VALUING THE NATURAL RESOURCES AND ECOSYSTEM SERVICES OF LELIEFONTEIN COMMUNAL RANGELAND IN NAMAQUALAND, SOUTH AFRICA

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Valuing the natural resources and ecosystem services of Leliefontein communal rangeland in Namaqualand, South Africa

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Keywords

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Abstract

Valuing the natural resources and ecosystem services of Leliefontein communal rangeland in Namaqualand, South Africa

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Natural resources play important roles in ecosystem service delivery, more especially in rural households where livelihoods depend heavily on natural resources for the delivery of ecosystem services. The various benefits derived from provisioning, supporting, regulating and cultural services of natural ecosystems such as food, medicines, carbon sequestration, spiritual fulfilment all support human life and sustain its well-being.

Research on valuation of natural resources suggest that the values derived mainly from non-marketed natural resources are insignificant and thus, not reflected in national accounts. Economic valuations have traditionally been concerned with the quantification of direct use values of ecosystem services that are marketed to produce tangible benefits. The scope of natural resource valuations have, however been broadened by scientists in recent years to consider passive or non-use values to reflect the total economic values of natural resources and ecosystem services to societies.

In this study, I valued the streams of ecosystem services derived from natural resources in Leliefontein communal rangeland; an area of 192 000 hectares in the semi-arid region of Namaqualand in South Africa. Rangeland forage for livestock, medicinal plants, fuelwood, and water resources from the Communal Area were valuated for one production year between January and December 2012. Valuation was done to incorporate both marketed and non-marketed natural resources which

were used within the production year. The total economic value for the area was estimated at R20 156 672 per annum. Value of rangeland forage was estimated at R61.92 ha^{-1} yr^{-1}, fuelwood's value was estimated at R25.04 ha^{-1} yr^{-1}, value of medicinal plants was R2.26 ha^{-1} yr^{-1} and water resources valued at R9.45 ha^{-1} yr^{-1}.

The non-use value was estimated by eliciting the willingness to pay for the conservation of the natural resources using a contingent valuation method. Economic value of natural resources in Leliefontein increased to R105 per hectare from R99 when non-use value was added to reflect the total economic value of ecosystem services in the area. Household income level positively correlated with individual's willingness to pay for ecosystem services.

I recommend that decision making should take into account the socio-economic conditions of a community when determining the total economic value of ecosystem services. Non-use value of the ecosystems should be considered especially in rural areas where people depend on the natural environment for livelihoods and socio-cultural well being. Sustainable and equitable utilisation of natural resources for the purpose of maintaining a sustainable flow of critical ecosystem services should form the basis for formulating policies on land use and sustainable development.

Declaration

I declare that "*Valuing the natural resources and ecosystem services of Leliefontein communal rangeland in Namaqualand, South Africa*" is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Oluwagbenga Olaitan Ogidan

Signed: …………………………….   November 2014

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Chapter One: Introduction

1.1 General introduction

Natural resources constitute stocks of goods and capital freely occurring within the environment which are crucial to supporting human lives. Life on earth would be practically impossible without the flows of beneficial life support services from these natural ecosystems. Ecosystems are forms of renewable natural capital that yield goods such as foods, timbers, medicines or to generate flow of services such as nutrient cycling, pollination and erosion controls (Costanza and Daly, 1992).

The complex interactions of a community of living organisms (biological) with the non-living (chemical, physical) components of the environment constitute an ecosystem (Tansley, 1935; Lindeman, 1942; Fenton and Spencer, 2010). The United Nation's Convention on Biological Diversity defines ecosystem as "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit" (UN, 1992).

Humans, being an integral part of ecosystems (Leopold, 1949; MA, 2005) derive various benefits from the complex interactions between organisms and their physical environments. These benefits people derive from ecosystems can be collectively termed "ecosystem services" (MA, 2005; Barbier, 2007; Ranganathan et al., 2008; Layke, 2009; Salles, 2011). Daily (1997) suggests that ecosystem services are conditions and processes that sustain and enhance human well being through interaction among species and the natural environments.

