Pastoralists' Dilemma.

Assessment of Changes in livestock production and household dynamics among the Maasai due to development of boreholes in Moindabi, Kenya.

Oduor Cornel Ouma

February 2001.

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By

Oduor Cornel Ouma

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The MSc. Degree Assessment Board

Chairman (Social Science Division):	Prof. W.H. van der Toorn
External Examiner:	Prof. H. van Keulen
Internal Examiner:	Dr. B. Toxopeus
Primary Supervisor:	Dr. M. McCall
Secondary Supervisor:	Drs. J.J. Verplanke

INTERNATIONAL INSTITUTE FOR AEROSPACE SURVEY AND EARTH SCIENCES (ITC), ENSCHEDE, THE NETHERLANDS.

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Disclaimer

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Dedication

My parents the late Mr. Oduor Omollo and Mrs. Margaret Akumu, beloved wife Debora Auma Awuor and Children Sheryl, Cecil and Cedrine.

Abstract

Pastoralists inhabit rangelands, which often experience scarcity of water resources required to support both livestock and human beings. Development of water points for people and livestock forms one of the development interventions in the rangelands. This study assessed the impact of water points on both livestock production and households in Moindabi Location in Naivasha, Kenya. Major findings include changes in herd management, production, domestic water use and cultural adjustments. Conflicts associated to resources use was also observed. These results suggest that water points have direct effects on livestock production and standard of living of the pastoralists.

Key words: Livestock, water points, pastoralists, rangelands, Naivasha and Spatial analysis

Acronyms and Abbreviations

AAME	African adult male equivalent
IDRC	International Development Research Centre
FAO	Food and Agricultural Organization of the United Nations
Landsat TM	LandSatellite Thematic mapper
LE	Livestock equivalent
RRA	Rapid Rural Appraisal
UNSO	United Nations Development office to combat Desertification

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Table of Contents

List of figures

List of Tables and Pictures

List of Pictures

Chapter 1

1.1 Introduction

This thesis focuses on development of water resources, its impact on livestock production and household dynamics among pastoralists (Maasai), who are predominantly found in the rangelands. The rangelands of Kenya comprise 490,000 km^2, which is 80% of the country's total land area of 582,644 km^2. The total human population inhabiting rangelands number two million and they own 60% of the country's beef cattle (Lucas, 1978). Although the annual rainfall is very low within the rangelands, moisture availability is further limited by high rates of evaporation and loss due to percolation. Arid and semi-arid areas (rangelands) of Kenya receive an average of below 600mm of rainfall/ year and which is unevenly distributed. Therefore, the entire population has to depend on water either from dams or boreholes constructed by development agencies to support both livestock production and household use. The recharge of these water reservoirs is through rainfall which is, however, highly variable both in time and space. The water requirements in these areas are for domestic and livestock watering. To some extent, water consumption for these purposes is influenced by natural, economic and social conditions such as poverty, topography, water availability, quality and distance from where it is obtained.

The rangelands contain vast resources which support livelihood of pastoralists who are mainly dependent on livestock economy and whose production objective is not just to increase herd size, but also increasing milk yield, maintaining appropriate herd structure for short and long term productive success (Monod, 1975). The priorities given to each goal will however change depending on household's particular circumstances (Niamir, 1983).

1.2 Background and Justification for research.

Water is a scarce resource in the rangelands of Kenya while its availability is limited within the rangelands. However, if reliable available, it may contribute to improvement in standard of living and quality of life of the pastoralists. To achieve this there is provision of water points whose reliability with regards to quantity and quality are not only aspects of resource use and management but are also the main determinants for livestock production and household use. Although some parts of Kenyan drylands are suitable for agriculture, livestock husbandry is a more important production system since the peoples' livelihood depends on livestock economy. However, livestock production is still centred on traditional pattern of livestock movement in search of water and pasture.

The aim of this work, therefore, is manifested from the standpoint that developing water resources within rangelands has the potential for partially improving livestock production and thus welfare of the people. This viewpoint is also shared by the Kenyan Government whose policy puts emphasis on water as a basic need for every household and an essential resource for increased economic activity. It further states that within the rangelands *" rehabilitation of livestock watering points and additional provision of such facilities is intended to reduce range destruction caused by concentration of livestock numbers…" and "… Improving living conditions through increased productivity and creation of employment opportunities" and "… generating opportunities for improving quality of life…"*

As much as provision of water points in rangelands an array of social and economic benefits, it may also be the main cause of environmental degradation if not properly managed. To avoid this entails creating appropriate institutions for its management and improvement causing better livestock economy, which is central to pastoralist's livelihoods with regards to provision of income and employment.

The importance of livestock to national economies is not usually easily visible, partly because sale of livestock is by no means crucial element for pastoralists, as only the surplus to subsistence requirements is taken to market.

1.3 The Problem

The problem to be addressed was generated from the problem tree (Figures 1 and 2) of Amboseli Biosphere Reserve which was generated using objective oriented project planning approach (Toxopeus, 1996). In the problem tree, a number of clusters are generated and the one that this study focuses on is that of limited water supply for livestock in dry seasons.

Figure 2 illustrates the effects to problems of limited water supply for cattle and domestic consumption during dry season. These include inadequate drinking water for livestock and domestic, inefficient control of tick borne diseases, increased settlements around water points, localised degraded areas around water points, sedentarization, domestic water sought from long distance, livestock travel long distance in search of water and pasture, inadequate grazing time, irregular watering of livestock, frequent livestock deaths due to long distance travelled, conflicts between resource users, low livestock productivity, more time required by people in fetching domestic water, irregular watering of livestock, reduced time in undertaking household tasks, controlled use of water and increased land degradation. In summary these effects have greater impact on environment, household dynamic and gender role and are which sub headings that form literature review.

Toxopeus (1996) said that improving these problems would require supply and distribution of watering points, which will meet both livestock and household needs. The outcome of these are changes on livestock production, labour requirements, control of tick borne diseases, herd sizes and management, settlement patterns, cultural values and gender roles

1.4 Implications for the thesis

In conclusion, development of community water points within pastoral areas is to look at the effects of improving water supply for livestock and domestic consumption. This study covers Moindabi location, Naivasha Division of Kenya and its' objectives are to determine:

- Changes in livestock production due to presence of water points
- Changes on household dynamics due to presence of water points
- Changes in gender roles due to the presence of water points

In this study, the following questions will be answered.

- What are the changes in livestock production at household level that been brought about due to the availability of water points?
- How have herd sizes and herd management practises at household level been influenced?
- What are the changes in household dynamics associated with introduction of water points?
- How have settlement patterns of the people been affected?
- What are the changes observed on the people's cultural values?
- How have gender roles been influenced by the availability of water points?

1.5 Structure of the thesis

Moindabi location in Naivasha Division, Kenya was chosen as the study area for carrying out an assessment. To develop a concrete foundation for research on this field, different existing literature in line with the research has been reviewed (Chapter 2).

Before presenting the results of this work, the study area as well as the methods used are described (Chapter 3). After data collection, they are analyzed and discussed in relation to their relevance to the study. In this case, the outcome has been presented under two major sub-headings: changes in livestock production (Chapter 4) and changes in household dynamics and gender roles (Chapter 5). Finally, relevant conclusions and recommendations are given in (Chapter 6).

Chapter 2

Impact of water points - A literature Review.

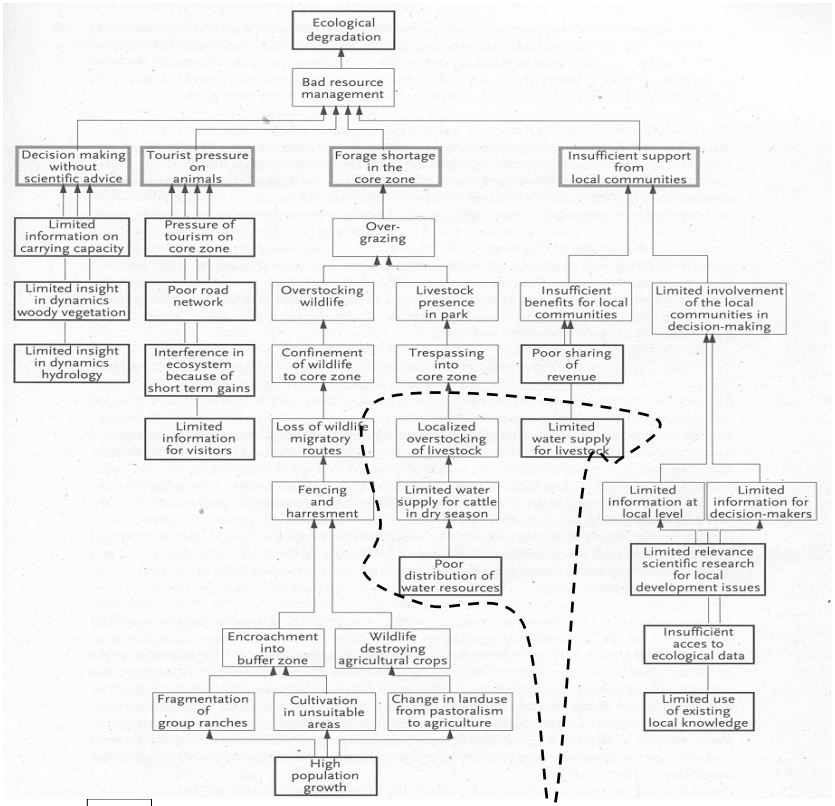
2.1 Introduction

There has been a general concern regarding the current situation of arid and semi arid lands (Rangelands) in sub-Saharan Africa and areas inhabited by pastoralists. This concern is due to the fact that these areas experience severe rainfall shortage thus having a dreadful negative effect on environment, people and livestock. An effort to make these areas habitable by developing required key resources is a fundamental issue as we approach the middle of this millennium. Shortage of rainfall calls for range improvements, which is defined as special treatments, developments, and structures used to improve forage production and key resources, to facilitate use by grazing livestock.

Vallentine(1989) said that water development, fencing and burning among others are management strategies which can be used to control livestock distribution. Since they involve management decisions they should be made part of planning in directing of range use rather than considered in isolation. He also said that these strategies provide an effective management for grazing and thus indirectly improving forage resource thereby increasing animal production. Water development not only controls/ improves access to pasture but is also a vital commodity for household domestic use and livestock production. It has been noted that development of water points within pastoral communities (Maasai) has been in practice for the last three decades. In Northeast Kenya, water point development has been in existence since 1969 (Internal reports of Ministry of Water Development, 1969). Other countries where water points have been put up to support rangeland development are Botswana (Hitchcock, 1978) and Tanzania (Jacobs, 1977). However, the important factors worth considering in using water points (wells or boreholes) to develop pastoral regions should include distance to water points, quality and quantity of water discharged.

The sections review looks at changes associated with development of water points aimed at alleviating the core problem in Figure 2 of limited water supply for domestic and livestock water are solved by developing water points. These changes are divided into changes in livestock production, household dynamics, environment and gender roles and may be due to reduced distance to water point, quality and quantity of water discharged from water points.

Figure 1 Problem tree for Amboseli National park. Adapted from Toxopeus (1996).



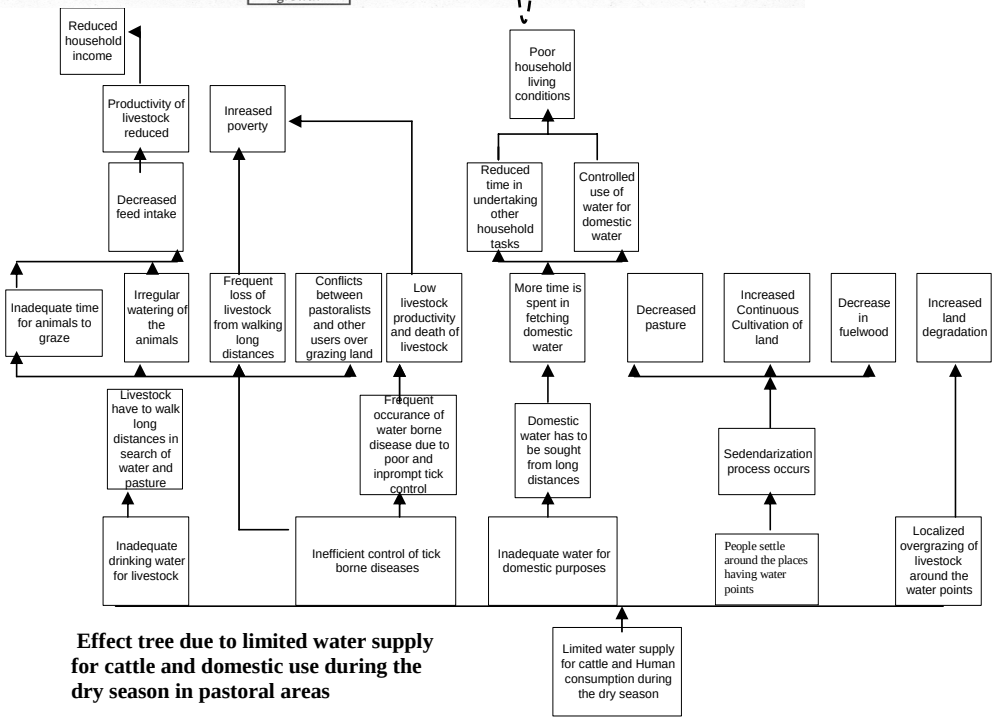


Figure 2 **Effect tree due to limited water supply for cattle and domestic use during the dry season in pastoral areas**

2.2 Impact of Water points

2.2.1 Environmental Degradation

Water is a major limiting factor for survival and growth of livestock in arid and semi-arid areas and is usually available at only few scattered point sources which become the main focus of animal activities (Andrew, 1988) sometimes refereed to as 'pioshere[1]". Within the 'pioshere', livestock tend to over utilise existing forage until there is nothing left for them to feed on causing severe soil erosion thus land degradation. Degradation is caused by high concentration of livestock found at these water point sources 'piosheres' during dry seasons. Livestock number usually goes up by amount of nearly three times, making such stocking rates to exceed by far the required carrying capacity. The resulting increase in stocking rates thus cause destruction of grazing resources in a radius of 20-30 km around each water point " piosheres" (Desertification control bulletin, 1998), Chevallier and Claude(1989) due to overgrazing (Andrew, 1988).

The above condition is aggravated further whenever water points are unevenly distributed relative to potential grazing area resulting in poor livestock distribution. This leads to uneven utilisation of plant cover thus leading to vegetation deterioration. Presence of water points also leads to habitation by human beings in these areas. Cutting down of trees for either putting up houses or animal enclosures (livestock fencing) and fuel wood for cooking further deteriorates these areas. However, it has also been urgued on the contrary, that "piosphere[1]" degradation due to overstocking or increased carrying capacity during dry seasons is part of an old paradigm. The new paradigmatic shift suggests that environment around water points can be improved because nutrients are brought in by cattle from surrounding rangeland areas whenever they are being watered (UNSO, 1992) and (Darkoh, 1993) by defecating within these areas. This theory does not apply in very dry conditions since excess ammonia in the soil requires plenty water if the active components are to be made available to plants.

2.2.2 Changes in Livestock Production due to water points

The review of literature on changes in livestock production is structured into livestock management (stocking rate, herd size and management, watering regime and management, labour requirements for watering and control of tick borne diseases) and livestock production aspects.

Stocking rate
Carrying capacity of rangelands refers to the maximum number of livestock units that a given range area can carry when forage is at its lowest (Relma, 1999). The estimates of livestock carrying capacity are usually derived directly from rainfall parameters or are linked to productivity of the vegetation (Grandin *et al.*, 1991). It has been noted that there is usually a variation in carrying capacity depending on seasons. In Kajiado, carrying capacity increases from 7-ha/tropical livestock unit (TLU[2]) in the south to about 3ha/TLU in the North where there is availability of moisture. Since daily management of herds and flock is aimed at satisfying immediate requirements of livestock for feed and water. Long term strategies of grazing management are closely linked with the longer-term variations in forage supply (Grandin *et al*., 1991) thus need for keeping appropriate stocking rate at any time of the year.

The application of carrying capacity concept within rangelands has promoted the belief that all communal rangelands are overstocked. Practitioners have insufficiently questioned the concept and conclusions from it since they consider it harmful to communal area dwellers and wrong for range management and development. The point raised in the paragraph above becomes more obvious when

[1] Pioshere is a zone of attenuating animal impact. It is coined from the Greek word 'pio' meaning drink

[2] A tropical livestock unit (TLU) is equivalent to 250 Kg Liveweight

investments that favour livestock keepers are put in place. Such investments include provision of water points for dry season grazing. In such circumstance, there is a notion that pastoralists have a propensity to expand their holdings of livestock beyond carrying capacity of the range, resulting in overstocking and degradation of pastures. Therefore, it may appear that the intensity with which grazing resources are being used is directly related to the location of water points (Van Wijngaarden, 1985: de Leeuw and Nyambaka, 1988) within pastoral range areas.

Those who are critical of developing water points support the concept mentioned above by arguing that these water point areas help keep larger number of livestock alive during dry seasons than are warranted. Even though the carrying capacity of the range cannot support these large numbers, this does not constitute a genuine increase in livestock numbers in the long term (Livingstone, 1984). Similar sentiments have also made by Perry (1962) who argues that there is a relationship between carrying capacity and water points and that carrying capacity of livestock could be increased between 150%–250% by providing water points to command usable areas that are not yet utilised effectively.

