the period immediately following the 2002-2003 drought, all vegetation types were grazed below the recommended stocking rate.

Within variable environments, high livestock mortalities during drought usually keep animal numbers below the carrying capacity of the veld (Ellis and Swift, 1988; Sullivan and Rohde, 2002; Vetter, 2005).The effect of high livestock mortalities during drought, which is a characteristic of non-equilibrial systems (Vetter, 2005), was evident in 2003-2004 in Leliefontein when no vegetation type was grazed above the recommended stocking rate. However, the livestock population recovered to pre-drought levels after two years and large parts of the Leliefontein communal area continued to be grazed at levels above the recommended stocking rate. This recovery in stock numbers after drought is faster than the four-year recovery period of the Turkana livestock population following the 1979-80 drought and which occupy a larger area (Ellis and Swift, 1988). In Leliefontein, the good rainfall periods following the 2002-2003 drought resulted in the rapid recovery of the livestock population. This recovery was facilitated by the small size of the study area as well as by the pastoralists' long-term strategy of selecting for livestock that produce multiple offspring.



The greater variability in the total size of the livestock population in the Leliefontein communal area over time suggests that livestock are vulnerable to climatic perturbations in variable and spatially constrained areas. Greater vulnerability might also result from the fact that the vegetation in some parts of Leliefontein has over the years shifted from a perennial to an annual dominated plant community (Anderson, 2008; Todd and Hoffman, 1999). Thus during periods of low rainfall, forage production would be less than what is required by the livestock population in Leliefontein and this results in high livestock mortalities.

Thus, could a livestock management strategy with a fixed carrying capacity as proposed by agricultural policies be applicable if forage availability varies in space and time across the landscape? Campbell et al. (2006) show that the "one size fits all" stocking regime does not fit all farming systems. Carrying capacities depend on vegetation type, rainfall and on the specific farming objectives (Fritz and Duncan, 1994). By using flexible and opportunistic stocking rates in variable environments such as Leliefontein, pastoralists would be able to take advantage of increased primary production in wetter years, which they cannot do if they use fixed and conservative stocking rates. Pastoralists do suffer high livestock mortalities during drought but they might overcome this by reducing their herd sizes (Sanford, 1983b) which would also reduce grazing pressure (Campbell et al., 2006). However, the ability to reduce herd sizes depends on whether pastoralists have access to markets and in Leliefontein pastoralists do not have access to permanent markets. Pastoralists in Leliefontein sell their animals mostly to speculators during October and November when the lambs and kids are about six months old. When they sell their livestock at speculators' rates, they often get much lower prices for their animals than the market price. This is the reason why some pastoralists prefer not to sell their animals during some years.

### *6.4.3 What may be the conservation implications of different intensities of grazing on the vegetation of the region?*

Within the Leliefontein communal area, Namaqualand Klipkoppe Shrubland had about 30% of its area ungrazed annually whereas Kamiesberg Mountains Shrubland and Namaqualand Blomveld were about 20% ungrazed annually. Kamiesberg Granite Fynbos, Namaqualand Granite Renosterveld and Namaqualand Heuweltjieveld had less than 10% of their areas ungrazed annually. The fact that less than 10% of some vegetation types are ungrazed, indicates that grazing pressure might be more evenly distributed than in vegetation types that had 20-30% of their areas ungrazed. If the absence of grazing in a particular vegetation type is due to insufficient water, then there is the potential to improve grazing distribution through water point development. If the absence of grazing in certain parts of the study area is mainly due to inaccessibility, then roads may need to be built or repaired to access this resource. However, the effect of greater access on these ungrazed areas or refugia also needs to be assessed. Refugia could be considered important for the maintenance of populations of several important plant species in the area but excluding some vegetation types from grazing may also be detrimental to the maintenance of diverse communities than allowing disturbance from grazing.