The benefits and values of natural ecosystem services can be better appreciated if we consider the cost of replicating natural earth systems by an engineered artificial system. This is a very expensive, complex and likely an unattainable mission (Costanza et al., 1997; Daily, 1997). A typical example of this scenario was the failure of Biosphere II dome built in Arizona desert in 1991 at a staggering cost of over R500 million to re-create the ecological and self-sustaining conditions of the earth (Costanza et al., 1997; Salzman, 1997). Costanza and Daly (1992) explain that the creation of a manufactured capital requires the natural capital as inputs; a paradoxical creation of a substitute from what it is intended to substitute for. The complete irreplaceability of natural ecosystems highlights the significance of ecosystem services, more especially in rural economies where people depend heavily on natural resources for subsistence and livelihoods (Mcgregor, 1995; Cavendish, 1996; Cousins, 1999; Shackleton et al., 2001).

The role and importance of natural resources in sustaining human well being could be best measured by the benefits derived from their uses. Natural resources support human life by providing food from plants and animals, shelter from forest products, and clothing from wool and natural fibres.

Economic theory identifies four kinds of capital namely manufactured, financial, human and natural capital (Chee, 2004). The first three kinds of capital depend to a large extent on natural capital for productive activities. Natural resources interestingly constitute the environmental materials and components that make up natural capital. This further highlights the importance of natural resources more especially, in rural and developing economies where there is much dependence on these resources in their natural state; a development which is due to lack of technological capacity to transform them into manufactured capital to produce marketed consumer goods and services. Therefore, most of the transactions that require the use of natural resources are usually not marketed. Most of the resources are collected or accessed freely hence, there is no formal market exchange to determine their worth.

In recent time, there had been various attempts to assign economic values to ecosystem services. One of such attempt was a study by Costanza et al. (1997) that estimated 17 ecosystem services for 16 biomes across the world. The estimated value for the biosphere was in the range of R74-250 trillion/year averaged at R152 trillion/year. It is interesting to note that most of these values were outside the market as indicated by the findings, hence, the need to adopt a valuation method that would reflect the total economic value to estimate the use and non-use values of the resources.

The aim, therefore of conducting this research in the Leliefontein communal rangeland of Namaqualand was to assess the values and benefits of natural resources on sustainable livelihood in Leliefontein. The study seeks to assist in decision making on conservation of key natural resources in the communal rangelands of Namaqualand.

1.2 Rationale and objectives of the study

The primary aim of this research is to undertake an economic valuation of the natural resources within the Leliefontein communal rangeland. This is necessitated by the need to identify various benefits derived from natural resource use, more importantly, the non-monetised benefits.

The secondary aim is to aid in the decision-making process of biodiversity conservation and natural resource management using the derived data to determine the best and sustainable use of land-based communal resources. Cousins (1999) argues that despite the contribution of natural resources to food security, income and other basic neccesities of life, it appears that its importance are poorly understood by policy makers, conservation planners and fieldworkers alike. The understanding of the concept of total economic values of natural resources and its contribution to rural livelihoods will assist decision-makers on how best to prioritise conservation of natural resources in order to enhance sustainable livelihoods.

This research is conducted to assess the assumption that natural resources in the commons are unproductive and its values are insignificant to be reckoned. Carter and May (1997) reported that data on poverty in South Africa are drawn mostly from surveys focusing on cash income and expenditure without taking into account the non-monetised activities of the local economies. The various non-monetised benefits provided by the use of natural resources in communal rangelands and the need to fully appreciate the values of the natural resources in the area constitute the basis for this study.

1.3 Research questions

The research was conducted to provide answers to the following questions:

1. *What is the total economic value of ecosystem services from Leliefontein Communal rangeland?*

Studies have shown that the economic values of communal natural resources could be significantly tangible if passive or non-use values of the resources are included in the valuation exercise (Scoones, 1992; Cousins, 1999; Shackleton, et al., 2000). Little or no attention has been given in the past to the passive use value components of communal natural resources by policy makers (Cousins, 1999). This, invariably impacts on the decision making process on governance and management of natural resources.