However, those who oppose the concept say that the argument, which stipulates that keeping of too many livestock, outstrips the range capacity is part of old paradigm in range science which relates overgrazing and carrying capacity in arid and semi-arid areas. However, in recent years, there has been a paradigmatic change, suggesting that the problem is not just that of too many livestock relative to available grazing areas but (Darkoh, 1993) said that the state of rangeland ecosystems in arid and semi-arid areas which often experience irregular supply of rainfall within the year making it fragile. This is a typical case that also applies in Moindabi location.

Livestock distribution

The distribution of livestock tends to be dictated by availability of water points. Study conducted shows that only 25% of livestock are observed in areas greater than 15 km from water points while 50% of livestock are observed in areas within 10 km from water sources (De Leeuw *et al*, 1998). This indicates that presence of water points could cause inefficient livestock distribution within rangeland areas if water points are inadequate and not properly distributed relative to potential grazing area (Andrew, 1988). It has been further suggested that uniform distribution of water point within rangelands, tend to reduce the rate of degradation and opens up more land for utilisation by livestock.

Herd sizes and herd management by splitting.

It has been established that during drought pastoralists herds generally die of starvation rather than thirst. Even though livestock losses are mainly due to starvation, scarcity of water also plays a major role since livestock also die from trekking long distances in order to reach water sources. Commonly affected are calves because they cannot withstand long distance trek under conditions of forage scarcity resulting from low dry season rainfall (Leisinger and Schmitt, 1995). The long distances travelled to water sources and scarcity of fodder thus contribute to loss of livestock and subsequently reduction in herd sizes. Reducing distance to water sources by interventions such as drilling of boreholes tends to contribute towards an increase in herd sizes because livestock losses are high when travelling long distance.

Presence of water points has also immensely contributed to changes in herd management practises, which are aimed at raising herd productivity, maintaining existing herd, or at investing as little effort as possible. The major aspects of this practise are direct herding, watering, branding, de-horning, breeding, herd splitting, culling, weaning and supplementary feeding (Corjan, 1993). According to Grandin (1991) herding is an art of guarding and conducting livestock. One important herd management technique is herd splitting which involves dividing livestock into separate herds, depending on sex, age, type and productivity either during grazing or watering.

Pastoralists are known for separating large ruminants from small one’s as practised by the Rendile of Kenya (Fratkin 1986) who herd camel with sheep and cattle with goats (Winter, 1984). While

Grandin (1991) added that cattle are usually divided into two groups comprising lactating and dry cows as well as older heifers and steers. The Borana also split herds depending on sex, age, type and productivity. They tend to keep milking herds near settlements while dry cattle travel further a field in search of dry season grazing (Cousins and Upton, 1987). Herd splitting is also practised by both Fulani in Northern Nigeria (Diop, 1987) and Dinka of South Sudan (Niamir, 1982) who do it to separate 'milk herd' (mostly milking and pregnant livestock and their young); and a main or dry herd. In South Kgalagadi, Botswana, Jerve (1982) made differentiation of herd and watering units pointing out that a watering unit consists of several herd units. During watering of cattle, someone must represent each herd unit during watering and who has to water all cattle that show up in the watering unit.

Labour requirements for watering.
Watering requires the most labour of all livestock duties (Corjan, 1993). It has been found out that a linear relationship exists between herd size and labour requirements for watering. The amount of labour required increases proportionately with herd sizes (Helland, 1980). Livingstone (1984) emphasised that labour for watering livestock imposes heavy demands on people. In Masteng area, Botswana, Corjan (1983) showed that 2 or 3 people are required to retrieve a bucket from the well and pouring water into the trough. Another 2 or 3 people are required to regulate livestock while drinking. This is demanding task that takes upto 3 or 4 hours every day. These are a non-motorized boreholes that where more people would be required to draw out water for livestock.

In certain instances, labour requirements for watering is low compared to other pastoral systems (Cousins and Upton, 1988; Swift, 1981; Helland, 1977). This happens in areas where watering source is a motorized borehole requiring a single person to operate (Grandin *et al*. 1991).

While presence of water points is usually a sign of good times ahead for pastoralists, the process of lifting up water manually is not an easy task. Blench & Marriage (1999) also supported Corjan (1983) by explaining that watering herds at these wells is so labour-intensive that they usually do not allow numbers of livestock to rise to levels that cause major landscape degradation. Sandford (1983) concluded in a study conducted in East Africa that 10% of the time spent on looking after livestock is spent on watering within deep wells. While for Twareg in Mali, the amount of annual labour amount ranges from 5% – 10% of the total labour required.

Watering Regime and management of livestock.
Pastoralists' grazing and watering aims at four things (Grandin *et al*., 1991): minimising the distance between homesteads and water sources; avoiding predators and other losses for small stock; ensuring that livestock arrive at the watering point at the right time and providing the best possible grazing for each stock class. To realise this, herders' select specific water sources where they take their livestock and where they would be watered at predetermined frequencies. Since distance between homesteads and watering points determine frequency of watering, the further a producer lives away from water, the more likely it is that he practises alternate day watering (Grandin *et al*., 1991) during dry seasons.

The frequencies of watering livestock vary depending on seasons and species. Watering of small stock during wet season is less frequent since Maasai believe that green grass provides much water needed by livestock (Grandin *et al*., 1991). Sandford (1983) concluded that when water is provided closer to livestock, they watered more frequently, spend less time looking for drinking water while the extra time saved is used in grazing. He also found out that increased watering frequency is directly proportional to that of feed intake of livestock. However, experiments have shown that there is a decrease in feed efficiency use measured in terms of proportion of dry matter eaten that is digested. The lower efficiency tends to be 5–10% down from 65% with infrequent watering though it is not known whether decreased digestibility is due to water intake or an increased feed intake (Sandford 1983).

McCabe (1983) suggested that in Turkana, five different livestock species are raised (camels, goats, sheep, cattle and donkeys) and each has its own water requirements. He further said that normal watering regime involves watering of goats and sheep on alternate days, cattle on alternate days in dry seasons and everyday during wet seasons. In order to meet water needs for these species, he suggested that livestock be divided into species-specific groups. When livestock are walking and grazing freely they establish their own drinking frequency and this is influenced by water point location, degree of dehydration and level of nutrition (Wilson and Hindley, 1968). In small paddocks, drinking frequency may be high (Sneva *et al*., 1973) but as grazing areas become larger the time required to reach water assumes considerable importance and frequency may decline (Lampkin *et al*., 1958). In his studies in Ferlo[1], Barral (1982,1983) found that increased watering frequency increases pasture utilisation.

Tick- borne disease control by Livestock Spraying

In Kenya, tick borne diseases are the major constraint to keeping livestock (Maina, 1994). Major tick borne diseases being faced are: theileriosis in cattle, heartwater in cattle and shoats (sheep as well as goats); babesiosis in cattle and shoats; anaplasmosis in cattle. The most important among these is East Coast fever and where it is endemic, control is by either routine dipping or hand spraying (Maina, 1994) with acaricides. Dipping or spraying of livestock requires a considerable amount of water making it very difficult for pastoral communities to carry out because water supply is often limiting during dry seasons. On well-organised farms, no tick control problem occurs, however, in smallholder and pastoral; farming areas, it is irregularly done or there is under-strength dip wash or spraying.

In this context, accessibility to watering source may determine frequency of spraying livestock. The Maasai own large herds of cattle and it would be difficult to hand spray when water is being fetched from far. Accordingly, during dry seasons, they spray their livestock as close as possible to watering points because they are able to fetch adequate amount of water that is required for spraying. Zaal (1998) contradicted this view by stating that spraying can be done even with less reliable water supply as long as there is enough to dilute the pesticide.

The other factor which determines frequency of spraying is shortage of cash (Peacock, 1984). In this case poorer households spray less frequently than rich households. Among the Maasai, ticks are mainly controlled by hand- sprayers or dipping livestock with acaricides, although poor livestock keepers removed by hand (Grandin *et al*., 1987). Many herders recognise the fact that spraying should be done after every two weeks, however, actual frequency vary depending on the amount of cash households have. Since most dips in pastoral areas are broken down, pastoralists have resorted to using hand sprayers which are cheap although less effective (de Leeuw and ole Pasha, 1987; Zaal, 1998).

Milk Production

The primary purpose among the pastoralists for keeping of livestock is to obtain milk whose production level is determined by availability of drinking water. Research has shown that development of water points within rangelands often leads to an increase in milk yield [2]produced by pastoralists herds (Kasusya, 1998: Sandford, 1983). When milk production is high, the Borana people sell milk to get some income to purchase grains in order to supplement household dietary requirements. Sandford (1983) concluded that increase in milk yield is attributed to closer provision of drinking water resulting in either increased frequencies of watering or increased water intake by the livestock. Moreover, production of milk within the year varies with seasons thus wet season milk

[1] The Ferlo is variously defined. Here the term is used in it's general sense and refers to the grasslands in a belt lying roughly between the Ferlo river valley and the Senegal river.

[2] Milk yield estimates are often based on verbal recall by the pastoralists daily records calibrated using traditional containers(FAO Website)

yield tends to be higher than the dry season. The drastic fall in milk yield is due to inadequate pasture and water (IDRC, 1981). Also observed is a rise in deaths and a fall in calving rate (Toulmin, 1983).

2.2.3 Changes in Household dynamic due to water points

House hold Accessibility
Development of pastoralists requires that they are accessible to key resources like water, irrespective of their social and economic class. Mostly, wealthy households might have preferential access to water resources compared to poor households and thus able to survive drought. Campbell (1978) gave the definition of wealth in terms of livestock per household, however, FAO (website 2000) defines it as the ratio of herds to number of adults within household but Zaal (1998) states that there are different ways of characterisation of household wealth and suggested the use of either total livestock unit per capita (TLU/capita) or the ratio of livestock equivalent per African adult male equivalent (LE/ AAME).

Accessibility to water points by Borana livestock is guided by complex social structures set by community (Johan, 1978). At times, however, accessibility to water is not easy as it is limited to family members who dug the well or their relatives on a more restricted basis (McCabe, 1982). The role of accessibility and ownership to natural resources must be recognised and respected to realise any tangible development Squires and Sidahmed (nd). This is because whether a family has an access to borehole directly impacts on household livelihood patterns. Inaccessibility to water points may lead to increased water related diseases and determine the kinds of livestock kept. Accessibility to water points tends to dictate the kind of livestock that can be kept by pastoralists. Hitchcock (1978) noted in Botswana 20% of residents not holding water rights owned sheep and goats while only 7% of this group owned cattle.

Sedentarisation.
In a wide sense sedentarization refers to a partial or complete settling of pastoral household or community that may be permanent or temporary and that may or may not involve abandonment of livestock keeping. This may involve moving to refugee camps for food relief while young men take the depleted herds off to pasture in an attempt to re-establish a herd capable of supporting the whole family. There are various forms of sedentarization but the form important to this study is that which involves mass settlement by a large number of households following an event such as drought or Government intervention (Toulmin, 1983).

In cases of drought during which large herds of cattle are die, this makes households to move to places with water and pasture however others opt to stay as they are sedentary in nature. The reaction of different households to high livestock losses depends on alternative means open to them. Based on literature, consequences of sedentarization can be categorised under ecological, economic, socio-political and demographic. Some of the consequences are discussed below:

Ecological
Helland (1977) contrasted sensitivity of human and livestock numbers to pressure on range resources in pastoral systems with that in which agriculture or some income generating activity is combined with livestock keeping. He stated that less sensitivity in systems not exclusively depending on livestock, is a result of household's capacity which, when faced with declining productivity, turn to alternative sources of support such as expanding cultivation. Hence, he concluded that in mixed farming systems there is usually no tendency to maintain a balance between livestock and range resources and that rangelands will be subject to ever increasing pressure and degradation. The discussion, however, does not necessarily follow from sedentarization by pastoralists. Brandstrom (1979) pointed out that the above scenario is not observed where herds can be taken to less heavily used forage resources by households or hired labour and in which degradation of pasture does not necessarily follow from settlement and cultivation by pastoral households.

Economic
Positive effects are related to a higher level household income stability due to receipt of income from more than one source and not exclusively depending on livestock although there is trade off between livestock production and agriculture (Toulmin, 1983). On the other hand, these effects are usually assumed to be negative in terms of animal productivity due to constraints on availability of labour for herding. The economic effects include:

- **Income stability**

When pastoralists combine herding with farming, there are advantageous effects on total household income resulting from two sources because fluctuations in output in one sector being offset by those in the other sector. The diversification should also be looked at from the aspect of whether it will have negative influence on livestock production and farming sectors or if there may be significant advantages to productivity by combining the two systems. Bonte (1997) suggested that combining two systems is one way of reducing their vulnerability to wide variations in labour productivity that are the result of rapid growth or decline in herd numbers.

- **Livestock Productivity**

It has been noted that tendency for herd morbidity to reduce following settlement has certain consequences for levels of animal productivity, as demonstrated by herd parameters such as age at first calving, rates of calving and mortality. High mortality rates are caused by scarcity of grazing and an increased incidence of disease and parasitic infection due to high proportion of land under cultivation and limited amount of labour devoted to migration with herds to distant, less intensively grazed pastures. Bernus (1981) noted that many cultivating pastoralists have abandoned annual migration with their herds during rainy seasons. Huntings (1974), however, showed that calving rates are higher in migratory systems as compared to sedentarized systems. This is because former allows livestock to have access to their favoured pastures and consequently demonstrates higher growth and productivity.

Social effects
Some degree of sedentarization is seen as having consequences on social organisation within the society. This follows from reduced mobility of pastoral groups that have settled in order to maintain social contacts. It results in decline in social institutions, which include a system of co-operation and redistribution between pastoral households. A decline in traditional systems of sharing and co-operation stems from the lesser importance of livestock as the basis for subsistence in mixed crop-livestock systems and reduced social contact between households brought about by sedentarization of some or all of its members. This implies that gathering of many families belonging to wider social group that would only be possible during short period of relative abundance in the rainy season no longer takes place. To conclude, provision of additional water points in community areas could increase pastoralists reluctance to undertake an extensive seasonal migration in search of water as in the past, increasing time spent in the base areas (Livingstone, 1984).

Changes in Household distribution/Patterns
Research has shown that important short term considerations in choosing places to live include proximity and freedom of access to water for human and livestock consumption, quality and reliability of water supply and labour necessary to extract water (Grandin *et al*., 1991). He Grandin (1991) concluded that pastoralists usually select a neighbourhood that meets their goals, needs of their livestock and preferences of their family. Herds need access to water and pasture while families need schools shops and friends (Grandin *et al*., 1991

Areas around water points are concentrated with human settlements because they are used for dry season grazing and provide water and pasture (Kasusya, 1998). To avoid this threat of increased concentrations, an appropriate amount of water supplies will lead to dispersal of not only livestock (Mainguet, 1994) but also human settlements thus opening much of rangelands for productive use. This increased concentration of settlements. There is a tendency of pastoralists to adopt a semi

settled existence around areas with water causing stocking densities to reach reasonably close to maximum potential compared to areas not supplied by wells.

Previous studies done in Kajiado found residential places for pastoralists close to permanent water sources. In Olkarkar region all neighbourhoods were within 7km of Simba Springs (Grandin *et al*., 1991) leaving almost half of the ranch without human settlement. Western and Dunne (1979) demonstrated that concentration of settlements in pastoral areas depends on resources mentioned above. This is well exemplified in Amboseli ecosystem where settlements are located at an average of 8 km from the water points. At this distance, potential grazing range on alternate days is maximised without imposing a high cost on cattle through water deprivation.

Sandford (1983) acknowledged the fact that installation of permanent water supply brings about permanent settlements of people around water points. He further suggested that ability to settle might help the impoverished pastoralists who are trying to rebuild their herds after drought. A good example is a case of the FulBe, in Senegal, who have succeeded in maintaining flexible grazing strategies that permit herders to follow grass and water by settling around boreholes (Schoonmaker *et al*., 1993).

Household Expenditure

Expenditure on livestock and human consumption among the Maasai can be divided into that which is spent on veterinary medicine for controlling outbreak of diseases, purchasing water from boreholes and food (Zaal, 1998). In most cases, richest households spend more regularly towards these two items compared to poorer households. This view is also supported by (Grandin *et al*., 1991) indicating that the wealthier a Maasai household became, the bigger its investment on livestock production became.

The expenditure on watering of livestock depends on size of household livestock holding and wealth status. In their study in Kajiado District, Kenya, Grandin (1991) showed that the mean annual expenditure on households was Kenya Shillings 9400.00, two- thirds of which was on household consumption. Moreover, the expenditure on water for livestock and domestic use would definitely be higher during dry season since they have to purchase water for their livestock as well as for domestic use. Household expenditure would vary from one season to another.

Conflicts over resource use during dry seasons.

A review of literature suggests that major area of conflict on resource use is that of pastoralists and cultivators which are related to water. Water points set in place a new range of problems concerning forage supply that may end up making matters worse in the long term (Bougeot, 1981) giving rise to conflicts. As discussed earlier, presence of water points and overgrazing are positively correlated. The latter often leads to depletion of forage. Attempts to use forage from neighbouring places results in conflicts.