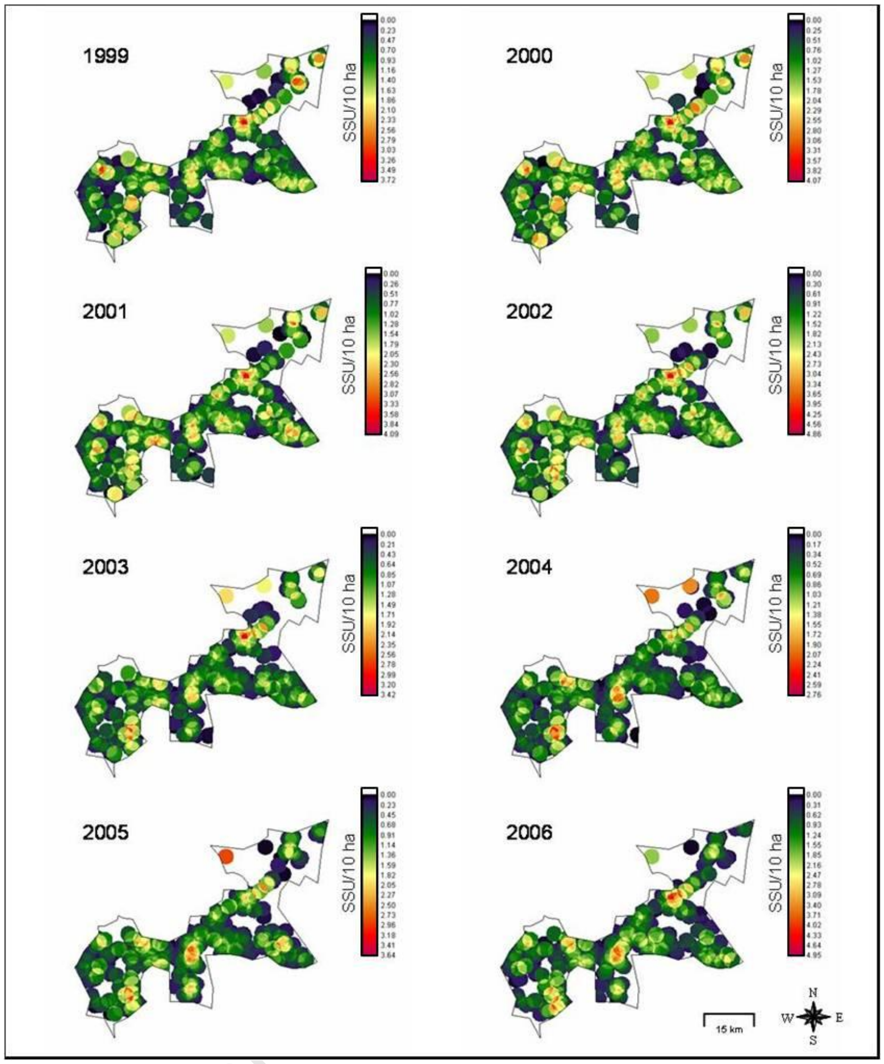
Overstocking has also been reported to have negative implications for plant diversity in the Namaqualand region (Todd and Hoffman, 1999; Riginos and Hoffman, 2003). It could therefore be assumed that overstocking of Kamiesberg Granite Fynbos and Namaqualand Granite Renosterveld vegetation types during the flowering season of most plants could have severe negative consequences for the vegetation. Todd and Hoffman (1999, 2009) suggest that grazing during the flowering season might explain the lower seed production and recruitment of palatable plants in the communal area. However, it is argued that vegetation types found in the study area might be resilient to the current levels of grazing pressure. It was found even though plant cover was significantly lower in the Leliefontein communal area than in adjacent private farms where conservative stocking rates are used, plant diversity was similar between the communal area and private farms (Anderson, 2008). Then again, high plant diversity does not necessarily indicate a higher conservation value. An area can have higher conservation value if there are more red data species present even though plant diversity is low.

Grazing could be beneficial to the vegetation of the region since it has been shown that intermediate levels of disturbance may be good for maintaining species diversity in Namaqualand (van Rooyen, 2002). The diversity of ephemeral species in these vegetation types is a product of past heavy grazing by antelope and are probably dependent on heavy grazing events to survive (van Rooyen, 2002). The presence of grazing as opposed to cropping may also help conserve an area. Cropping has been shown to remove plant species from an area when the land is ploughed (Carrick, 2003).