2. *Do socio-economic conditions (such as income and education level) of a community affect their stated willingness to pay for ecosystem services?*

The value and importance attached to an ecosystem service often reflect the socio-economic attributes of the beneficiaries of such service (Carpenter and Folke, 2006; O'Farrell et al., 2011). The temporal and spatial scales of ecosystem services must be taken into consideration when valued (Hein et al., 2006). Therefore, the interpretation of values of ecosystems require the knowledge of the spatial scales of services by defining the flow and characteristics of specific services for valuation, taking into account the values, cultural and belief systems of the various stakeholders affected with the valuation process (Kremen, 2005; Chan et al., 2006; Hein et al., 2006; Fisher et al., 2009).

1.4 Thesis outline

Chapter one of the thesis gives a general introduction and background on natural resources and its contribution to livelihoods. The various benefits that are derived from natural resources and the ecosystem services associated with the resources are highlighted.

Chapter two reviews existing literature on the value of natural resources and delivery of ecosystem services, with emphasis on rangeland ecosystems and the classification of ecosystem services as compiled by the millennium ecosystem assessment (MA, 2005). The chapter further looks into choice of valuation method and debate surrounding the typology suggested by (MA, 2005) to check if it is applicable for all purposes or a need to further deconstruct it to fit for specific valuation purposes.

Chapter three gives the historical background of the study area. The biophysical characteristics and socio-economic conditions prevailing in the area will give a better understanding into patterns and processes adopted in the utilization of the naturally occurring resources.

Chapter four of the thesis describes the valuation methods used to determine the values of ecosystem services derived from the communal rangelands. Semi-structured questionnaire was used to collect socio-economic data of respondents and their willingness to pay for ecosystem services.

Chapter five outlines the results of the valuation of major ecosystem services in the study area and discusses the pattern and trends of these services. This chapter highlights the values and contribution of ecosystem services from natural resources in the study area to the livelihood and wellbeing of the Communal Area.

The final chapter (chapter six) draws on the findings from this research to conclude and make appropriate recommendations for conservation of natural resources by policy makers.

Chapter Two: Literature review

2.1 Background

Valuation of natural resources is considered a complex process because most of the services and benefits are non-marketed and thus placing a monetary value on them represents a challenge (Chee, 2004). There have been arguments against assigning economic values to natural ecological systems (Heal, 2000) and the moral implication of placing monetary value on ecosystems for its "God-given" purposes. However, Costanza et al. (1997) argues that valuation of ecosystem services are implicitly done whenever society make decisions on improvements of human lives and environments.

Little attention is paid to values of ecosystems mainly because their services are not fully traded in a structured market and thus, receives little or no consideration in a decision making process by various policy makers. In recent years, scientists have developed different methods to value the ecosystem services that increase human welfare. However, values are subject to interpretations in different disciplines (Farber et al., 2002).

In neoclassical economic theory, an entity is considered to have economic value only when people are willing to pay for such an entity or willing to accept compensation to forego it (Farber et al., 2002; Chee, 2004). This is often termed the utilitarian approach to ecosystem service valuation. The utilitarian approach of valuation assigns values to the tangible and mainly directly-utilized portions of ecosystem services (Chee, 2004). In a non-utilitarian approach to ecosystem services, different school of thoughts emerge from the assumption that values encompasses both intrinsic and extrinsic nature of a given entity (Alcamo and Bennett, 2003). Figure 2.1 shows the linkages between the valuation approaches for estimating economic values of natural resources