In pastoral areas, key resources that are in high demand like water and pasture are therefore a source of conflict between different groups of users, in this context, between pastoralists and non-pastoralists. By its very nature, key resource management would require addressing issues on resource use conflict so as to confront problems of immediate concern amongst stakeholders in order to come to an amicable solution. Therefore, controlling access to key resources (Behnke, 1994) rather than numbers of livestock will be fundamental.

In building pastoral associations " new ecological paradigms" suggests that future rangeland management policies should be concerned with resolution of resource use conflicts and equity among others. Trond (1983) further suggested that strict regulatory measures are not necessary in drier areas. He recommended that a critical point to note is that in times of resource scarcity, pastoral communities often aspire to expand their territories and resource entitlements rather than to destock and adjust numbers of livestock.

2.2.4 Changes on Gender roles due to presence of water points.

The impact of water points does not only result in changes in environment, livestock production and household livelihood patterns but also to the nature of roles taken by men and women. The later is important because improvement of pastoral areas is not only contributed to the intervention itself but also the roles executed by both men and women. Gender roles though closely linked to culture or traditional customs is seen as being dynamic and thus influenced by external interventions such as resource development.

Hesseling (1994) noted that in the Sahel region women are responsible for looking for firewood, medicinal trees and make food for the family. Amazingly, she noted that women do not have rights to plant trees. However, women fetch water for household purposes and they have the gardens and livestock under their care. Hesseling (1994) concluded by saying that women's role in raising livestock has not been precisely delineated and it is a regular practice for them.

Bruijn and Van Dijk(1995) gave a comparison by stating that in FulBe, Senegal, the women raise stock and sell milk. Ligunya (1994) found out that in Amboseli, Maasai women collect water and are primary managers of water. However, she noted that in all water point committees within the six group ranches, only 1 woman is represented. She also pointed out that woman are involved in fuelwood and water collection, farming, looking after livestock and household chores. Water collection by rural households tend to consume considerable amount of time especially for rural women who rely on water sources found far away from their homesteads (Opiyo, 1995).

However, there are emerging new trends showing that women are now taking key roles in development projects involving resource management. A good example is shown by (Faure, 1992) in which he cited women in Burkina Faso taking part in local level resource management. In her work with the San people of Kalahari Desert, Loermans (1993) found out that as they became more sedentarized, the San developed a mixed economy of foraging and food production. She further established that women were mainly responsible for domestic work. Women also do foraging while men go hunting and are employed in the mines and as herders. In her work in Botswana, livestock rearing is a male dominated job while children take care of goats. The San tribe has adopted this practise. In self-employment, both genders produce and sell traditional handicraft. Draper (1975) pointed out that in sedentary life the number of female maintenance tasks is multiplied. She urgued that this is caused by increased need for storage and storage oriented food processing. Finally, the role of women in herding livestock is an aspect that has long been neglected. In some cases women and young girls are responsible for herding sheep and goats and milking all livestock, while men and boys are responsible for herding cattle (Middleton and Kershaw, 1953), as with the Pokot of Kenya (Borrow, 1988), and Tonga of Zambia (Colson, 1951). Also, women herd small groups of camels without assistance from men though sometimes travel with men and help them in herding and watering (Behnke and Kerven 1984).

Chapter 3

3. Study Area and Research method

3.1 Study Area

3.1.1 Agro-pastrolism in Naivasha

The study area, Moindabi, is located south west of Lake Naivasha in the Rift valley of Kenya, administratively; it lies under Naivasha Division of Nakuru District. Naivasha area has attracted diverse activities. These activities include fisheries, agriculture tourism/recreation and agropastoralism. Agriculture in Naivasha is the principal land use system, which has however changed over time. History has it that pastoralists occupied the area but farming by using intensive Livestock keeping and irrigated crop farming has taken over. This is not however the case within South and South –West of Naivasha which is still inhabited by a large number of pastoralists. Due to the changing situation and need to diversify their income sources, agropastoralism is quickly picking up.

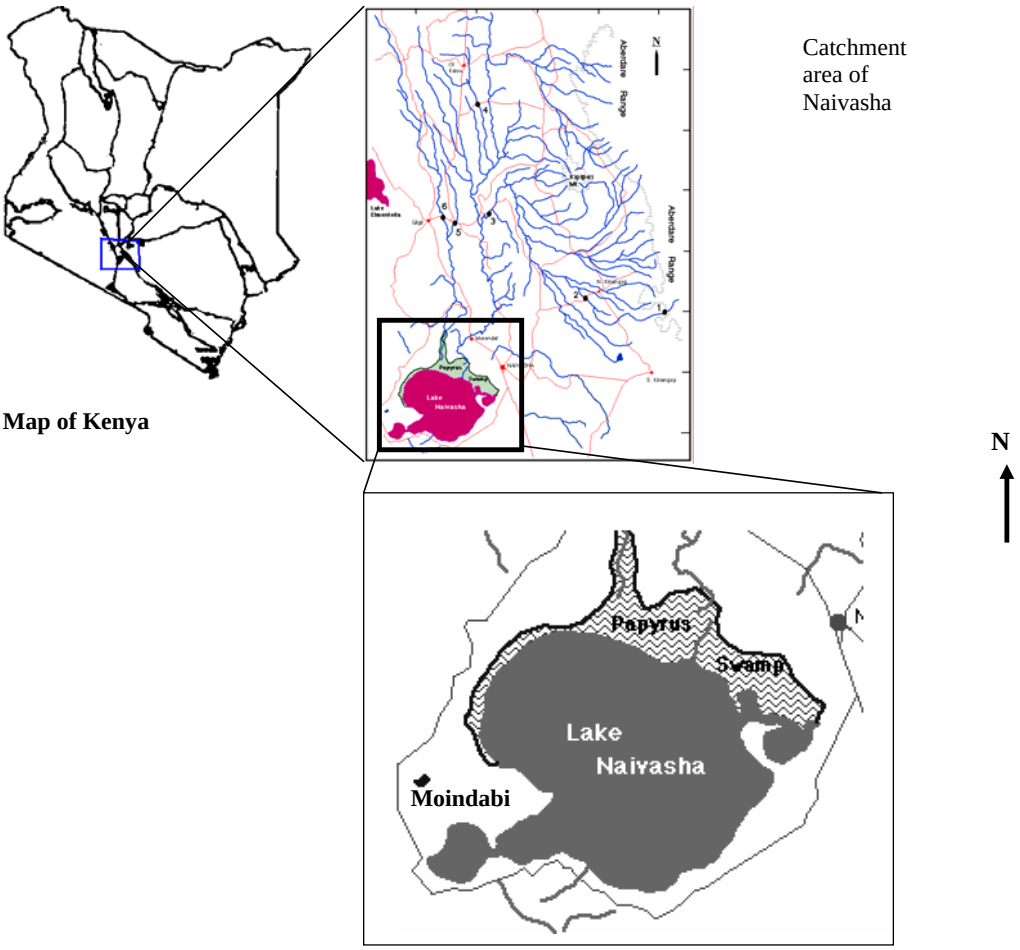


Figure 3: Map of study area and its position in relation to Kenya. Scale 1: 260,000

Mixed tribes, some of whom are agriculturists, occupy the South-Western part of Naivasha. The Maasai occupying the area were originally full time pastoralists but with the changing times they have moved in agropastoralism. In this system, keeping of Livestock is still the mainstay of economy although intensive cultivation of maize, beans and vegetables is also done. The main livestock species kept are the cattle, sheep, goats and the donkeys. Livestock keeping is practised with extensive grazing within mountainous area surrounding Moindabi and which is state owned land. Livestock are grazed during the day and made to return home in the evening. During dry seasons, grazing of livestock may in some cases be done at night. The crop cultivation system is rain fed, thus putting the system into a risky situation should the rains fail. Cultivation is mainly done by hand and labour is either from family, or hired from amongst them. The peak period for cultivation is from March while in August the crops are harvested.

3.1.2 Landscape, soils and Vegetation.

The study area is located within the floor of the Rift valley and is made up of volcanic cones and craters and Lakes. It is confined by Mau escarpment to the west (exceeding 3000m) and Kinangop plateau on the east forming a broad step between Nyandarua range (elevated at over 3960m) and the valley floor(Stuttard *et al*., 1995).

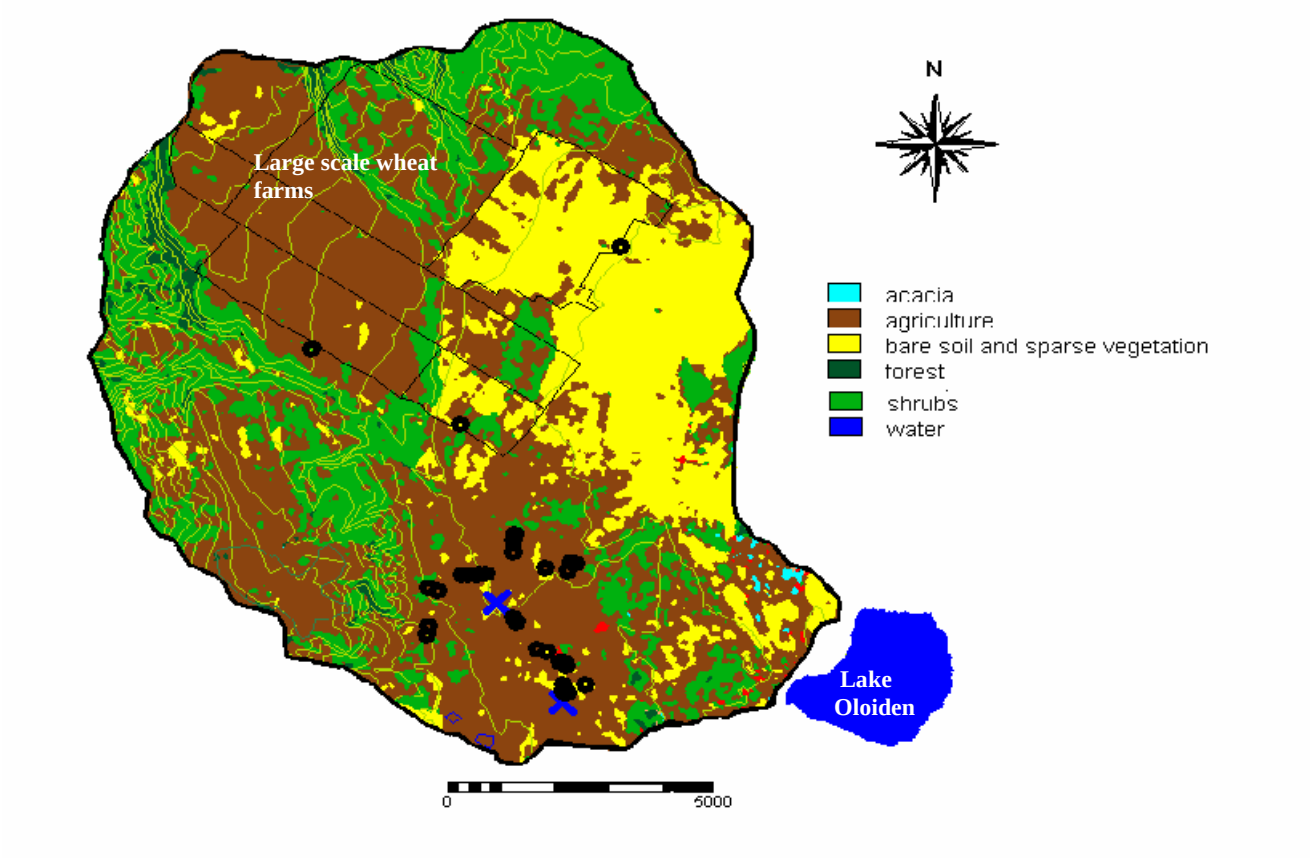


Figure 4 Contour map with Land use classes of Moindabi area. (Source Landsat TM 2000)

Soils in Naivasha basin are young and poorly developed and the two upper plateaus above 2060 metres are well drained, deep to very deep, dark brown and friable to little smeary soil. The diverse physiography of the study area has resulted in a wide range of soils influenced by intensive variation in relief, climate, volcanic activities and the underlying rocks. The soils are mainly from weathered volcanic and pyroclastics. Generally, the soils can be grouped into those developed on lacustrine and volcanic plains (Ataya, 2000). Soils around Moindabi are developed on sediments from volcanic ashes. They are deep, dark grey brown, firm saline sodic and little calcaric. The soils are of low agricultural potential and poor workability (Byname, 1998)."

The Vegetation of the area is classified as scattered tree grassland dominated by *Acacia- Themeda* (Edwards and Borgan, 1951). In the rocky areas are found Euphorbia. Acording to (Pratt *et al*., 1966) the area is classified as Group IV/V Acacia woodland. Annual grasses and forbs mainly *Themeda, pennisetum, Eragrostis Hyparrhenia,sateria* and *cyadon plectostachyum* contribute substancially to the biomass in good rainy seassons.

3.1.3 Drainage.

According to John Goldson Associates (1993), the Naivasha ecosystem consists of the main Lake Naivasha, a shallow fresh water Lake Oloiden and Lake sonachi. Lake Oloiden is a sodic with three times salinity as Lake Naivasha.

3.1.4 Ground water Quality in Naivasha.

A considerable data on water chemical composition on Lake Naivasha is available. Various research teams (Richardson and Richardson, 1972) describes it as being characterised by low solute levels while Gaudet and Melack (1981) found that water was alkaline bicarbonate, with sodium and calcium. On physical characteristics, the pH of Lake Oloiden, which is frequented by livestock from Maasai community, is about 9.2.

A summary of the concentration of key elements that would affect livestock and human consumption is tabulated below.

Flouride	Sodium	Bicarbonate	carbonate
8.0	125	496	43

Table 1 Mean concentration of ions for each compartment (mgl^{-1})- Source: Gaudet and Melack (1981)

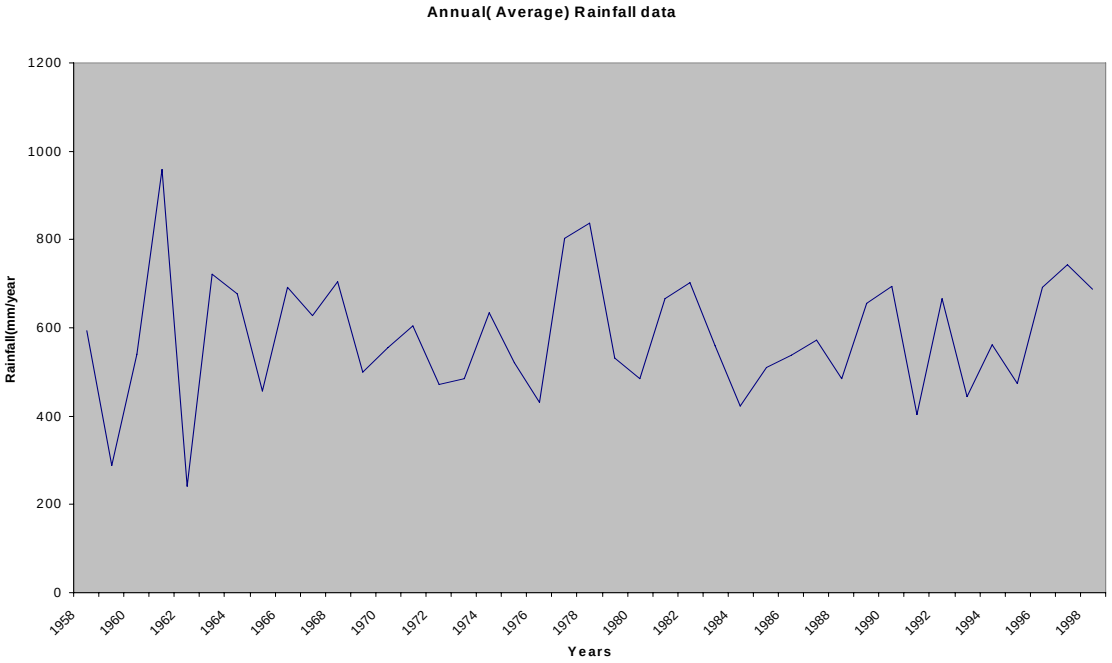


Figure 5 Average annual rainfall from 1958- 1998 taken at DO'S office Naivasha

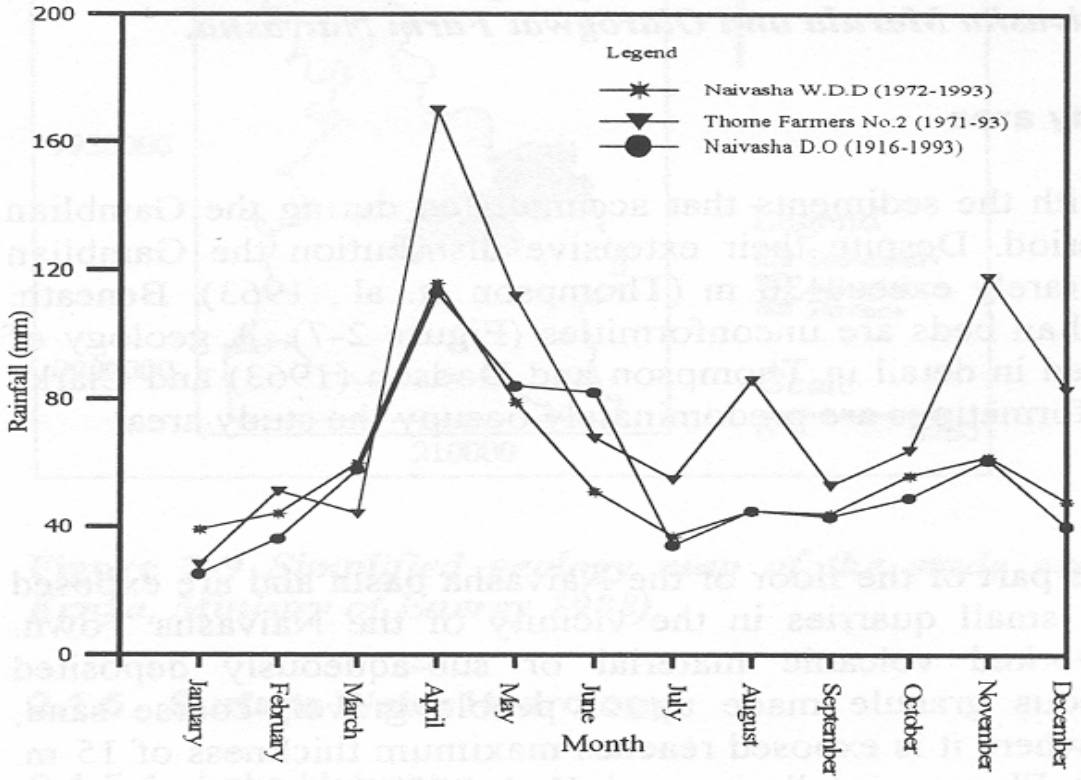


Figure 6 **Long term mean monthly rainfall for Naivasha different rainfall stations as shown above**

3.1.5 Rainfall

The annual rainfall averages about 650 mm per year with two main rainy seasons per year, "the long rains" occurring in March, April, May while the "short rains" in October and November (Stuttard *et al.*, 1995). It can be observed from the graph above that rainfall pattern is bimodal, however, the actual pattern and quantity of rainfall in any year may differ significantly from the long-term average. Rainfall records for selected stations around the Lake and in the catchment area are given in the figure above.