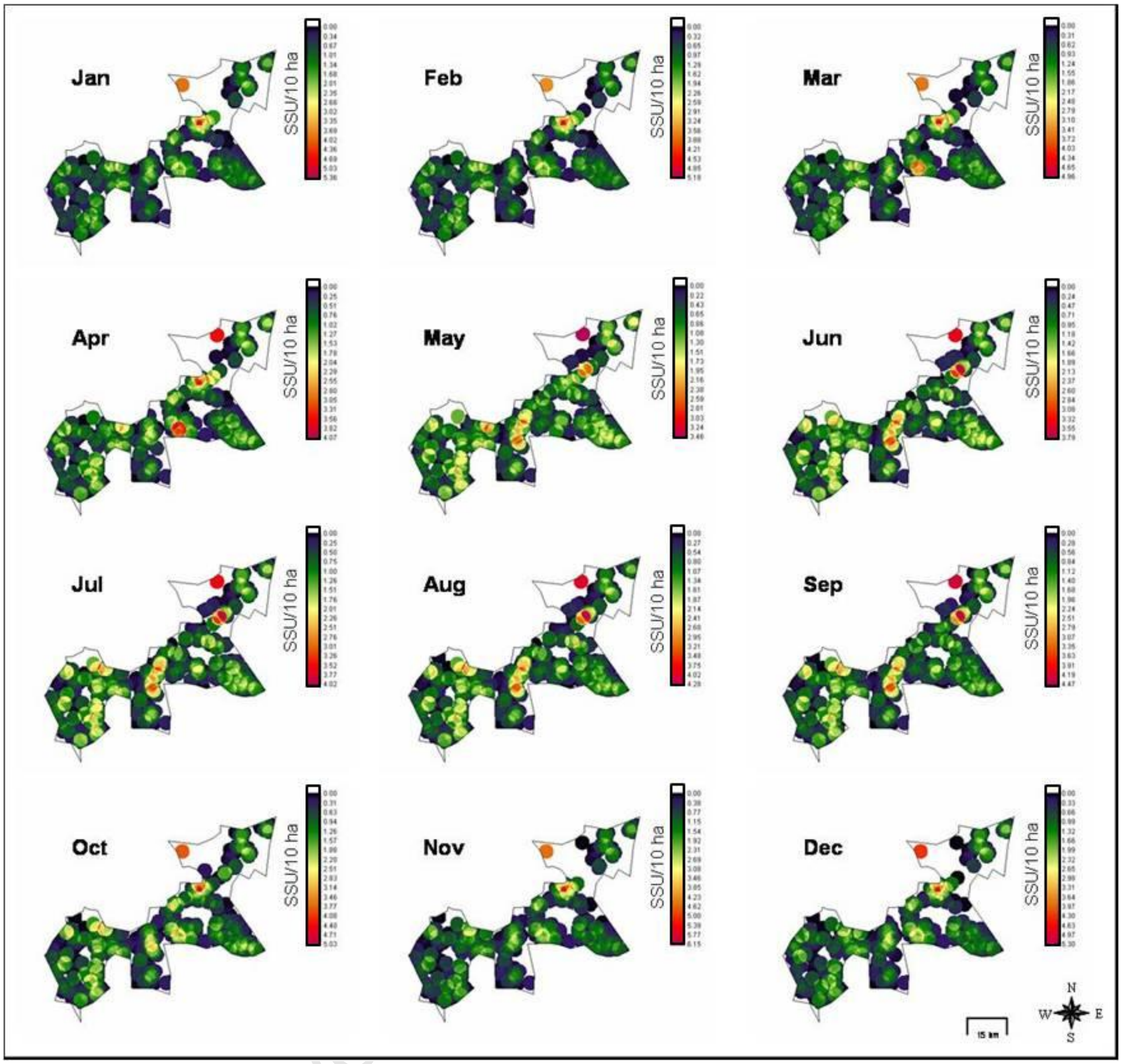
During this study, I observed that there is spatial variability in preferred forage species in the communal area and this provided pastoralists with various options of grazing sites.