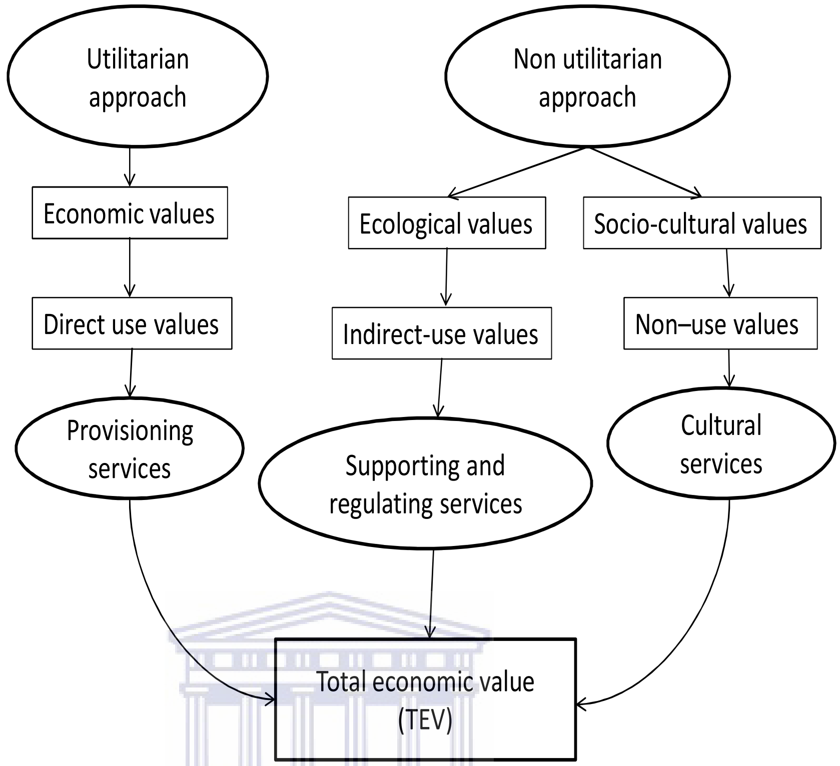

Figure 2.1: Valuation approaches for estimating ecosystem services (modified from Alcamo and Bennett, 2003).

The importance of values and consequent valuation of ecosystem services are regarded and expressed in different ways by different disciplines (Farber et al., 2002) from ethical, cultural, philosophical and economic perspectives (Goulder and Kennedy, 1997). The relationships that exist among the various services provided by natural ecosystems are usually non-linear relationships characterised by a complex mix of inter-linkages (Chee, 2004; Limburg et al., 2002; O'Farrell et al., 2011), hence it will be inappropriate to value the services using the same denominator (Koch et al., 2009).

Fisher et al. (2007) suggested that the design and implementation of ecosystem valuation should take into consideration the complex ecosystem processes and the characteristics of ecological services provided. For instance, rangeland ecosystem which is predominant in Namaqualand provides different services at different scales. The valuation of these services requires different methods to fully appreaciate all the benefits derived from the ecosystem.

2.2 Rangeland ecosystems

Rangelands are natural terrestrial land surfaces that comprise grasslands, shrublands, woodlands, deserts and tundras. They constitute more than half of world total landmass (Mathews et al., 1986; Lean, et al., 1990). Rangelands represent the largest terrestrial ecosystems occupying about 51 percent or 6.7 billion hectare of the earth land surface and contain about 36 percent of global carbon in its above and below ground biomass (Solomon et al., 1993).

These terrestrial ecosystems are characterised by self-reproducing native vegetation that is primarily grasses, forbs, shrubs and/or open canopy scattered trees (Stoddart et al., 1975; Joyce, 1989; Maczko and Hidinger, 2008).

Rangelands are mainly found in the arid and semi-arid regions where rain fed agriculture are unsuitable and thus, extensively utilized for animal grazing (Mathews et al., 1986; Skaggs, 2008). They remain a primary source of forage for most livestock in Africa and Asia (Allen-Diaz et al., 1995). Rangelands provide forage for livestock and wildlife, and support millions of world population (Briske and Heitschmidt, 1991) with an estimated 50 percent of the world total livestock raised on rangelands (Allen-Diaz et al., 1995). Forage from rangelands and pasture provide between 80 and 85 percent of feed for ruminant livestock (FAO, 1983). About 95 percent of livestock intake in developing countries is derived from rangelands (Mathews et al., 1986).