3.1.6 Water (Re)sources and Development in Naivasha.

Water sources for agricultural and livestock production is being drawn from Lake Naivasha or from the numerous boreholes that have been drilled in the area by Ministry of Water Development so as that water shortage is reduced. These boreholes are used for irrigating commercial farms that apply chemical fertilisers that finally finds it's way into Lake Naivasha.

In the drier parts of South and South-West, the boreholes are meant to supply people with water for both domestic and livestock use. Moindabi has two of these boreholes that were drilled by International Federation for Red Cross to assist the community gain access to safe drinking water supply for both domestic and livestock use.

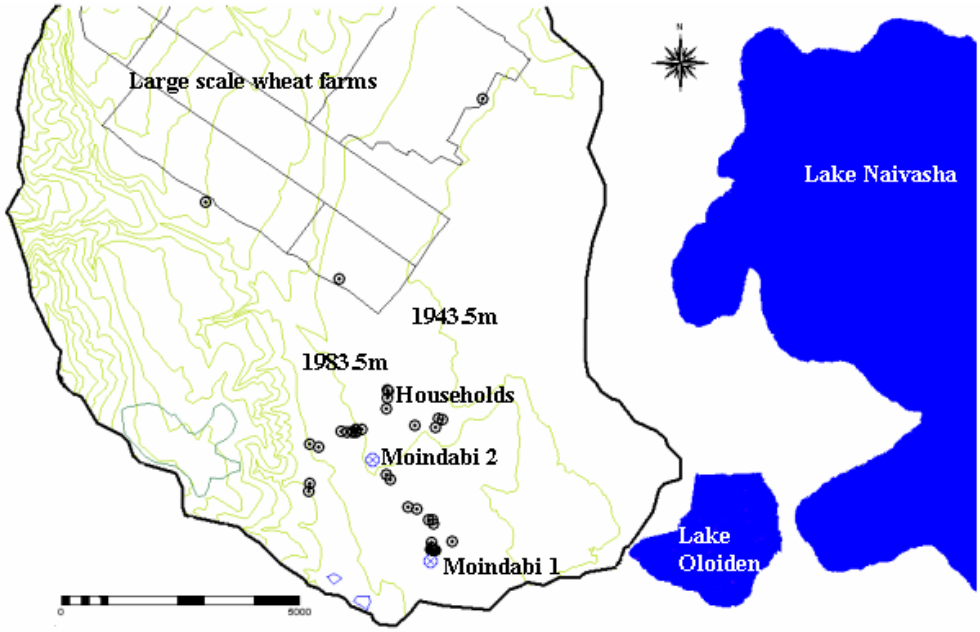


Figure 7 Contour map showing spatial distribution of households with respect to water points (Moindabi 1 and 2)-Source, Landsat TM 2000

* 1943.5 m and 1983.5m are altitudes above sea level

3.1.7 Land Tenure

There is private tenure system where land has already been adjudicated, however, they still practise communal grazing in these areas as a strategy to help them survive where rainfall and vegetation are scarce. The traditional Maasai lifestyle is declining as they have adopted a more sedentary type of settlement.

Provision of formal recognition of pastoral land rights would maintain pastoral access to the resources, however, this formal or legal recognition requires some understanding of pastoral tenure systems which assigns rights to variable types of resources including those of access to water points by all.

3.2 Research method

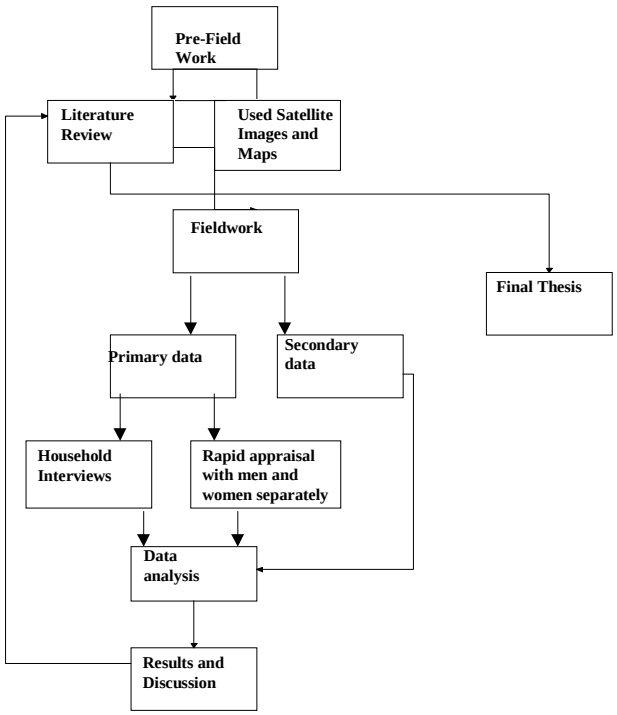


Figure 8 Flow diagram of the steps followed during the research process

3.2.1 Sampling methods

Data was acquired using simple random sampling. The entire area has approximately 600 households and out of which 25 households were selected.

3.2.2 Data Acquisition

To acquire data, remotely sensed image of Landsat TM 2000 was used. Locating household and water point positions while ground truthing was done with the aid of Global positioning system. As in most social science research, Rapid rural appraisal (RRA) was also used in acquiring data that related to gender roles. During the research, two rapid appraisals were held separately both men and women in order to obtain accurate information on gender as related to pastoralists. Also household

semi- structured and predesigned questionnaire was used for collecting data during household interviews.

During the exercise, a local person assisted with identification of households and translation. Maasai elders identified the person since he is a person of high moral standards and has high respect with the community. Discussions were also being held with key informants, development agencies working in this area, local administrators, Veterinary Department, District and Divisional Livestock /Agricultural Officers. Other offices where secondary data gathered were University of Nairobi (Department of Range Science) and (Dutch Volunteer Organisation) SNV office in Nairobi.

3.2.3 Collection of data on the households.

A universally acknowledged problem with pastoralists is the reluctance of those interviewed to disclose number of livestock in their herds and to give appropriate responses. Considerable discrepancies may exist between the numbers of livestock mentioned on separate occasions if the same person is visited on more than one occasion. Therefore, an interpreter was selected from the area in which the study undertaken. Community elders who have a larger say and are respected by the community selected him. This formed the basis of trust between the team and household heads that were interviewed.

Chapter 4

4.1 Changes in Livestock production

Introduction

This section describes major parameters of livestock production and management that have been changed or influenced to some extent as a result of presence of Moindabi 2 water point which is accessible at reasonable distances by households in the study area.

4.1.1 Livestock / Herd management

Calf Survival.
Maasai calf management is mainly aimed at avoiding calf losses. The most critical period that requires efficient calf management is during dry seasons. This is because during this time there is not enough milk for calves due to low milk production from cows, there is no adequate pasture to graze on and insufficient water to drink. In dry seasons, women are faced with the demanding task of having to water all the young stock. This they do by either taking young stock to the water source or fetch water and bring it to the homestead.

In Maasai tradition, work of watering young stock is left for women. Watering of calves in Moindabi is mostly done within the borehole since the distance from homestead to the borehole not very far. In the case of those who have newly borne calves, water has to be carried from the borehole to where they are tethered. This is done to reduce calf losses that may arise from walking long distances to reliable water source. Decreased calf loss eventually contributes to fast herd size build-up after the dry spell caused by high survival rate of calves during the period. When homesteads are closer (few meters) to the boreholes, women do not have to fetch water for calves but rather calves are taken to the borehole. This is a much lighter task to undertake compared to having to make several trips while fetching water for the young stock. This is economical since women collect domestic water while calves' drink from the watering places.

Stocking rates
The Maasai believe that young stock and weaker livestock are able to gain weight, withstand and survive drought effects so long as there is an access to a water source at reasonable distance. Most pastoralists in Moindabi being close to water source (borehole) purchase weak livestock from those who stay away from water sources. This is because the owner sells weak livestock at very low prices for fear that they may die. The stocks that are purchased are given tender care to enable them surviving the dry spell. In the event that they survive, the new owner builds up his herd size within a short time. It has been noted that survival of these stocks contribute to rapid build up of livestock numbers among the Maasai soon after the dry season subsequently contributing to high stocking rates by the herders.

Survival of calves and other young stock during dry seasons highly depends on the distance to water source or watering point. In Moindabi, calves are usually kept (tethered) within homesteads. This entails fetching water either by using donkeys or women carry on their back. Given that distance to the borehole is near, women can go to fetch water that is enough for household use and watering of young stock that are left behind. Households that are away from watering source hardly fetches enough water to meet both the domestic use and take care of young stock. Some fetch as little as 40 litres, which has to be shared between household use and young stock. This is by far not enough for the daily requirements of calves and in such circumstances; calves often die with time.

In cases where there is no access to watering point within reasonable distance, like in neighbouring districts of Kajiado, calves are take taken for watering to Lake Naivasha and have high chances of dying due to the long distance they have to trek. Death of calves is further increased because lactating cows have low milk yield (offtake) therefore unable to suckle the calves satisfactorily.

Calving rate

Presence of boreholes at reasonable watering distance may contribute significantly to livestock production because of increasing calving rates. In areas that are semi arid, presence of a borehole at an accessible distance may positively influence calving rate of livestock. During the study, 43% of those interviewed explained that bulls that walk long distances in search of drinking water are likely to be tired. They may not be able to service cows that are on heat effectively while those walking short distances to the watering point may be very active and be able to service many cows effectively. This is attributable to the fact that bulls that walk long distances will spend much of their time resting instead of servicing cows. Cows that walk long distances to the watering point also are bound not to be on heat as regularly as they should.

Discussion

Stocking rates in Maasai community is determined by calving interval, rate at which calves survive dry seasons, availability of pasture and water and the management techniques by herders. The role water accessibility/availability and dry season grazing places play in determining stocking rates is of immense importance.

Availability of dry season watering and grazing areas are proportional to the calving rates. Calf management especially with regards to watering also tends to be influenced by availability of water points during dry seasons. Grandin (1991) concluded that the Maasai do not control breeding of their cattle and hence reproduction is primarily influenced by bi-modal rainfall. In his research carried out in Kajiado District, he, found out that there are two major peaks in conception that coincide with the two rainy seasons. This conception pattern results in a calving peak from the end of the dry season: Over 80% of calves are born during the 8 months when rainfall probability was high.

The bimodal nature of calving rates also indicates that nutrition has a role to play in calving rates. Poor nutrition is, in part, responsible for low average number of calves born to cows in herd. Improved fodder and water availability or better utilisation of existing production would do much to reduce the nutritional stress, particularly in dry seasons, and thus improve the reproductive rate (Wilson, 1986).

Calving rate is also affected by amount of rainfall and prevailing drought conditions. During drought, conception rates are low caused by either low nutrition or inadequate drinking water, which reduces feed intake. High calving rates occur after drought as many of the surviving cows are often open and likely to conceive once forage conditions improve. Therefore, it becomes clear that two factors, which may influence calving rates, are availability of pasture and water because these determine nutrition level that livestock can acquire. Hence, presence of dry season watering points may influence calving rates. This was evident in Moindabi in which 43% of the respondents agreed that calving rates are influenced by availability of dry season watering points.

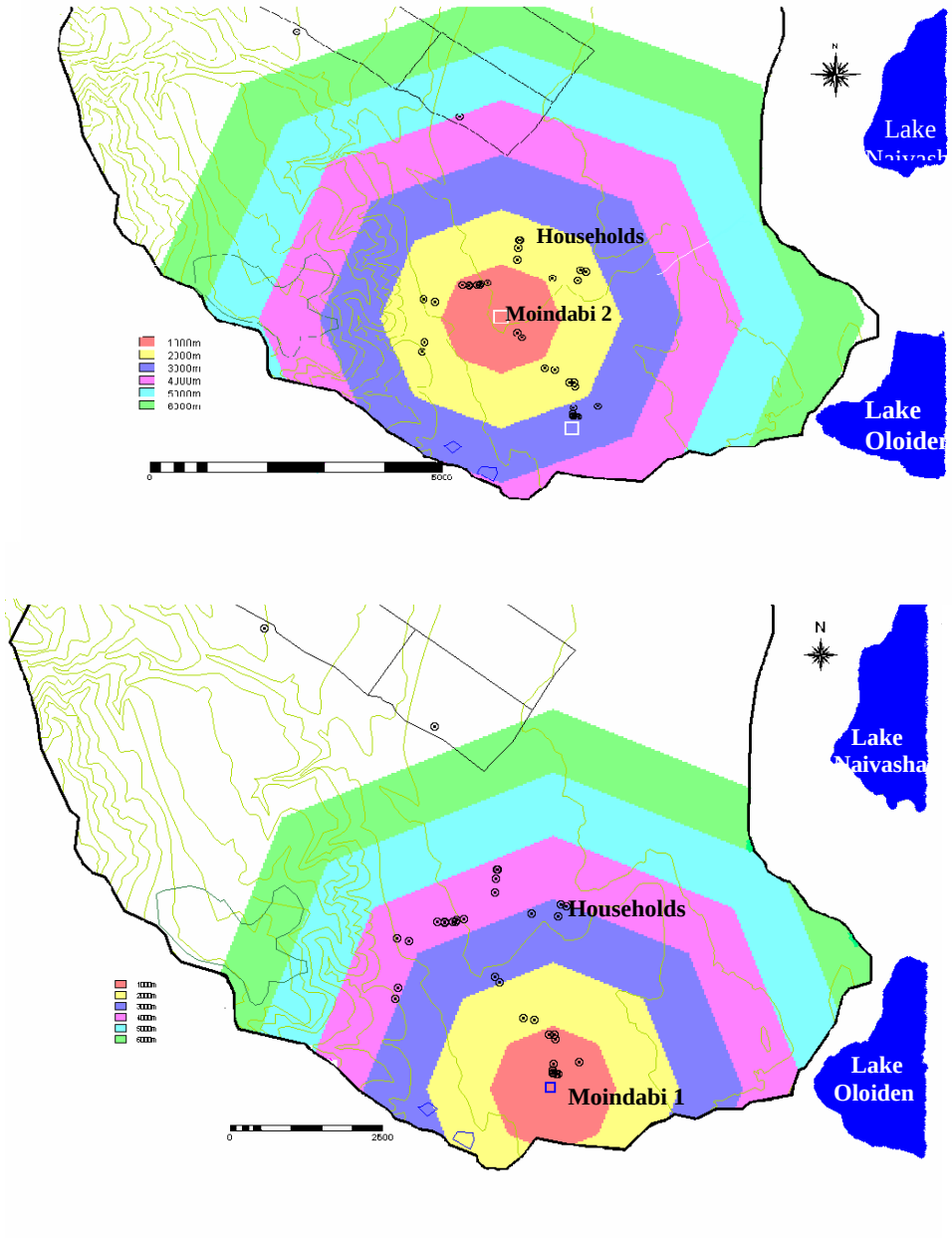


Figure 9 **Spatial variation in the distance between households from boreholes in Moindabi 2(Top) and Moindabi 1(Below)**

Grandin (1991) found that calf survival during dry seasons tend to influence stocking rate after drought periods. In Kajiado District, research has shown that calf survival upto four months of age is usually high due to the efficient management system that Maasai have adopted for young calves. An important calf management practice among the Maasai is that of watering calves. Calves from homesteads near water points are watered more frequently at an earlier age than calves far away from the water point (Grandin *et al*., 1991).