These options that are available to pastoralists might be due to the resilience of the vegetation because even at grazing pressure at twice the recommended stocking rates for several decades, the vegetation types in the Leliefontein communal area have not become homogenised (Anderson, 2008). Therefore, pastoralists could continue to use shorter range movements to access different grazing sites.

In this study, it is evident that there is no land set aside as grazing reserves, to provide livestock with critical forage during drought, such as in mobile pastoral systems in other parts of the world (McCabe, 1994; Oba, 2001; Fernandez-Gimenez and Swift, 2003). This could be mainly due to the fact that most of the Leliefontein communal area is grazed annually to satisfy the nutritional requirements of all of the 256 herds. As mentioned earlier, the areas that are not used by livestock either do not have water during summer or are inaccessible via road. Even though mountainous areas provide pastoralists with critical forage during drought (Samuels et al., 2007), Samuels et al. (2013) outline other possible scenarios to incorporate formal grazing reserves into the Leliefontein mobile pastoral system. Areas in the region that could be used as grazing reserves include the adjacent land reform farms, national parks or land purchased specifically for this reason. However, to establish formal grazing reserves would require capital to develop infrastructure and to build robust institutions to manage access to these reserves (Samuels et al., 2013).




**Annexure 6**: The distribution of annual average grazing pressure from small stock between 1999 and 2006 in the Leliefontein communal area.




**Annexure 7**: The distribution of monthly average grazing pressure from small stock between 1999 and 2006 in the Leliefontein communal area.

# Chapter Seven

## Synthesis and recommendations

### 7.1 Introduction

Studies on pastoral mobility have highlighted its importance in adapting to the dynamic ecological and socio-economic conditions that characterise pastoral systems in variable environments. Pastoral mobility in variable environments is used for a wide range of purposes including to access water (Bassett, 1986; Behnke, 1999) and high quality forage (Illius and O' Connor, 1999; Behnke et al., 2011), to prevent crop damage (Homewood, 2008), to escape conflict (de Weijer, 2007), to move away from disease stricken areas (Homewood, 2008; Behnke et al., 2011) as well as to access local and international markets (Touré, 1990; Adriansen, 2003; 2008).

Most studies on pastoral mobility have described its use in a combination of long and short-range distances (e.g. Turner, 1999a; de Weijer, 2007; Behnke et al., 2011). However, mobile pastoral systems around the world are shrinking and long–range movements are no longer possible to manage livestock. As a result short-range movements are being more used by pastoralists as a strategy to manage herds. When mobile pastoral systems in variable climates become smaller and spatially constrained, we need to determine whether short-range movements will be effective in managing livestock and rangeland resources. This study assesses whether mobility remains an important strategy to access resources and to manage livestock when a semi-arid pastoral system becomes spatially constrained. Specifically, this thesis assesses how a mobile pastoral system has changed and further examines the current key drivers of mobility and the spatial extent of herd movements in relation to rangeland resources in the communal area.

The objective of this chapter is to answer the following questions by using the knowledge gained through this study and interpret them in the context of existing knowledge on pastoral mobility.

1. Is pastoral mobility an important strategy to manage livestock and rangeland resources when a mobile pastoral system becomes spatially constrained?
2. How would pastoral mobility patterns be affected when extensive pastoral systems become spatially constrained?
3. How does pastoral mobility compare between the spatially constrained Leliefontein communal area and other extensive pastoral systems?

## 7.2 Is pastoral mobility an important strategy to manage livestock and rangeland resources when a mobile pastoral system becomes spatially constrained?

Pastoral mobility remains an important strategy to raise livestock and manage rangeland resources in a variable and spatially constrained pastoral system. In Leliefontein, pastoral mobility is used to achieve ecological and socio-economic objectives. These objectives are important to pastoralists to ensure that their animals are in good condition and survive unfavourable environmental conditions and to reduce livestock impacts on the environment. In the study area, short-range movements allowed pastoralists to continue to have opportunistic and seasonal movements and migrate out of the commons which they considered important to manage livestock in variable environments (Chapters Four and Five).