In developed countries such as United States, natural rangelands make up 31 percent of the land area (Havstad et al., 2007) supply 16 percent of livestock feeds; 55 percent are derived from non-range grazing (improved pasture, silage e.t.c) while grains and concentrates contribute the remaining 29 percent of livestock intake (Mathews et al., 1986). Albeit extensively utilized for grazing livestock and wildlife, they provide diverse valuable ecosystem services including food, fiber, fuelwood, carbon storage, tourism to maintenance of watershed. Costanza et al. (1997) reported a per hectare value of R1 070 yr^{-1} of world's rangelands. A total value of R4 176 660 000 000 per year for world's rangelands was estimated (Costanza et al., 1997).

2.2.1 Ecosystem services provided by rangelands

2.2.1.1 Forage and livestock production

Ruminant livestock effectively utilize lands that are considered too poor for cropping by converting vast renewable resources into food (Oltjen and Beckett, 1996). They are able to break down cellulose which is not digestible by humans and convert it to protein-rich meat and milk (Hinrichsen, 1987). Livestock are important source of animal protein and contribute substantially to dietary requirement of human beings. The livestock industry represents about a third of the value added for agricultural sector in developing countries and more than half of value added in developed countries (Pica-Ciamarra et al., 2014).

Rangeland dependent livestock production partly or fully supports about 60 percent of the rural households in developing economies (Pica-Ciamarra et al., 2014). Globally, over 200 million people depend on rangelands in some way for income and livelihoods (Paden, 1989). The contributions of livestock to national economies are significant, particularly in developing countries (Otte et al., 2012). Thirty to forty million nomadic and pastoral people in Africa depend primarily on livestock production in vast arid and semi-arid lands of countries such as Mauritania, Sudan, Mali, Kenya, Somalia and Ethiopia (Sandford, 1983). For instance, livestock products accounted for about 82 percent of total agricultural export in Somalia in 1985 (Paden, 1989) with only 10 percent of its population regarded as pastoralist (Mathews et al., 1986).

Livestock are important sources of farm power and energy. The cost avoided by developing countries by using livestock for farm power was estimated as R35 billion and animal manure was estimated as R5 billion (Murray, 1978). Animal power generate half of non-human energy used in agricultural production (Sandford, 1983) in developing countries and remains more important than tractor as power source in farms in Africa and Asia (Mathews et al., 1986).

Livestock farming on rangeland remains an essential source of livelihoods for a vast number of people in drylands and developing countries (Otte et al., 2012). Fuelwood, medicinal plants, fruits and other wild products which are usually not marketed are also derived from rangelands, thus adding values to local economies and livelihoods. The economic value of the livestock sector globally is estimated at over R448 billion (FAO, 1983).

2.2.1.2 Carbon storage and climate regulation

Rangelands are diverse but are the largest single terrestrial ecosystem, thus, they play a critical role in the terrestrial carbon cycling and storage (Reeder and Schuman, 2002). The quantity of carbon stored by rangelands globally is estimated at 749.7 petagram of carbon (Solomon et al., 1993). Organic carbon of rangelands is 303-330 petagram of carbon while the inorganic carbon amounts to 470-550 petagram of carbon; these represent 20-25 percent of terrestrial carbon worldwide (Havstad et al., 2007). However, unlike forests ecosystem which stores a vast amount of carbon above ground in its vegetation, rangelands store most of their carbon in below ground (Burke et al., 1997).

Reeder and Schuman (2002) report that the amount of above ground carbon in range and grasslands plant biomass are generally less than 10 percent with most of the carbon stored in the plant roots. In rangelands ecosystem, the soil organic matter stores about 90 percent of the organic carbon thus constituting the largest reservoir of carbon in rangelands ecosystems (Reeder and Schuman, 2002). Carbon stored in rangelands soils is estimated at 591.6 petagram of carbon. This value represents 44 percent of total global carbon stored in soils (Solomon et al., 1993).

Carbon in rangeland soils is considered relatively stable if disturbances are minimal (Follett et al., 2001). However, water and wind erosion could lead to decline of organic carbon at the rate of 1 Tonne Carbon ha^{-1} yr^{-1} over 20-25 years (Brown et al., 2006). Overgrazing and degradation of rangelands generally lead to loss of terrestrial carbon into the atmosphere. Rangelands can be best managed for its climate regulating role if intact rangelands are maintained, degraded land are restored to some functional level or change in land use i.e. change of marginal croplands to perennial grass cover (Havstad et al., 2007).