Conclusion

- **Presence of water points in pastoral areas contributes to easy access dry season watering areas for livestock. This makes livestock meet their daily water requirements and also increasing feed utilization. The two contribute to improved nutritional status of livestock thus improving calving rates.**

- **Short distance to watering sources during dry periods contributes to improved calf management. This contributes to increased calf survival during dry seasons. In most cases increased calf survival during dry seasons will lead to increased livestock numbers and thus stocking rates.**

- **Provision of water points close to homesteads may contribute to increased conception rates of livestock because bulls become active while cows get readily on heat.**

Herd separation/ Splitting

Herd management during watering by Maasai community is to ensure that both small and big stocks get adequate time for drinking and to provide comfort for livestock while drinking by using the most appropriate method. In most cases livestock are usually divided into two groups for watering purposes. Adult cattle (lactating and dry cows as well as steers) drink separately from calves and shoats (sheep and goats). This is because watering trough at the borehole from where cattle drink is raised high and may not be convenient for small stock and calves. Also, this is to ensure that shoats get enough water to drink without any competition from big stock. However, in terms of managing herds during watering, children mainly do watering of shoats since the community entrusts them. The time spent to water one persons' herd at the borehole ranges from 30 minutes to 1 hour due to the fact the herders have to queue up their livestock because watering of livestock is done on first come first served basis. Even though the watering time might seem long, there is a lot of time saved by herders when compared it to the time taken to walk to Lake Oloiden, watering time at Lake Oloiden and time taken to walk back. The queuing system is advantageous in that it is aimed at preventing mixing of livestock from different owners/ herds at the watering trough.

Even though it is the responsibility of the herd owner to take care of his livestock at the watering point, water point committee members also assist in managing livestock within the trough. This includes counting the number of livestock that are to be watered by every herder, so that a fee is paid that is commensurate with the number of livestock watered. In Moindabi, adult men and boys carry out watering of cattle at the trough while children take care of small stock. The widows also take the responsibility of watering their own livestock when they are unable to hire labour.

Discussion.

This herd management strategy of herd splitting is practiced by the Rendille of Kenya (Fratkin 1986). The same experiences by Winter (1984) in his study about the Twareg of Niger, Diop (1987), the Fulani of Northern Senegal, Dinka of Sudan (Niamir, 1982). Herd splitting practices are aimed at raising herd productivity, maintaining existing herd, or at investing as little effort in cattle rearing as possible, leaving the herd to look after itself (Corjan, 1993). Splitting of herd is required during dry seasons when water for livestock is very scarce and has to be shared by livestock.

Among Maasai, herd-splitting techniques are aimed at ensuring adequate watering of all their livestock species during dry seasons and are practised from time to time. The Maasai in Moindabi separate cattle (adult stock) from small stock and calves during watering at the borehole to ensure that all species drink adequate water and graze pasture conveniently. Grandin (1991) agreed with my this by stating that cattle are usually divided in two groups for herding: adult cattle comprising lactating, dry cows, old heifers and steers are separated from young stock.

Herding involves three distinct stages: there is time for grazing for trekking and for watering although trekking to watering places consumes most of livestock's time. The time for watering is often the least (about half an hour a day). This is, however, not true for Moindabi where herders have to queue while waiting for their livestock to be watered. This waiting process takes up one hour during dry seasons.

In Moindabi, one person, mostly the owner or the herder does watering of household herds. This contrasts the system employed in South Kgalagadi, Botswana, (Jerve, 1982) in which a representative of any herd unit waters all livestock that show up. Controlling of livestock at the watering area is done by adults while control of small stock is done by children who ensure that livestock is divided into two or separated into herder specific groups. Control of big livestock, which is mostly done by adults, is to guarantee that there is no mixing of livestock from different households. This view is different from that in Masteng area, Botswana, (Corjan, 1993) in which two to three people are required to regulate the number of livestock drinking from the trough and keep track of livestock that drink. However, they all acknowledge the fact that herd splitting exercise is meant to increase niche specialisation, in reduce competition among livestock for same vegetation and in dispersion of grazing pressure as each type of livestock is taken to the best area that suits it. This research shows that the same exercise is done not only while grazing livestock, but also during watering with a view to reducing competition among livestock.

Herd splitting entails division of labour between men and women. While the former together with boys are known for looking after cattle and camels, women herd sheep and goats as noted by Middleton and Kershaw (1953), Borrow, (1988) and Colson, (1951). Sometimes women will herd small stock, or may travel with men assisting them in herding and watering (Behnke and Kerven 1984).

Conclusion.

- **Herd separation during watering ensures that there is more equitable use of key spatially limited resource by all e livestock species during dry periods.**

- **It requires collaboration between herd owners as it make this demanding duty less tasking. The work is not be left for only 2-3 people at the water point but rather involves all those present at the watering point at that particular time.**

- **When well managed or organised it may result in reduction not only in the amount of time spent on watering livestock but also in ensuring that all categories of livestock are watered equally and adequately. This results in saving more time, which ensures that there is adequate grazing time left for the livestock.**

Labour requirements for watering

Labour requirements during herding and watering are important within Maasai production system. The amount of labour required for watering depends on water source and mode of drawing up water. It is particularly high during watering of livestock from a non-motorized borehole where increased manpower is needed in order to draw water from underground, compared with a motorised borehole. Presence of a motorized pump in Moindabi has contributed to a reduction in labour during watering

of herds since one pump attendant employed by the Water Committee is responsible for overall daily water management thus controlling pumping of water.

Water is pumped daily into an overhead tank from where it then flows by gravity to the cattle trough. During dry seasons, pumping is done till all livestock have been watered. Pumping exercise starts as early as 6.00 am up till about 3.00pm in the afternoon. During wet seasons, water is pumped between 6.00 am and 11.00 am. This is so because the demand for borehole water is reduced and limited to that which is used for domestic consumption. Herds are watered in the near by dam, which collects water when it rains. Labour to ensure that all livestock queue up during watering is also enormous and is taxing for herders. However, queuing of livestock tends to have physiological effect on their feeding habit, as they cannot break their thirst as soon as they reach the water point. This affects water-drinking capacity (water intake) of livestock, which in turn affects their feed intake.

Discussion

Investigations and research have shown that the most time consuming tasks in livestock management are herding, watering and caring for livestock in the "boma". However, (Cousins and Upton, 1988: Swift, 1981: Helland, 1977) say that labour for watering is low compared with other pastoral requirements. While Grandin (1991) remarked that a single adult person per herd is necessary to ensure that livestock are not pushed away prematurely, however, extracting water from wells in the dry riverbed demands hard work. In Moindabi pumping of water from the borehole requires only one person thus reducing labour requirement during watering of livestock. However, this is due to the fact that the pump is motorized and running it would not require more people. Motorization makes labour demand for this technology less as compared to non- motorized pumping which requires more labour.

On the other hand, drawing water from the borehole by buckets requires 2 or 3 people and in some instances more are needed if watering of large herds of cattle is to be done (Corjan, 1983). Additionally extra people are needed to regulate the number of livestock drinking from the trough and to keep track of livestock that have drank and those that have not. Even though this is also labour demanding, 2-3 people for every herd (Corjan, 1983) are assigned tasks to control livestock for three-four hours daily to ensure that livestock do not get mixed up and getting lost in the process.

Conclusion

- **Labour requirements while watering of Maasai cattle is considerably reduced when water is drawn from borehole using motorized pumps. This relieves livestock owners from spending some of their income on hiring labour for drawing water out of the borehole. However, to keep the pump running for long, considerable amount of money has to be set aside to assist in maintenance of the pump in case of breakdown.**

- **A well-organised Water Committee that can efficiently run the water point and ensure that there is timely repair in case of break down is important for future sustainability of the pump.**

- **Drawing water by pulling water-using buckets is quite expensive for pastoralists because it costs them a lot of money to draw enough water. The daily expenses incurred dry seasons for all the livestock goes quite high.**

Watering Regime and Management of livestock

Watering management is aimed at among others, minimizing the distance between watering source and homesteads. This benefits herders and their livestock and is achieved through selection of the appropriate watering source and doing so at predetermined frequencies.

The frequency of watering livestock varies within the study area and is influenced by livestock species, distance to the watering point and seasons. Watering of livestock in Moindabi borehole is done on first come first served basis. During dry seasons, herders have to wake up early enough to be able to water their livestock adequately and get enough time for grazing. Much time is spent lining up for water because people from neighbouring districts come to use Moindabi borehole, this results in queuing at the watering point making those who come late to hardly have enough time for grazing livestock.

Frequency of watering	Cattle		Shoats		Donkeys	
	Dry with borehole Functioning. %	Dry season without borehole. %	Dry with borehole Functioning. %	Dry season without borehole. %	Dry with borehole functioning. %	Dry season without borehole. %
Daily	25	5	9	9	44	41
Skip a day	70	84	23	19	44	41
Twice /week	5	-	49	67	6	-
Thrice/week	-	11	14	-	-	18
Weekly	-	-	5	5	6	-
Total	100	100	100	100	100	100

Table 2 This table shows the percentage of different livestock species and the frequency of watering at the borehole during the dry season.

Comparison of results from above table indicates that in the absence of operational borehole or any other watering source, about 5% of people take their cattle daily for watering. This percentage is much lower compared to that of 25% who water their cattle daily when a borehole is fully operational. This implies that presence/accessibility of a borehole within reasonable distances increases frequency of watering of livestock.

This difference in frequency of watering is not only determined by reduced distance to watering point (distance), but also household economic status since water from the borehole has to be purchased. The cost of purchasing water at the borehole varies with quality and whether it is for domestic or livestock use. It costs two Kenya shillings for watering every cattle per day while watering small-stock costs one Kenya shillings per day for watering. On domestic water, treated water costs two Kenya shillings for every twenty litre container while untreated water with high fluoride content costs one Kenya shillings for every twenty litre container. The more livestock a household has, the higher costs they have for watering. The direct implication of the latter is that poorer households cannot water their livestock as frequently as they would wish. Alternatively, they take their livestock for watering at Lake Oloiden which is about 7 Km away. Taking livestock this distance also leaves hardly enough grazing time for livestock.

Generally frequency of watering of both cattle and calves was inversely related to the distance from water and directly proportional to the wealth status of households. Whenever the borehole is operational during dry periods, more cattle are watered either everyday or every second day. Also the proportion of shoats and donkeys watered either everyday, every second day goes up. When the borehole was not functioning, proportion of cattle watered daily reduced and so is that of shoats and donkeys. The Shoats (goats and sheep) tend to be watered either every second or third day of the week. This is because of the belief by Maasai that these livestock can withstand stress. Watering for the donkeys are very regular since they are watered every time women go to fetch water from the borehole.

The dot plot indicating clusters of households and the range of distances travelled while fetching water from the borehole

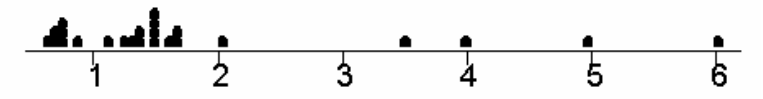


Figure 10 Plots indicating the clusters of households and their distance in km away from the water point.

Discussion

As stated above, watering management is to ensure improved livestock management by reducing the distance between homesteads and water sources. Grandin (1991) says that watering management ensures reduction in distances between water sources and homesteads and also assists in avoiding predator attacks and other losses more so for small stock. Provision of best possible grazing areas and ensuring that livestock arrive at the water point at specific appointed times is realised by improved watering management. In reducing watering distance, herders water their livestock early enough so as to get adequate time for grazing livestock. Sandford (1983) says that when water is provided closer to homesteads, livestock spend less time and energy in walking to watering places and spend more time grazing within the best possible grazing areas. Sandford (1983) further stated that in Australia, experiments have shown that depending on the breed, ambient temperature and type of feed, a sheep eats 25% and 75% (in terms of dry matter) respectively if watered daily than if watered after every three days. Also, cattle with a water intake restricted to 40% reduce their feed intake by 40%.

The distance from water source directly affects the frequency of watering both cattle and small stock. during dry seasons. Research done by Grandin (1991) found that that in dry periods, homesteads close the water source tend to water their cattle every second day. This is so because the day in between is solely left for grazing. Their results are elaborated in the table below.

Watering frequency	**Adult Cattle**		**Young cattle**		**Small Stock**	
	Olkarkar	**Merueshi**	**Olkarkar**	**Merueshi**	**Olkarkar**	**Merueshi**
Daily	56	84	56	79	23	39
Second day	43	15	42	19	56	34
Third day	1		2		9	9
Infrequently		1		2	12	18

Table 3 Percentage of herds of adult cattle and young cattle and flocks of small stock and their watering frequencies *(Adapted from Grandin et al, 1991)*

The table above shows that alternate day watering was common in olkarkar during dry periods. Similarly, McCabe (1983) wrote that in Turkana District, Shoats are watered every second day, cattle on alternate day during dry seasons and everyday during wet seasons. The Maasai believe that their small stock are able to withstand drought during dry seasons and therefore water their small stock every second or third day. During wet seasons, however, small stock are not watered regularly since there is another belief by the Maasai that green grass has high water content that is enough to meet the water requirements of small stock (*Grandin et al, 1991*).

We noted that another factor affecting accessibility to the water point is economic status of households. Rich households get frequent access to the borehole than poor households. In Kajiado District (Grandin et al, 1981) found out that household expenses for both livestock production (such

as watering of livestock) and consumption units is determined by relative wealth. Campbell (1978) further said that apart from just being more accessible to water, wealthy households are in a better position to escape drought. However, it is clear to point out that different writers (Zaal, 1998 and FAO website) have come up with varying methods of assessing relative wealth. [1]Another theory stated that accessibility is guided by complex social structures under the guidance of the community (Johan, 1978) and that it may be restricted to particular family members on a restricted basis (McCabe, 1982).

Conclusion.

- **Provision of water points in pastoral areas reduces the distances to where livestock are watered. This reduction in distances makes pastoralists improve on watering management of livestock such that they are able to increase frequency of watering livestock. Linked to increased frequency of watering is the ability of livestock to improve feed intake and therefore improved production. Livestock that are watered less frequently tend to produce less milk. Also milk yield on days livestock are watered is higher than days when they are not watered.**

- **However, it was also realized that reduction in watering distances does not automatically lead to increased watering frequencies since the latter is determined by wealth status of households. This particularly implies where water is purchased.**

Tick- borne disease control by Livestock spraying

This section describes preventative measures the Maasai take to guard against cattle and small-stock against tick borne diseases which is aimed at controlling tick load on livestock since heavy infestation by ticks may lead to low productivity. Watering areas are points where ticks are spread since some of these livestock that come to the watering site have ticks and which can easily be transmitted to other herds. This makes disease control very expensive and difficult among the Maasai hence requiring frequent tick control.

Picture 1 **Maasai hand spraying their livestock against ticks.**

Hand held sprayers containing accaricides is used for control of ticks among Maasai. They make spraying yard in their own way using local available materials (small enclosures). The spraying yard is located about 20 meters from the cattle trough in order to get easy access to water. This is also to ensure that they do not carry water for spraying over very long distances and to enable them carry adequate water to be mixed with the accaricide. The short distance travelled while fetching water to be used in spraying makes work for the Maasai quite easy since they usually have to spray many cattle at the same time. Hand spraying process involves between 10-15 livestock at a time, however, this method seems less

[1] Wealth is defined in terms of Total livestock unit(TLU) per/ capita (TLU/capita) or the ratio of livestock equivalent per African adult male equivalent (LE/AAME).

effective since not all parts of the animal's body is reached by accaricides while spraying. The exercise is repeated after every three weeks.

Since watering of the animals is paid for, those who are unable to water their livestock from the borehole due to financial constraints do so at Lake Oloiden, which is 7 Km away where they then spray their livestock at the shores. This poses a serious pollution risk within the Lake and whose consequences are detrimental for human, livestock and the Lake's biodiversity. However, the Maasai have enough knowledge on the type of accaricides that they should use and also the appropriate ratio of water to accaricide they should use for effective tick control.

Discussion.

In Kenya, tick-borne diseases are the major constraint to keeping livestock. Major tick-borne diseases (Maina, 1994) that seriously affects livestock is theileriosis, more particularly East Coast fever (ECF). Tick control is affected by factors such as economic status of the family, availability of medicine and water. While in Moindabi water for spraying is easily drawn near the cattle trough, it is a difficult task in carrying since the exercise requires a lot of water which in most cases is obtained from far (Wilson, 1986). It has also been found out that the long distance over which water has to be obtained and volume of water required makes it difficult for pastoralists to carryout regularly.

In effective control of ticks, there should be strict dipping/ regimes and regular spraying which is not being observed. The frequency of spraying depends on income level of households. The implication of this is that poorer households spray less frequently than rich households do (Zaal, 1998). This is because they may not afford to purchase the accaricides or water from boreholes in order to spray. In such cases, spraying ticks is done either near Lake Oloiden, in this case Maasai in Moindabi have to walk long distances compared to when then are to go to the borehole.