The high compositional turnover of vegetation and the temporal variability and patchiness in resources in the study area permitted herds to move over short distances where they could access different rangeland resources. The movement distances of herds between grazing areas shortened from more than 100 km historically (Penn, 1986; Webley, 1986; Rohde and Hoffman, 2008) to distances of 4.2 km (range: 0.7 to 12.1 km) within and 8.4 km (range: 7.6 km to 9.0 km) between village commons. When pastoralists moved onto the adjacent land reform farms to access resources outside the Leliefontein communal area, the average distance a herd moved was 12.1 km (range:1.8 km to 30.9 km).

There appears to be no suitable alternative to pastoral mobility to manage livestock and rangeland resources in the Leliefontein communal area. During the 1980s, fencing was implemented as a tool to manage livestock when the study area was divided into economic units. Fencing and the subsequent subdivision of land has been shown to be effective in wetter and less variable climates (Tainton, 1999). However, it has been argued to be ineffective in variable environments (BurnSilver and Boone, 2003) including the Leliefontein communal area (Chapter Three). This study showed that the introduction of fencing, particularly in the 1980s led to inequitable access to resources and increased stocking rates and conflict in this spatially constrained pastoral system. Moreover, fencing is too expensive for pastoralists to purchase and maintain on their own. Pastoral groups are often poor and in Namaqualand, they are largely dependent on remittances and social grants to supplement their income from livestock (Rohde et al., 2003).



Another alternative to pastoral mobility would be to buy supplementary feed when there is insufficient food for the animals in the rangeland. However, pastoralists in Leliefontein cannot afford to constantly buy feed for their animals. Moving herds to areas where they could find sufficient food to eat thus appears to be the only affordable and ecologically rational management option.

## 7.3 How would pastoral mobility patterns be affected when extensive pastoral systems become spatially constrained?

When the Namaqualand region became colonised, pastoralists lost their ability to move over longer distances into other agro-ecological zones and this could be expected when larger pastoral systems become smaller. In pre-colonial Namaqualand, pastoralists in the Kamiesberg occasionally moved their livestock over long distances to the Orange or Olifants Rivers when resource became scarce (Rohde and Hoffman, 2008). They also moved more regularly over middle distances between summer grazing areas in the uplands, winter grazing in the lowlands or in Bushmanland in the east when droughts only affected the Namaqualand region (Webley, 1982; 1986). These mobile patterns started to break down when Dutch farmers competed for grazing as they moved from the overcrowding of the Western Cape area into the Namaqualand region. Later colonial policies formally made provision to take grazing lands away from the Nama and reduced their traditional control over the remaining pieces of land that they still occupied. In 1913, legislation promoted segregation and later, in the 1950s, privately owned white farms became fenced off from the Leliefontein communal area. Fencing took away pastoralists' option to move over long and middle distances into other agro-ecological zones to find good quality forage for their livestock.

Another aspect that was lost when Leliefontein became smaller and spatially constrained was the role of drought as a driver of pastoral mobility. In many mobile pastoral systems drought has often lead to a significant increase in the frequency and distance of herd movements. Under such circumstances pastoralists attempt to evade unfavourable environmental conditions and access better forage and water (Oba and Lusigi, 1987; Touré, 1990; Scoones, 1992; McCabe, 1994; Niamir-Fuller, 1999a; Behnke et al., 2011) which might be located outside their core territory (Scoones, 1999; Solomon et al., 2006). Drought was not found to be a key driver of pastoral mobility during this study in the Leliefontein communal area since it did not lead to a significant increase in the frequency of stockpost movement or to an increase in the distance moved between stockposts. Most pastoralists in Leliefontein cannot evade drought conditions to search for better forage and water since the area is small. However, several pastoralists do attempt to access better forage on their daily grazing routes (Samuels et al., 2007) and also possess a range of different herding strategies what they use during drought periods (Samuels, 2006).

Some aspects of traditional mobile pastoralism were maintained by pastoralists in Leliefontein (Fig. 3.11). For example, pastoralists in Leliefontein used seasonal movements to access different vegetation types during winter and spring. Pastoralists know the palatability of the vegetation and move their livestock to areas they perceive as having the highest grazing value at that specific time of the year. Seasonal movements along an altitudinal gradient were also maintained by herds in Leliefontein village to evade unfavourable environmental conditions at high altitudes during winter. These altitudinal movements were also made by Nama pastoralists before the colonists occupied Namaqualand (Hoffman and Rohde, 2007; Webley, 2007). This study shows that pastoralists currently evade median minimum temperature differences between 0.2 and 2.0 $^{0}$C when they move to lower altitudes in winter.

The tracking of water and forage during unfavourable environmental conditions, which is a common strategy in larger mobile pastoral systems (Niamir-Fuller and Turner, 1999; Solomon et al., 2006), is still evident (albeit only occasionally) in Leliefontein. Pastoralists did not have to travel farther than two kilometres on average to reach water during the dry summer season. This could mostly be attributed to the high number of watering points available within the daily grazing routes of most herds. However, the absence of water in some areas during the dry season has led to some areas not being grazed during summer. This resulted in undergrazing in areas where watering points are broken and overgrazing around functional watering points. During winter, the vegetation almost always has sufficient moisture for the animals to not having to drink water daily, so pastoralists moved to areas that are not grazed in summer due to water limitations.

During the study, about 27 % of herds did not move at all and it could be expected that more herds will become sedentary in Leliefontein over time. This could be ascribed to the dynamic socio-ecological conditions of pastoralists. General Circulation Models project that Namaqualand will become hotter and drier (MacKellar et al., 2007) and an increase in 1-2 $^{0}$C in the uplands might allow pastoralists not to move to lower altitudes to escape the current cold temperatures during winter. Moreover, a decrease in rainfall or shift in rainfall patterns in Namaqualand as projected by these models and as experienced by pastoralists (Samuels, 2006) may result in more agro-pastoralists abandoning cropping as a component of their livelihood strategy. A decrease in cropping, therefore, might influence pastoralists to not move away from growing crops since there would be fewer croplands to protect during winter.

### 7.4 How does pastoral mobility compare between the spatially constrained Leliefontein communal area and other extensive pastoral systems?

Pastoralists in Leliefontein used mobility to evade low temperatures and frost periods in the uplands by moving to lower altitudes during winter. Moving over short distances to lower altitudes in winter remains a necessity to ensure livestock survival. This strategy appears to be common amongst many mobile pastoral groups occupying more extensive rangelands (Dyson-Hudson and Dyson-Hudson, 1980; Niamir-Fuller, 1999b; de Weijer, 2007).

In Leliefontein pastoralists use mobility to exploit different areas in the rangeland. Pastoralists established their stockposts in the uplands during summer to access ephemeral wetlands, which have good quality forage and carry water for livestock long into the dry season. In other extensive pastoral systems ephemeral wetlands and other wetter habitats are also preferred by livestock during the dry season and could be regarded as key resource areas (Scoones, 1991; Hendricks, 2004; Hempson, 2010).

In a spatially constrained area cropping is a key driver of pastoral mobility since pastoralists move their herds away from croplands to prevent livestock from damaging growing crops. In some extensive pastoral systems, cropping also increased mobility (Homewood, 2008) but in other pastoral areas cropping resulted in pastoralists becoming less mobile since croplands block transhumant routes which deny herds access to water and forage especially during the dry season (Shazali and Ahmed, 1999; Niamir-Fuller, 2000; Solomon et al., 2006). However, cropping in the Leliefontein communal area is declining and some croppers have fenced off their arable lands. As a result some pastoralists have decided not to move their stockposts in winter as there was no danger of livestock damaging crops in the area during the growing season.

In this study, croplands were accessed mostly after harvesting during November and December when herds moved closer to the arable lands to graze on crop residues. Arable lands have been identified as key resource areas in other pastoral systems (Scoones, 1995a; Ramisch, 1999; Shazali and Ahmed, 1999; Bennett et al., 2007) since they may offer more nutritious forage than natural veld during a particular time of the year (Bayer and Waters-Bayer, 1989). Fallow croplands are also preferred by pastoralists in Leliefontein in winter due to the abundance of ephemerals which they consider good quality forage (Samuels, 2006).