The distance from where herders obtain water for spraying also determines the frequency of tick control. Pastoralists who are far from water sources spray less frequently than those who are close to water sources. In Moindabi, herders spray their livestock after every three weeks. This is made possible because the distance to water source is close thus making control of ticks by hand- spraying easy and cheap (de Leeuw and Ole pasha, 1987) and (Zaal, 1998). This type of tick control regime is not aimed at total control but reduction in the tick burden. The advantage of this is that livestock are able to build natural immunity against ticks. This view is also supported by (*Grandin et al, 1991*) by proposing that it is needless for pastoralists to have a very expensive and intensive tick control (upto twice a week) since this makes ticks become resistant to accaricides.

Hand spraying of livestock is quite tedious and, therefore, only a small number of livestock have to be sprayed at a time. It is for this reason that in Moindabi, spraying of livestock is done for livestock ranging from 10-15 at a time. This is meant to improve the efficiency of tick control by ensuring that all parts of livestock are covered by accaricides while spraying (*Grandin et al, 1991*).

Conclusion

- **Provision of water points in pastoral areas where there are no cattle dips enables the Maasai control ticks using sustainable practices. In most cases use of cattle dips results in very expensive tick control methods requiring putting up expensive cattle dips. Use of cheap, simple hands sprayer that is affordable by resource poor farmers' enables long term use of the technology.**

- **Tick control to reduce their load on livestock can be can be attained if there is adequate water available for diluting accaricide. Inadequate availability of water may lead to poor ratio of accaricide to water.**

- **Pastoralists who live away from water sources do not adhere to dipping or spraying regime for controlling ticks. This is caused by long distance they have to fetch water to be used during spraying of livestock.**

4.1.2 Livestock / herd production

Milk Production and Seasonal Fluctuation

It was noted from data collected that there is a wide variation in the amount of milk produced during wet and dry seasons. However, it was difficult to establish to what extent presence of water points has contributed towards increased milk production during dry seasons. This is due to limited period of research, nonetheless, perception of pastoralists interviewed show that presence of a borehole contributes to an increase in milk yield during dry seasons.

The chart below shows that milk yield fluctuates with seasons. The main reason for fluctuation in dry seasons is due to inadequate pasture and drinking water for livestock.

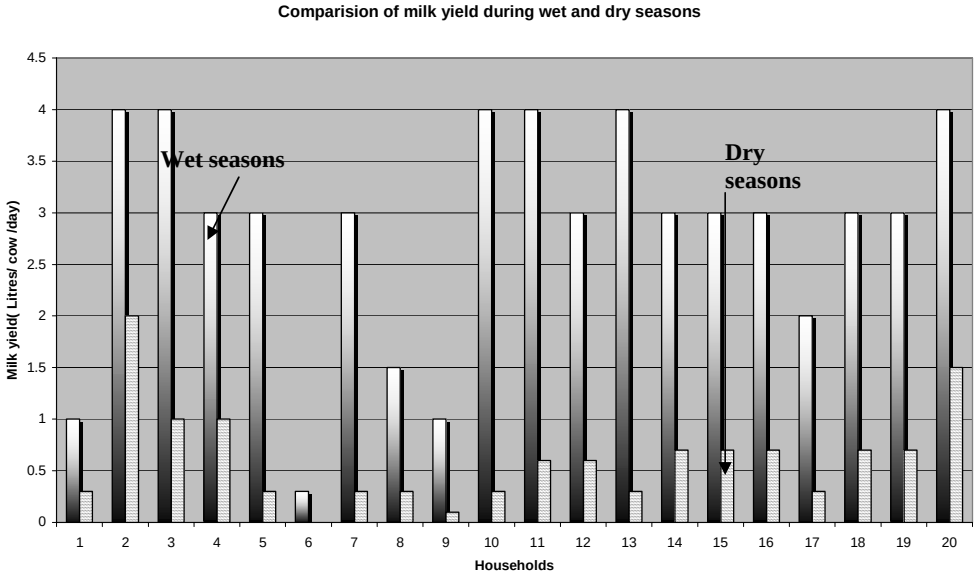


Figure 11 Chart showing the comparison of milk yield produced during wet and dry seasons for different households.

It was found out that milk yield on the days that livestock are taken for watering is higher that on days livestock are not taken for watering. There is a difference in milk yield if comparison is made between periods that the borehole was not constructed and after construction as well as between the days livestock drink water and days they skip drinking. Those interviewed remarked that with the construction of the borehole, milk yield has gone up.

Discussion

Pastoralists keep livestock primarily for milk production and whose production level is determined by availability of drinking water and pasture. During dry seasons, rangelands experience shortage of

pasture and drinking water, which reduces production level of livestock drastically. However, research by (Kasusya, 1998 : Sandford, 1983) indicate that development of water points often leads to an increase in milk yield because availability of drinking water increases feed intake of livestock thus more production of milk. This concurs with my findings and also Moindabi peoples' perception about the contribution of water points to milk production during dry periods. With the water available, cattle are able to make use of available pasture given that drinking increases their feed intake. During this study, It was very difficult to determine the exact quantity by which milk yield is increased after the borehole is drilled and used for dry season watering of livestock. The only viable option was to rely upon information provided by respondents, which in most cases is never accurate. Grandin (1991) also based most of his results on milk yield within Kajiado District on the verbal recall. The pastoralists often use locally calibrated containers to measure the milk yield (FAO[1], Website).

In Moindabi, it was quite clear from information obtained that milk yield varied with seasons. The production being higher during rainy seasons as compared to dry seasons. Before constructing Moindabi 2 borehole, there was low milk yield due to lack of adequate pasture and water (IDRC[2], 1981). Grandin (1991) made comparison of milk yield between days when livestock are watered and days they are not watered finding out that milk yield is higher on watering days as compared to non-watering days. Simenye (1987) further adds milk yield on watering days is 10% higher than non-watering day due to increased feed utilisation.). However, presence of water points increasing utilisation of scanty pasture, which is available during dry seasons leading to increased milk outlet.

The implication is that those pastoralists practising skip day watering methods for their livestock obtain less milk on days that livestock do not drink water. Reduced productivity may even be more evident for Borana pastoral system where livestock are restricted to access water and pasture (FAO, Website).

Conclusion

- **Availability of water points for dry season watering improves feed intake of livestock. This indicates that even though pasture is usually in short supply during this period, livestock have the ability to maximize on the little pasture that is available. Increased feed intake leads to may lead to increased nutritional value of livestock thus increased milk production.**

- **Daily watering of livestock influences daily milk production of herds. Livestock produce more milk on watering days than on the day they are not watered. Taking livestock to a borehole daily will lead to increased milk production for pastoralists whose source of livelihood revolves around milk.**

[1] FAO represents Food and Agricultural Organization.
[2] IDRC represents International Development Research Centre.

Chapter 5

Introduction to changes in household livelihood dynamics

The pastoral economy is based on an aggregation of individual households, their labour and herds. Pastoral development initiatives are not only aimed at improving range conditions but also living conditions of the people. Interventions such as water development in pastoral areas bring about changes within individual households over time. These changes are manifested in livelihood and patterns of water use due to ease of accessibility to water point

This chapter outlines results and discussions of the impact of water points on households and shows the changes in household dynamics and gender roles associated with water point development in pastoral areas.

5.1 Sedentarization

The Maasai in Moindabi location currently lead a sedentary lifestyle mainly because they have access to water for their livestock and domestic uses. They hardly move away from their homes in Moindabi even though most of them have second homes in neighbouring Narok district. Settlement pattern is mostly concentrated around the water point as is shown on the graph of distance travelled to the borehole. It was found out that 81% of households sampled in Moindabi settle within a distance of 3 Km from the borehole. As a result of settled form of life and settlement patterns, some of their children are taken to school, there is increased cultivation of agricultural crops to meet food needs (mainly maize and beans) and new born livestock are looked after.

Some negative effects of sedentarization realized in the area include decreased fuel-wood availability due to cultivation and decreased grazing land. There has been a severe shortage in pasture associated with sedentarization. In summary, effects of sedentarization on pastoral system are:

- **Increased Cultivation**

In an attempt to diversify sources of income and to develop security against drought, Maasai are moving more into agropastoralism. Agricultural production is meant to improve food security during hard times of drought. In Moindabi, households are converting some of their pastureland into agricultural farms. The size of farms put under agriculture depends on the size of land and amount of labour which households have. The crops grown include mainly maize and beans at subsistence level.

- **Decreased grazing land.**

Increased cultivation of grazing land has caused severe consequences on the amount of grazing land that is left for livestock to graze on. Maasai are putting increasingly more land into cultivation.

- **Decreased fuel wood.**

Increased sedentarization means that people have to put up houses and put up enclosures for livestock. These practices lead to cutting down trees thus reducing availability of fuel wood.

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Discussion

Consequences of sedentarization upon peoples' livelihoods involve some reduction in mobility of households and herds (Toulmin, 1983), reliance on income from more than one source, non-exclusive dependence on livestock and new livelihoods while also combining livestock production with other activities.

People and livestock in Moindabi have become more sedentary since water points were introduced. Similar practice was observed in Kaputei group ranch in Kajiado District where the Maasai adopted a more sedentary lifestyle as a result of group ranches (Grandin *et al, 1991*). The contributing factor is that as resources become reliable, Maasai opt to settle down in one place because they are sure that livestock will not be adversely affected by drought. They view building of permanent domestic structures as ways to claim land says Grandin (1991). This is a contributing factor to sedentarization process in Moindabi as most of the people have put up permanent domestic structures. In Kaputei, Kajiado District, 82% of people had put up permanent structures adds Njoka(1979).

The ecological consequence of sedentarization in Moindabi includes decreased pasture/grazing land, decreased fuelwood due to constant cutting down of trees and increased frequency of cultivation.

Picture 2 **Cutting down of trees for construction of houses and fuelwood.**

Toulmin (1983) puts it that there is more sensitivity of human and livestock numbers to pressure on range resources in pure pastoral systems compared with that in which agriculture or some other income earning activity is combined with livestock This is due to over dependence of pastoral system on grazing/pasture land, which is drastically reducing in case of sedentarization. In contrast, in systems that are not exclusively dependent on livestock production, households have alternative sources of support.

Sedentarization has positive effects on household income stability due to receipt of income from more than one source, says Toulmin (1983), here there is combined farming and herding. However, it should be considered whether diversification of production activities and reducing vulnerability to risk is at the cost of lower productivity levels in both livestock and farming sectors, or whether there may be significant advantages to productivity at household level from combining cropping with herding

Some researchers say that the tendency for herd mobility to decrease following settlement has certain consequences on levels of animal productivity. Toulmin (1983) notes that herd parameters such as age of heifers at first calving, rates of calving, and levels of mortality may increase. The main reason advanced for high death rates are scarcity of grazing land and increased incidence of disease and parasitic infection. Research in Moindabi, however, shows that sedentarization may reduce herd mobility in circumstances where key pastoral resources are not adequately developed. If well developed, availability of reliable water source enables livestock to make use of limited pasture and able to overcome effects of drought periods.

Conclusion

- **Adoption of cultivation into their economy enables Maasai to have food security during drought. Food security makes Maasai less averse to risk of drought even if they lose their**

livestock. It is important though to consider that livestock is still the main stay of their economy.

- **Even though there is decreased land for grazing and decreased fuel-wood as a result of sedentarization, human comfort derived from settling down together with multiple production systems adopted, improve pastoralists living standards.**

5.2 Spatial household distribution/patterns

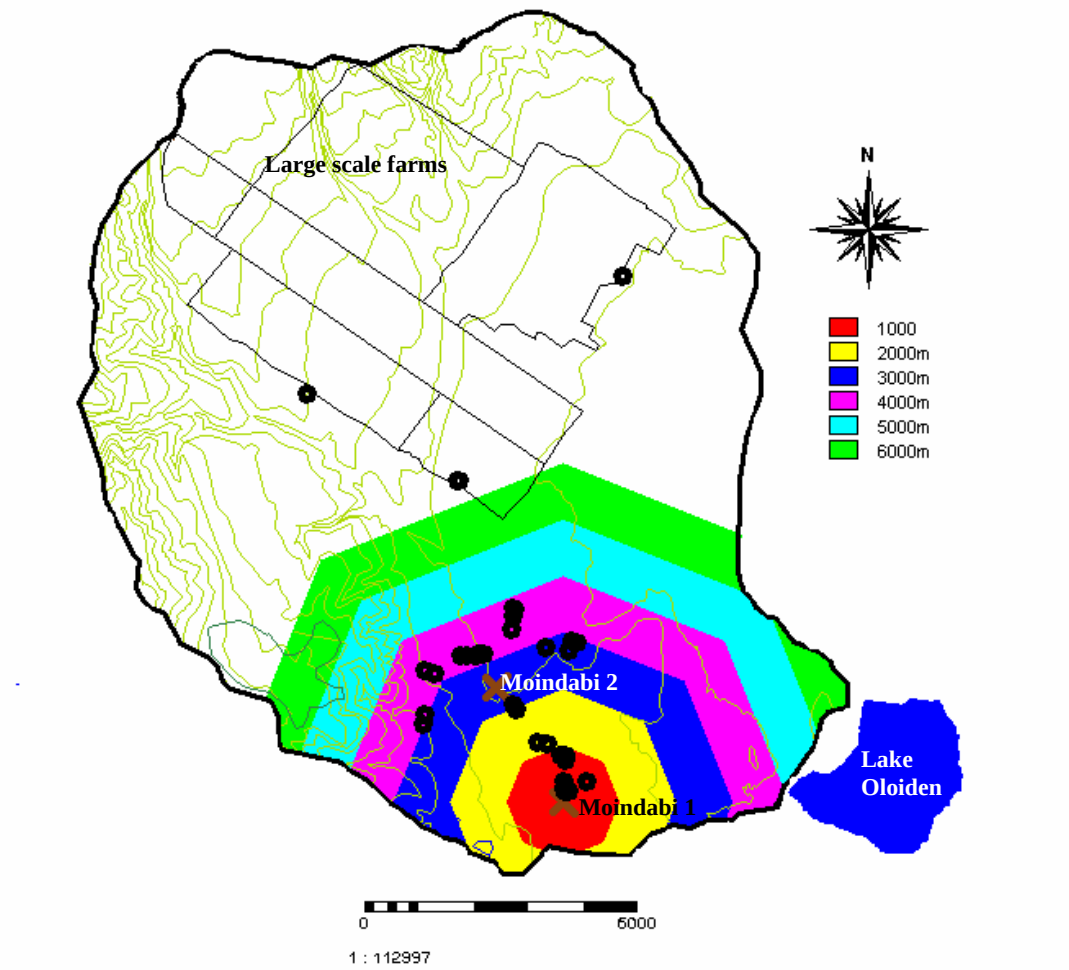

Figure 12 Distribution of households as a function of distance to Moindabi 1 borehole (Sources- Field data)

The figure above gives household distribution or settlement pattern in Moindabi area. It will be noted that settlements are concentrated around water point area, on the low-lying land, since they want to reduce distance between water point and settlements. The Maasai have been unable to occupy the entire area of Moindabi because one part of the area is mountainous and steep while large-scale private wheat farms occupy the other part. As illustrated in the figure above, most people are found within a radius of 1-2 Km in Moindabi 2 and 3-4 Km in Moindabi 1 boreholes. The main reason behind the wide spatial difference in settlement patterns between the two boreholes is their construction. Moindabi 2 borehole has an area around the borehole where livestock can rest without encroaching in people's farms while Moindabi 1 does not. Watering from Moindabi 2 often leads to conflicts as livestock always find their way into people's cultivated fields. Also Moindabi 1 is more salty compared to Moindabi 2.

Discussion

In most cases, pastoralists select a neighbourhood for settlements that best meets their goals, the needs of their livestock and preferences of their family. Livestock requires access to pasture and water, while families like to be near water, shops, schools and friends. The most important short term considerations in choosing a place to live are proximity and access to water for human and livestock consumption and also good grazing area (*Grandin et al, 1991*). These factors have influenced settlement patterns among pastoralists in Moindabi. Therefore, most households tend to be within a radius of 1-2 Km from the water point and concentration of households' decreases as the distance from water point increases. Western and Dunne (1979) who pointed out that concentration of settlements depends upon major resources pasture and water also saw similar patterns.

Settled area of Moindabi is also a dry season grazing area due to the constant and reliable water availability. Moindabi Maasai do not move when seasons change because of availability of reliable water and pasture. Pasture areas are found about 6 Km away from water and settlement areas. These two make them move their livestock for grazing and return them back in the afternoon. Herders which come to water livestock in Moindabi and who come from far often graze the whole night during dry seasons.

Western and Dunne (1979) found that in Amboseli has distinct wet and dry season grazing areas with the latter being confined to limited areas around permanent water areas. These areas form two distinct settlement clusters, one in the North and the other in the South being occupied during wet and dry seasons respectively. In the South, settlements are occupied later as dry season shifts from Northern pastures to woodlands and swamps which serve as late season forage (Western and Dunne, 1979). Grassland areas in Amboseli are located about 8 Km from water sources making it only possible for Maasai to water their livestock on alternate days. At this distance, not too much cost is imposed on livestock through water deprivation.

Western and Dunne (1979) said that southern settlement cluster, which is meant for dry season, provides a large standing crop of low quality forage in permanent swamps and woodlands. This area is highly aggregated and is occupied for longer periods because water is available in the swamps.