Pastoralists in Leliefontein considered their environment when making herd management decisions. More than 12% of the movements between 1997 and 2006 were to prevent trampling around stockposts. Conservation farming methods are also evident in other pastoral system such as in Namibia, where Himba pastoralists prefer grazing further from water during rainy season to rest pastures and make use of underutilised areas (Behnke, 1999). Thus, even though resources are limited in the small and spatially constrained areas, pastoralists in Leliefontein conserve resources for future use. Preventing the overuse of resources through pastoral mobility is a strategy contrary to that recommended by agricultural officials who emphasise that pastoralists should destock to reduce their impact on the environment. Destocking could result in an increase in the levels of poverty in the area since there would be fewer animals to sell or to trade for other essential products. There would be fewer livestock products to share amongst the community which is important in maintaining social capital in the study area. Culturally it would erode their status in the community as livestock are seen as a symbol of wealth.

In extensive mobile pastoral systems that are not spatially constrained, migrating to other areas where better forage and reliable water could be accessed is important so that livestock could survive unfavourable environmental conditions (Oba and Lusigi, 1987; Behnke, 1999; Ramisch, 1999; Behnke et al., 2011). In the spatially constrained Leliefontein communal area, these opportunities are limited and strong social cohesion is important so that pastoralists could benefit from shared resources in times of need.

During this study, some pastoralists were provided the opportunity by the municipality to move onto the adjacent land reform farms to ensure better survival of livestock when forage was scarce during the 2002-2003 drought. However, the lack of water and infrastructure on the farms forced them to return to the Leliefontein communal area. Seven pastoralists also reached agreements with private farmers to use their grazing lands when the rangeland condition was poor. However, in Leliefontein moving beyond communal land onto private land comes at a cost since pastoralists have to give the farmer 50% of new born lambs while the herd is on the private farm.

Pastoralists move from overcrowded areas since they did not want their and their neighbours' rams from mixing with the ewes. Since not all the rams are camped during the non-breeding season in Leliefontein, it could result in lambs being born during the dry season when forage is scarce. Moreover, a pastoralist wants his own ram to impregnate his livestock to improve the overall quality and hardiness of his breeding stock. The strategy of a 'safe' distance is also used in other African pastoral systems but over larger spatial scales to prevent the spread of diseases and pests (Niamir-Fuller, 2000).

### 7.5 Future research directions

While this study has shown that pastoralists move their herds between grazing sites, it did not determine how efficient, in terms of quality of diet, it is to move between the grazing sites at different times of the year. A future study on diet selection amongst livestock species during different times of the year could answer this question. We could then determine how the use of mobility translates into livestock production indicators such as lambing percentages and mortality rates.

A possibility also exists for combining smaller herds into larger management units which rotate between different village commons taking advantage of variability at a larger spatial scale and leaving a larger area to rest in-between grazing events. We could determine whether this is a potential strategy to use mobility at a different scale to foster vegetation recovery and forage availability within low-lying areas and the rocky uplands and between different vegetation types.

This study provided detailed information about mobile practices of pastoralists in the Leliefontein communal area. These movements could also be modelled to assess how herds would adapt to the projected climatic changes described by MacKellar et al. (2007). Moritz et al. (2010) modelled grazing pressure in Cameroon and Macopiyo (2005) used a spatially explicit, herd foraging and movement model to simulate pastoral mobility in East Africa to assess how future changes in climate might affect rangeland use. Simulation models could be used to predict grazing distribution in the Leliefontein communal area in relation to the future options for livestock management in Namaqualand as described in Samuels et al. (2013).

This is particularly of interest since pastoralists in Leliefontein village will not have to move to evade cold conditions in the uplands when the temperatures increase by 1-2 $^{0}$C. If pastoralists in the uplands do not move to lower altitudes in winter, we also need to determine the impacts of increased sedentarisation on the environment. Since rainfall patterns are projected to be more variable in Namaqualand (MacKellar et al., 2007), it would also be important to assess the impacts of these changes on cropping and pastoral mobility.