The study of the location of settlements in relation to major resources like food and water is useful in determining the location for settlements. This is because proximity to water usually has marked effect on the number of livestock per household kept (*Grandin et al, 1991*) with households near water owning more cattle than households further away.

Conclusion

- **Availability of water points in pastoral areas has great influence on settlement patterns of inhabitants. Most settlements are found in close proximity to water points and decrease as you move further away from water points. These results in over utilization of natural resources found within the environs of water points. It also leads to land degradation due to overgrazing by livestock.**

- **Organized scattering of water points within pastoral areas may assist in attaining equal distribution of households through out pastoral area, thus achieve equal development and pasture utilisation where settlements are located. However, this will only be attaine dif pasture quality is uniformly distributed.**

- **In social context, close habitation near water points is viewed as a measure by the pastoralists in providing security amongst them in case the enemies raid them and this also helps keep the social ties together.**

- **There is increased accessibility to services, drinking water, schools shops is realized arising from the settlement patterns.**

5.3 Conflicts on resource use during dry seasons

Large-scale wheat farmers inhabit areas of Moindabi bordering Ndabibi location. While the rest of Moindabi location where pastoralists are living lose vegetation cover/pasture during dry seasons, large-scale farms contain harvested wheat still standing on them. During dry periods, most livestock from neighbouring Narok district are watered at Moindabi 2 water point which is only 6 Km away from these large wheat farms. Since these wheat farms are the only areas with wheat straws and which livestock can feed on during dry spell, Maasai have always opted to graze their livestock on these farms after watering their livestock. However, owners of these wheat farms have always objected and not welcomed the idea, reasoning that grazing the farms by well over 10,000 livestock would course severe land degradation.

This difference in opinion and failure to agree between Maasai elders and these large-scale farmers has always resulted in serious conflicts. Maasai herders who decide to graze within these farms are usually arrested, taken to court and charged with trespassing into these large farms. When arrested herders are usually fined which is often paid by stockowners seeking to release their herders.

Constant disagreements between these parties have occurred because there is no framework put in place that can be used in resolving conflicts, the is to use litigation as the only option. Continued grazing of Maasai herds in large farms is due to their culture which is stated literally as*" **what is on top of the soil after you have harvested your crop belongs to the Maasai".*** This means that after one has harvested, the Maasai ***"have the right to graze***" on it since what is left after harvesting belongs to them. To avoid being arrested, herdsmen resort to grazing overnight, and because they take much of the time queuing while they are watering livestock during the day. However, The Maasai elders believe that there must be a mechanism in place that allows them to graze within these large farms during dry seasons when wheat has been harvested since they do not have any other areas to graze on.

There is a high likelihood that these conflicts have been aggravated by presence of the water point since utilisation of pasture by the Maasai community is linked to presence of accessible water.

Discussion
In contexts where pastoralists and agriculturists are engaged in multiple resource use systems, a resource is used by more than one user, either for the same purposes (eg. Rangelands which are grazed by different herdowners or groups of herdowners), or for different purposes (eg. used for both cropping and for grazing) as seen in Moindabi location. Causes of disputes and conflicts in such systems are examined, and different approaches to prevention, management and resolution are discussed briefly.

Multiple resource use is a central feature of many including pastoralists and agro-pastoralists production systems.

Pastoral communities struggle for access to key resources during dry periods due to competition for grazing or watering livestock. Interventions like development of water points in pastoral areas give rise to conflicts because they facilitate efficient grazing by livestock. Bougeot(1981) put it that presence of water points sets in place a new range of problems concerning forage supply. Similarly, resource use in Sahel involves a multiplicity of users: an annual pasture is often accessible to many users from different directions who remain for an indeterminate time; valleys may be exploited and jointly controlled by several agro-pastoral village.

Niamir-Fuller (1994) asserted that multiple resource use in pastoral Africa was traditionally regulated by informal or formal rules based on priority of user groups: "primary users" had highest priority within their home territory, "secondary users" had seasonal access, and "tertiary users" had infrequent access in times of need eg. drought years. With land tenure that provides security of tenure to landowners such a system is not workable. This is well illustrated in Moindabi given the fact that land ownership is no longer communal. The main source of conflict in Moindabi has been between different users and involves the Maasai who graze on large-scale wheat farms without permission to graze from wheat landowners because they believe that large farms should have multiple uses of cultivating wheat and to be converted into pastureland on harvesting.

Behnke and Scoones (1993) said that for pastoralists, "opportunistic" herd movement over long distances is essential in order to track environmental variability and thus to maintain large herds, which constitute their main source of livelihoods. Variability occurs at both macro-scale (eg. contrasts between clay veld savanna and sand veld savanna), and at micro-scale (eg. between riverine areas and toplands), and thus modified forms of opportunism are found in agro-pastoral systems as well (Scoones 1989; Cousins 1992).

The "new thinking" also asserts that a situation of chronic or endemic conflict is a central feature of non-equilibrium settings (Behnke and Scoones, 1993; Scoones, 1994; Niamir-Fuller, 1994). This helps to explain the high degree of inter-group /different user conflict often associated with pastoralism, but also patterns of co-operation and reciprocal access which are found (Behnke, 1994).
The policy implication of this perspective is a shift in administrative focus from regulation and control of resource use to mediation and arbitration between conflicting interests of individuals and groups. This further suggests that legal frameworks should focus on procedural rather than substantive law (Vedeld 1993), which cannot easily codify customary law without losing its internal complexity, flexibility and adaptability to change.

Similarly, Scoones (1994) suggested that conflict be explicitly addressed and accepted as inevitable rather than being ignored or treated as an incidental or removable feature. Again, it is recommendable to establish formal institutional arrangements for negotiation, arbitration and resolution. Sylla (1994) and Vedeld (1992) advocated for a central role in conflict resolution for pastoral organisations, and Swift (1994) highlights conflict resolution as a central function of pastoral administration at different levels.

This discussion suggests two additional variables, which are likely to be found in multiple resource use systems:
Institutional arrangements for managing multiple use (eg. for allocating resource use rights within groups; negotiating access between different groups or individuals and households within groups; developing or adapting rules of access or management).

Conflict management and dispute resolution institutions and mechanisms (eg. age-group systems, councils of elders, traditional courts and tribunals, informal police forces, "modern" courts and judicial systems)

Conclusion

- **Pastoral areas will continue to be characterized by conflicts due to competition for resource use either among the pastoralists themselves between pastoralists and Agriculturalists. If**

not checked, ugly incidents will be realised because there are no institutions at grass root or higher levels that have the capacity and mandate of either managing or resolving conflicts. Litigation is not appropriate better form of conflict resolution.

- **Large-scale farms within the pastoralists' area should offer multiple uses for cultivation and grazing land.**

- **Administrative policies on conflict over resource control in rangeland areas should be redirected towards mediation and arbitration taking into account the customary laws.**

5.4 Household Expenditure for water purchase

Water from Moindabi 2 borehole is fitted with a motorized pump, which has to be maintained regularly. The maintenance funds are generated from daily collections by the pump attendant paid by community members who water their livestock or when they have gone to fetch water for domestic purpose. This, however, has an impact on household income financial expenditure.

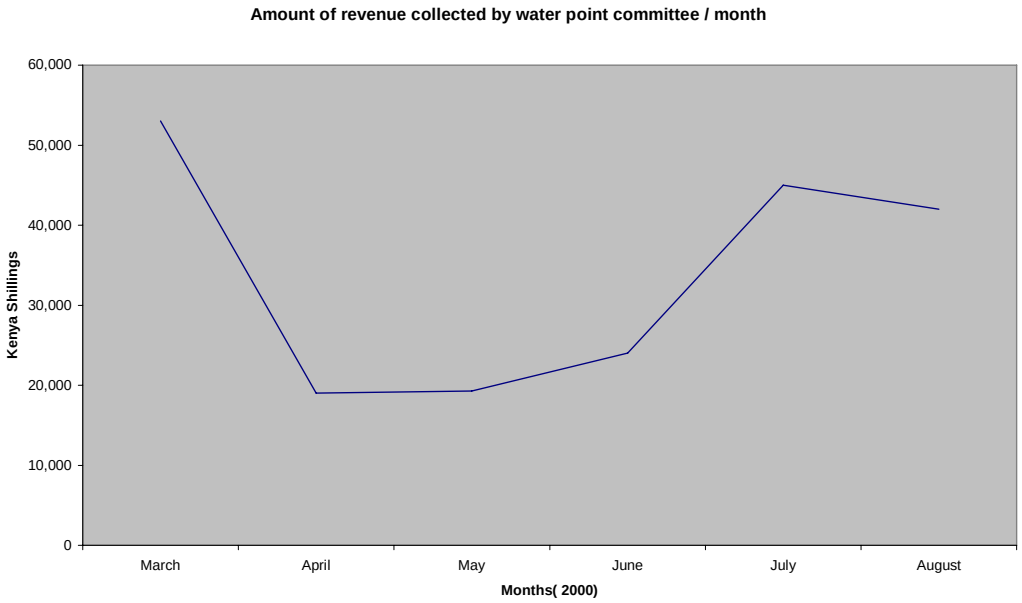

Figure 13. Revenue generated by the water point committee during the months shown.

During this research, obtaining household expenditure on water was not very reliable although it was reflected in the monthly collection by the water point committee.

Discussion

Expenditures within Maasai community can be divided into several categories the most important of which are expenditures on food such as beans, rice, tea and cooking oil among others. To make meals, availability of water is essential. This has to be purchased during dry seasons because rainfall is quite low while all other water sources apart from Moindabi 2 and Lake Naivasha are dry.

Expenditure on livestock inputs can be considerable as well since sudden outbreak of diseases and regular care call for veterinary medicine and control against ticks and worms (Zaal, 1998).

To make food, control diseases or to improve livestock feeding intake during dry seasons, an adequate amount of water is essential and has to be purchased for water points. The monthly expenditure on water by pastoral households is enormous and this puts poorer households at a disadvantage, as they often do not have adequate funds to purchase water. The only alternative for them, therefore, is to walk long distance in search of free water. Apparently, expenditure by the pastoralists on water has not received due attention in the recent past because it has not been viewed as an economic good which people have to pay for.

The exact household figures of daily expenditure on water are sometimes difficult to obtain during household interviews. This section is, therefore, discussed based on the revenue generated or collected by water point committee on monthly basis which is a good reflection on how much the community spends on purchasing water. However, this method has a limitation in that exact expenditure by individual households can not be projected from these figures. However, Zaal (1998) in his study of household expenditure among the Maasai of Kenya elaborated that wealthy households incur more expenses. However, this argument contradicts the fact that both poor and rich people depend on the market more than middle class range households who depend on milk from their herd in a traditional production environment. He pointed out that poorest and wealthy categories of households are expected to have high expenditures because they have to buy food and the wealthy require more inputs and labour to invest in an increasingly productive livestock sector.

Expenditure on water varies with seasons being low during rainy seasons and high during dry seasons. This can also be observed from the graph above since the revenue collected during dry seasons is higher than that collected during wet months. This is in line with the results of (Zaal, 1998) in which poorer household expenditure shows a steady growth over time untill the first month of rainfall when it drops to a low level as milk production starts to pick up.

Conclusion

- **Household expenditure by pastoralists towards purchase of water for both domestic and livestock consumption has not been given much weight by researchers undertaking studies on household expenditure. Expenditure on purchase of water varies not only with the amount of wealth but also the seasons of the year. The increased expenditure on water during dry seasons when there is food shortage and loss of animals may have an adverse effect on the poor households.**

- **During dry seasons, the expenditure is quite high, however, the benefits derived such as reduction in the rate of loss of livestock, reduced time while fetching water tend more thus the reason for the pastoralists willingness to purchase it.**

- **From development perspective, paying for water if it is being drawn from the motorised pump is a positive way towards sustainable development since efficient use of revenue collected will be used for operation and maintenance of the pump.**

- **Rich and poor households incur high expenditures among the Maasai compared to the middle class because of the poor have to buy food while the rich have to invest heavily in productive livestock sector**

5.5 Task relocation from time saved by women

As a result of reduced distances in fetching water, women save a lot of time compared to when water was being fetched from Lake Oloiden (the nearest alternative water source).

Mean average distance taken by households to Moindabi 2 bore hole and Lake Oloiden is 1.35 Km and 6.6 Km respectively. Therefore, they take less time to fetch water from Moindabi 2 borehole and the rest of the time is spent by women in either household income generating activities or carrying

out other important household tasks to which they would have otherwise allocated less time." We find extra time to carry out some tasks," they said. Respondents said that major tasks to which extra time is spent are as stated below.

Figure 14 Extra activities undertaken by women as a result of time saved

- **Daily cleaning of the pens of the young stock**

In Maasai communities all young stock spend the night inside pens in order to avoid predators and avoid bad weather at night. These pens usually have an accumulation of waste matter that makes them a health hazard either for young stock or for people residing within the homestead. Quite often, pens are breeding places for flies which can be seen flying all over the homestead thus posing danger of transmitting disease carrying microorganisms. Also, pens are susceptible to infestation by bacteria, ticks and other disease pathogens.

Presence of a water point which is within reasonable distances from homesteads has made it easier for women to find extra time in making these pens clean regularly thus reducing chances of infestation by disease causing microorganisms. This is because before the water point was drilled or whenever it breaks down, there is hardly any time available for this exercise to be carried out since only vital tasks such as fetching water, fetching fuel-wood and cooking for the family are given priority.

- **Washing and stitching of clothes for the Children.**

This is the responsibility of women among the Maasai. Since children play a lot during the day, their clothes become dirty and get torn quite often. The task of either washing or stitching them is quite tedious and requires lot of time from the women. In cases where women can not find time to either wash or stitch clothes, children put on either very dirty or torn clothes. This situation becomes worse during dry seasons when water has to be fetched from far.

If there is a borehole that is within reach, women will tend to save time due to the reduced travelling distance. The time saved is spent on thoroughly washing clothes and also stitching those that are torn. The implication of putting on dirty clothes is that they are usually infested with lice. This sucks a lot of blood from human body and may result in being anaemic.

- **Collecting fuel-wood for household use.**

In Maasai households, the main source of energy for cooking, and heating and in some cases even lighting is fuel-wood. In areas they reside, woody biomass is insufficient and has to be fetched from far places. The main sources being forests, shrubs and on-farm trees.

When considering household fuel-wood use, two things are critical, availability of fuel-wood and distance from where it is obtained. In pastoral areas, availability of fuel wood is low and the distance from where it is obtained is far requiring more time for collection. During dry seasons, women have to walk long distances so as to fetch water and at the same time have to walk another far distance in search of fuel-wood. These tasks becomes difficult for women that may even involve making tradeoffs between looking for water and fuel-wood in case there are urgent household needs at the same time.

Since women in Moindabi save adequate time from fetching water, they use part of the time saved in searching for firewood. Firewood has to be obtained from forests about 5 Km away taking between 3- 4 hours of their time per day.

- **Assist in looking after cattle.**

Although it is a man's duty to look after cattle, sometimes women may be called upon to assist their husbands. This occurs only in the case of looking after young stock that does not require to be taken very far away from homesteads. These stocks will therefore be grazed near homesteads and it is her responsibility to take them for watering.

- **Timely preparation of food in the morning**

Due to complex and difficult circumstances in which pastoral system is run, it requires that all components of pastoral way of life be undertaken promptly. This is vital during dry seasons when there is scarcity of pasture while water is obtained after walking long distances. During discussions

with Maasai women, they stressed that in their culture, men do not take lunch and therefore have to eat very early in the morning before they leave for grazing. This makes it very difficult for women who obtain water from a distance of over 2Km during dry seasons because they have to wake up as early as 5.00 am to fetch water.

Presence of water point at a distance close to homestead makes a very big difference for women since they do not have to wake up very early in the morning. In Moindabi, women whose households are close to the water point do not have the daunting task of waking up in the early hours of the morning in order to fetch water but rather have adequate night rest. It was noted that women in those households that fetch water from far either have to wake up early or make their meals late thus affecting the entire time spent daily grazing and watering operations of livestock.

- **Looking after the young children.**

Children who are young require parental care for good moral and psychological development. This implies that parents should always have adequate time to be together with children. Maasai women also acknowledge the fact that children may not be able to get care they require from their parents since they have to spend so much time in undertaking multiple household duties such as fetching water, fuel-wood collection. Collection of fuel-wood requires more time and women have to travel long distances to the forest while in the dry spell, women not only travel long distances but also take more time searching for water.

Close provision of water points in pastoral areas enables the women to walk short distances in fetching water thereby saving time part of which is used in washing of children, baby sitting, feeding children whenever is necessary. Whenever, there is no time for these, then children are either taken to the neighbours or are left behind with fellow children who are not in a position to properly look after them.

- **Cultivation.**

The Maasai are mainly pastorals, however, they are taking up cultivation of agricultural crops so as to diversify their food sources and to guarantee of food security. Among the Maasai, women do cultivation of agricultural crops while men spend much time herding. Multiple tasks for women rarely leaves them with adequate time to cultivate adequate sized plots for growing crops.

Fetching water from nearby sources allows women to save some time, which they use to cultivate slightly bigger pieces of land as compared to seasons when they have to fetch water from distant places.

Conclusion

- **Extra time saved by walking only short distances paves way for pastoralists to engage themselves in other activities, for which they would have had no or very little time to undertake but which are crucial for the Maasai women.**

- **Among the tasks to which extra time is relocated are daily cleaning of the pens for young stock, washing/ stitching of children's cloths, collecting fuelwood, assist in looking after cattle, timely preparation of food, looking after the young children and cultivation.**

- **It can there be seen that provision of water points within reach of households may contribute significantly to the improved living conditions of the Maasai women and efficient use of time may lead to improved food production.**

5.6 Household water use.

5.6.1 Quantity of water and household use

Use of water for domestic purposes is usually restricted during dry seasons. This is because of water scarcity during these times and is fetched from far. Moindabi 2 water point has reduced effective distance travelled to collect water and households now are able use adequate amount of water for daily household duties. At present, there is an increase in household water use during dry periods as compared to periods before Moindabi 2 was constructed, or when it broke down in 1995.
Households interviewed reckon advantages of the water point:

- Reduced distance to water point enables them to fetch water whenever it is needed. When water is fetched from far its used carefully and restrictively.
- There is no need to no limit water used within households for bathing, washing both clothes and other household items. Also, more clothes and cooking utensils are used.
- Household members including children are able to take bath as regularly as possible. Clothes are also washed regularly.
- Watering of livestock that remain at home (calves, sick livestock) is done when needed since water point is near. Also, young stocks are either taken for watering at the water point or water is fetched for them and brought home. Sick livestock, which cannot manage to walk to the water point, are usually watered at home.
- There is constant smearing or plastering of entire Maasai residence by women in order to make it look beautiful and clean. In cases where water is far away, the frequency of smearing is very low. This many trips would be required for excellent smearing.
- The herders take their livestock for grazing as early as possible since they are able to eat their morning meals punctually. In Maasai households, women wake up at about 6 am to cook for their husbands and herders. Customarily, the Maasai never take lunch. When water points are far from their homesteads, women have to wake up as early as 5 am in order to fetch water for cooking morning meals.

It was found out that poor households restrict (limit) household water use because they cannot purchase water regularly. This results in irregular bathing, infrequent washing of clothes and occasional smearing of Maasai residence.

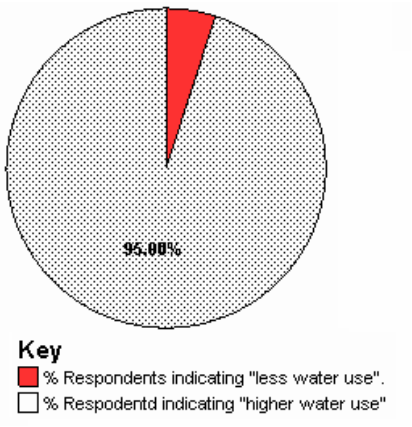

Figure 15: **Percentage of respondents perception on water use whenever water is drawn from the borehole**

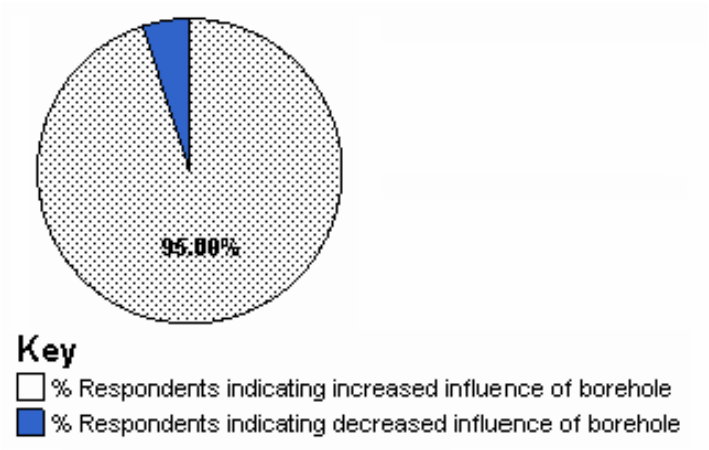

Figure 16: **Percentage of respondent's perception regarding influence of the borehole on household water use at household level.**

5.6.2 Quality of water and household use

Water quality often determines number of users. The ground water quality for Moindabi 2 borehole shows that it has high fluoride content, which is not healthy for drinking or cooking before purification. To make it pure, a purification compartment for reducing fluoride level has been incorporated into this borehole. Since water purification is an expensive exercise, community members pay one slightly Kenya Shilling extra fee for fetching purified water than unpurified. Therefore, there is a difference in use between richer and poorer households.

Uses of water		
Activity	**Treated %**	**Untreated %**
Cooking	87	13
Drinking	87	13
Washing	4	96

Table 4 Uses of Treated and Untreated water.

Results from the above table show that 91.4% of the respondents use both treated and non-treated water. However, among this group, results indicate that the use of water is varied as indicated on the next page.

Analysis of water quality indicate that Lake Oloiden is more salty and alkaline than water from Moindabi 2. Highly salt concentration makes it unfit for either domestic of livestock use.

Item	**Moindabi 2**	**Oloiden**
P^H	7	10
Ec[1]	430us	3680us
Hardness	0.95mmol/litre	0.75mmol/litre
Chloride ion	16mg/litre	156mg/litre
Alkalinity	5.0mmol/litre	10mmol/litre

Table 5. Water quality for both Moindabi borehole 2 and Lake Oloiden.

Conclusion

- **The distance from where is drawn affects household water use patterns, can determine the sanitary condition under which households live and may determine the rate of infection of water related diseases such as scabies.**

- **Water quality determines the manner in which water will be used. Good quality water is mainly used for domestic use while poor quality water for livestock**.

5.7 Cultural Interference

While the Maasai are known to be conservative in their culture, presence of Moindabi 2 water point has changed some of their cultural practices. Some of these cultural practices that have been interfered with are stated below:

- Since Maasai inhabit areas which are drought prone, they traditionally construct dams for harvesting rainy season water meant for use during dry seasons for either watering livestock or domestic consumption. These earth dams are constructed using community manual labour from men. Construction of these dams is usually done during dry seasons so that it would be filled up

during rainy seasons. For Maasai in Moindabi location, presence of a permanent water source from the water point has made them not think of putting up any dam. This is because water point has high recharge and is available throughout the dry season. Therefore, the skills that people have on dam construction are slowly disappearing and not being passed down over next generations.

- Maasai women have a long tradition of bathing within the areas where they have gone to collect water and where men do not go. This is important for them because they not only carry back home domestic water but also to safe guard their privacy and have time to share private issues with their fellow women. Construction of water points causes break down of this practice and, therefore, one of the main forums through which women communicate. The latter is the case for Maasai in Moindabi who obtain their water from the borehole. The water point does not provide women with a secure atmosphere to share private issues among themselves.

  There were cultural practices among Maasai that are meant to unite together two friendly families together. These cultural festivities are performed by Maasai elders either to strengthen friendship among different households or to offer sacrifice so that it rains. This important function/festival is performed at the dam site. Since water point provides reliable water throughout the year, there is no need for putting up the dams and therefore no adequate sites to perform such functions. The implication of this is that the younger generation will no longer be rich in Maasai cultural heritage as was there.

- Traditionally, Maasai do not count number of livestock they have since this is perceived to be a bad omen. Counting livestock among Maasai is believed to cause death of livestock thus reducing the number of livestock that one has. Since watering of livestock at the borehole has to be paid for daily, they have to be counted so that revenue is paid for accordingly. The water committee therefore had to make an agreement with elders regarding this sensitive issue. After consultations, the water point committee was given the mandate to count the livestock before watering within the cattle trough.

- Maasai are not accustomed to purchasing water because of the belief that water is a free good and is brought by God freely. Purchasing water for livestock to drink therefore goes against their culture. However, since revenue has to be generated from selling water and which can be used for maintenance in case of breakdown, it become necessary that Moindabi Maasai succumb to buying of water either for watering the livestock or for fetching domestic water.

Conclusion

- **The role of traditional cultural values in social and economic development is vital if success is to be realised from the project. Most development institutions have viewed the traditional cultural values as irrelevant in the planning for economic development, and hence often are neglected thus leading to failure of the project.**

- **When development has to take into account environmental and natural resource constraints and opportunities, the people's beliefs and customs must be considered. Therefore, there should be recognition of the traditional cultural values especially when the values are strongly held as is the case with the pastoralists during the planning and program execution.**

5.8 Gender and Water

While there slight changes with regards to gender roles attributed to presence of the borehole. Women make all major domestic decisions including those revolving around water collection and use.

The table below lists the gender roles of Maasai in Moindabi. There are two issues resulting from water point development. These issues concern ability of both men and women in taking up additional roles when water points are developed, and, in very limited occasions, ability of women to take up some of the roles that are done by men and vice versa. In specific terms, Men are able to participate in development projects; road construction, schools and health centres. They also support the women in fetching water for family need using bicycles while their role in dam construction has diminished.

The women are now able to involve themselves in income generating activities and participate in women group meetings. Both men and women have taken up the active role in cultivation of agricultural crops.

Women are taking up strong leadership roles in management of Moindabi 2 water point. Here, the water point treasurer is a woman although there were two other as committee members.

Gender	Roles before the borehole construction	Roles after the borehole construction
Male	Providing the family with basic needs: Clothes, food Grazing the cattle Taking cattle for watering Selling of animals Construction of dams	Provide family with basic needs: food, cloths, shelter Grazing animals Taking animals for watering Cultivate crop fields Participate in development projects Fetching water for the family using bicycles
Female	Construction of residential houses. Milking of cows. Fetching firewood and water. Making meals for the family	Women involve themselves in income generating activities Milking livestock Adult women participate in women groups Collecting firewood and fetching water Cultivate fields for agriculture

Table 6 Comparison of gender roles

Discussion

Changes in gender roles are attributable to construction of boreholes in pastoral areas. Traditionally, Maasai women have been responsible for construction of residential houses, milking of cows, collecting fuelwood and fetching water. Hesseling (1994) found the same view in her Sahel region study.

Cultivation of crops in Moindabi picked up after putting up the borehole because prior to that households were mainly preoccupied with looking for water. Seeking water occupied most of their time. Functioning boreholes made it possible for both men and women to involve themselves in cultivation of crops.

The role of women in herding livestock is an aspect that has long been neglected however in the Sahel region they take care the gardens and livestock said (Hesseling, 1994) and livestock under their care. In Moindabi women don't take care of livestock, men take care of livestock and are responsible for selling them while women are responsible for milking and selling of milk. Bruijn and Van Dijk(1995) stated that among Fulbe, Senegal, women are responsible for raising stock. In some cases women and young girls are responsible for herding sheep and goats and milking all livestock, while men and boys are responsible for herding cattle as with the Pokot (Middleton and Kershaw, 1953: Borrow, 1988). This is not the case in Moindabi since there may some differences between the Maasai and Pokot pastoral groups.

Lastly, a significant change in role has been the ability of Moindabi women to participate in development projects, similarly, Faure (1992) at key roles women are taking in development projects involving resource management in Bukina faso.

Conclusion

- **Provision of water points in pastoral areas contributed to some changes in gender roles. However, it may bring about the ability of men and women to actively involve themselves in cultivation, looking after livestock and sharing duties while fetching water.**

- **Women are included in committees responsible for managing resources and well as taking roles in development projects.**

Chapter 6

Conclusion and Recommendation

Conclusion

Assessing of the potential impact of the intervention should precede development and execution of action plans, which are aimed at developing key resources within pastoral areas. In the literature review, impacts of water points on environment, livestock production, household dynamics and gender roles have been outlined. The objectives of this study were to assess the impact of drilling water points in Moindabi location in Kenya and determine the changes in livestock production, household dynamics and gender roles arising therefrom. I have given very light weight on environmental impact, since it was not part of the objective for this study. However, the last paragraph of this section gives a brief account on the subject.

Evolving from this study are separate conclusions changes in livestock production and in household /gender because they demonstrate different responses to water point development. This separation produces distinct conclusions and recommendations for each section. The sections that follow give detailed conclusions on changes that were realised. Impact of water points on livestock production has been categorised into herd management practices and production. Developing water points in pastoral areas introduces changes in management practices, which are ultimately reflected in increased production.

Reduction in distance to the drinking water source in Moindabi 2 from households provides herders with an opportunity to take tender care of the calves. In areas where the distance to water sources is more than 5 km, there is increased calf mortality rate due to long distance trekking. Opportunity to provide tender care to calves is through tethering where there is pasture. Calves are taken to watering places only in areas where the distance to the watering point is less than 1 km. Reduced trekking distance during dry seasons when pasture is limited increases chances for calf survival during, drought periods thus increasing stocking rates soon after dry spell. It also noted in Moindabi that reduced trekking distance contributes to increased calving rates because cows come on heat regularly while bulls are able to service more cows.

Herd splitting is a management strategy practised by pastoralists in Moindabi to ensure that different livestock species have equal access to key resources. The practice benefits the pastoralists by being able to spend less time while watering livestock and reduces competition between species for water. The time saved from watering livestock allows livestock to graze for longer times. However, managing this exercise at the watering point is not an easy task and requires more than two persons when stock sizes are large.

Labour requirements for watering livestock during dry seasons in Moindabi are enormous. Presence of water point in the area has reduced labour requirement because it makes it possible for households to employ fewer herders in comparison to periods when many herders are required to assist in looking after livestock over longer distances. This is contributed by the fact the water points have motorized pumps, making labour requirements for pumping water low, compared to drawing using hand bucket.

Frequency of drinking water by livestock determines milk yield per cow. During dry seasons, milk yield in this area decreases because of reduced frequency of water intake. Introduction of water points in the area is associated with reduction in the distances to water sources, hence increased watering frequency and increased milk production.

Livestock production in pastoral areas is affected by tick infestation. Availability of dry season water points has made it possible to regularly hand spray livestock against ticks rather than using expensive cattle dips. Use of hand spraying method is cheap although it is not very efficient. However, availability of drinking water points enables application of the prescribed ratio of accaricide to water. Whenever water is fetched from Lake Oloiden, there are possibilities of not adhering to application regime thus ineffective tick control.

Water points in Moindabi area have also brought about sedentarization of households. As a result, they have entered in cultivation in order to avoid becoming risk and food insecurity whenever there is drought. However, the practise has contributed to a decrease in grazing land, and decreased availability of fuelwood because demand for construction timber had increased. The presence of Moindabi 2 dry season watering point together with the depleted pasture around it has increased propensity of herders to make use of any pasture that is available within the water point's vicinity. In Moindabi, pastoralists invade large-scale wheat farms after harvesting to feed livestock. This consequently is a potential cause of conflict whenever different users are involved.

Also, households that are sedentary lead a comfortable life and have the motivation to invest and develop places they inhabit. There is a tendency for households to be clustered around water points because households will have easy access to water. Habitation near each other also guarantees them security from one another.

Inspite of the fact that household expenditure studies have has not always taken into account the amount of household income that is spent on purchasing water for either domestic or livestock use during dry seasons, the amount spent by households which have large herds and big families during dry seasons is significant. Households that do not have enough cash to spend on water during dry seasons stand to lose some livestock because they cannot hire more labour to assist them in taking livestock to distant watering places

Some changes related to provision of water points have been observed within households. The availability of water in close proximity to households results in increased household water use because of increase in cooking utensils, bathing more regularly and washing of more clothes. Time saved is spent on increased income generation activities, looking for fuelwood, cultivation and cleaning calf pens. These tasks have contributed to improved quality and way of life.

The pastoralists have also become more particular on quality of water used should they be in a position to choose between good and poor quality water for domestic use. To this end, untreated water with high fluoride content is used for other domestic work, but not drinking.

Whenever issues like household expenditure, household water use and sedentarization are mentioned, gender roles have to be involved. This study realises the vital role which introduction of water points plays in pastoral household gender concerns. However, it must be pointed out that changes in gender roles may occur only to a little extent. It is clear that women have taken up strong leadership roles in managing natural resources as well as being incorporated into decision-making committees because two women one of the treasurer are committee members of Moindabi 2.

The role of water points in influencing the cultural or traditional values is an issue that has received little attention in pastoral studies. However, this study found that introduction of water points in Moindabi areas tends to erode some essential cultural values that appear to be totally gone with generations to come. The traditional practices that used to be done around the dam site is no longer done.

Lastly, an important aspect of developing water points, which was outside the scope of this work, is its effect on environment. The objective of putting up water points within rangelands is intended to reduce the range destruction caused by concentration of livestock, it is was realised during this study

that areas around water points are highly degraded and making them prone to severe soil loss due to wind and water erosion. This was as a result of livestock concentration around water points and overgrazing pasture within these areas.

Recommendations

- **Relevant line Ministries and development agencies in Moindabi should ensure that the improved herd management practices are substantially developed through regular skill development.**
- **There is need to undertake biomass assessment of pasture in Moindabi area. This should be able to determine whether the rate of destruction or regeneration of pasture species that are of high nutritional value for livestock**
- **Awareness among the Maasai in Moindabi on the importance of keeping improved drought resistant livestock.**
- **There is need to carryout a research on conflict analysis and management related to resource use in Moindabi.**
- **A community based conflict management and resolution team should be established and trained on the basic tools on prevent and manage conflicts. Also, future policies on administration and regulating resource use should be based on Arbitration and mediation rather than litigation.**
- **Existing water committee should be trained on maintenance of the water pump to equip them with skills on repairing them pump when it breaks down.**

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