Pastoralists in Leliefontein often referred to the feral donkeys that they say compete with their livestock for the limited resources. We could investigate whether donkeys compete directly with livestock for forage or whether they occupy a niche outside of the traditional grazing routes used by mobile herders. If they occupy the same niche, would solving the 'donkey problem', exert less pressure on rangeland resources and would herd mobility patterns change in response to this?

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**Appendix A:** Questionnaire for pastoralists or agro-pastoralists

**Livestock farming**

1. Name of owner/herder
2. Age of owner/herder
3. How long have you been farming with livestock?
4. Why do you farm with livestock?
5. How did you acquire your livestock?
6. How many livestock do you have? Does the number of livestock change annually?
7. What is the reason for the specific size of your herd?
8. Why do you keep sheep and/or goats in your herd?
9. Do you keep cattle? Why or why not?
10. Who looks after your livestock?
11. How many people own livestock in your herd? Why do you combine your livestock in one herd?
12. How many times did you move your stockposts from 1997-2006?
13. When and to where did you move to?
14. How long did you stay at each stockpost?
15. Why did you move your stockpost?
16. Did you ever move out of the communal area? When and why?
17. What was the arrangement for you to move out of the communal area?
18. Would you prefer your livestock grazing in a paddock or be herded? Why?
19. Where in the rangeland is the best forage available during summer and winter? Why would you regard these areas as the best?
20. Do you interact with other herders? When and why? What do you do when you meet?
21. What are the main challenges you experience as a livestock farmer?
22. How can conditions for livestock farmers be improved in Leliefontein?

**Crop farming**

1. Do you rent a cropland?
2. Did you plough your land in the last ten years?
3. When did you crop in the last ten years?
4. Why did you crop?
5. Where did you crop?
6. Where did you get your seed from?
7. Who assisted you when you cropped the land? How did you compensate them?
8. What are you main challenges as a crop farmer?

If a new topic arose during the interviews that were important to the research, then we discussed those particulars in greater detail.

**Appendix B**: Sources of livestock data from the Leliefontein communal area from 1997 to 2006.

| No | **Source** | **Period of collection** | **Frequency of collection** | **Method of collection** | **No of herds counted** | **Villages sampled** | **Place of collection** | **Notes** |
|---|---|---|---|---|---|---|---|---|
| 1 | May, 1997 | Sep 1997 | Once | Livestock census | 459 households | All | Livestock census conducted in villages | Livestock totals from households in the same herd were combined |
| 2 | University of Cape Town livestock database | Aug 1998 – Dec 2006 | Monthly | Field sampling | 39 livestock owners | Paulshoek | At stockposts | Livestock totals from owners in the same herd were combined |
| 3 | Debeaudoin, 2001 | Sep-Oct 2000 | Once | Field sampling | 26 herds | Leliefontein Kharkams Nourivier Spoegrivier Tweerivier | At stockposts | Herds were sampled during her masters study |
| 4 | Northern Cape Veterinary Services | Feb 2002 | Once | Dipping census | 353 livestock owners | All | Counts at 22 dip baths | Livestock totals from owners in the same herd were combined |
| 5 | Leliefontein Commonage Committee | Jul 2003 | Once | Annual livestock registration | 159 livestock owners | Nourivier Kharkams Rooifontein Klipfontein Tweerivier Kamassies | Commonage committee meetings | Livestock totals from owners in the same herd were combined |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | Kamiesberg Local Municipality | Aug 2003 & Dec 2005 | Annual | Annual livestock registration | 321 livestock owners | All | Municipality | Disputed numbers of livestock per owner were not used |
| 7 | Agri-Kameelkrans Famers Union | Nov 2006 | Once | Annual livestock registration | 30 livestock owners | Tweerivier | Union meetings | Livestock totals from owners in the same herd were combined |
| 8 | Collected during PhD fieldwork | Sep 2006 – Dec 2006 | Once | Field sampling | 96 herds | Kheis Klipfontein Nourivier Rooifontein Kamassies | At stockposts | Data collected during fieldwork |