2.2.2 Rangelands ecosystems and resources of South Africa

The primary rangeland resource of South Africa includes grasses, forbs, woody shrubs, succulent shrubs and trees for wildlife and livestock production (Palmer, 2003). The rangeland resources cover the agro-ecological zones and biomes of South Africa which are Succulent Karoo biome, Nama-Karoo, Grassland, Savannas, Thicket, Fynbos and Forest (Low and Rebelo, 1996). The natural vegetation of Fynbos biome with its high floral diversity have little or no forage value as well as the forest biome having less significance for livestock production (Palmer, 2003).

2.2.2.1 Management of South Africa's rangelands

South Africa rangelands are managed for livestock production under two distinct production systems, namely freehold/commercial and communal/subsistence (Palmer and Ainslie, 2006b). Under freehold, production is capital intensive and the lands are managed primariliy for grazing livestock and in some cases, wildlife with commercial interest largely inclined towards exports. Production under communal system is however labour intensive and utilisation of rangeland resources are mainly subsistence driven.

2.2.2.1.1 Freehold production system

The freehold system is a highly organised management system with well developed agro-support systems, including access to loans and financing, cooperatives, market supports and good infrastructural facilities (Van Zyl et al., 1994). There are some 55 000 farms of approximately 120 hectares each which are managed by 45 000 persons or entities (Palmer and Ainslie, 2006b).

Out of the total 100 million ha classified as farmlands; largely for grazing (68 percent), freehold or commercial system makes up 82 million hectare of such lands (McCarthy and Dagut, 2005).

Livestock are raised extensively by grazing on natural pastures in ranches under a freehold production system with occasional supplements of nutrients and minerals. Livestock production under this system accounts for 75 percent of total agricultural output in the country (Palmer and Ainslie, 2006b). In 2000, export of livestock products from this production system was estimated at R21 billion which represents about 10 percent of total national export (Palmer and Ainslie, 2006a). This system is primarily profit driven unlike communal production system which is managed for multiple use and diverse livelihood strategies (Cousins, 1999; Shackleton et al., 2000b).

2.2.2.1.2 Communal production system

Communal rangelands in South Africa account for 17 percent of the total farming lands with an estimated 72 percent of goat, 52 percent of cattle and 17 percent of sheep total population (Palmer and Ainslie, 2006b). The grazing lands and resources under communal system are collectively owned as a common property. However, lands for cropping are seldom allocated to individuals (Palmer and Ainslie, 2006a). The primary objective of production in this system is not for profit, rather as a safety net or store of wealth for emergencies (James et al., 2005).

Production objectives on communal rangeland are diverse, ranging from use of livestock as animal power, dung for manure, meat and milk for sales or domestic consumption and for other socio-cultural values (Palmer and Ainslie, 2006a). Rangeland resources are also utilised to mitigate rural poverty and to enhance diverse livelihood options (Shackleton et al., 2000b).

Their use is multi-purpose in nature such as collection of wood for energy, medicinal plants, wild foods and other wild resources are derived from the rangeland other than grazing (Cousins, 1999).The use of rangeland goods and services are often not traded hence, its importance are not fully appreciated and sometimes, undervalued. Cousins (1999) suggest that the value of communal rangelands yields high economic returns if its ecosystem services are adequately measured.

2.2.2.2 Ecosystem services provided by communal rangelands

2.2.2.2.1 Livestock production

Various studies conducted in the rural and Communal Areas of South Africa where livestock production has been a predominant use of rangeland show high economic returns (Scoones, 1992). Livestock production on communal rangelands is generally believed to serve diverse functions and yield higher rate of economic returns when all its functions are adequately considered and valued (Cousins, 1999). James et al. (2005) estimated the value of livestock production in Paulshoek commonage of Namaqualand using Household Income Approach (HIA) and Natural Habitat Value (NHV) to be R75 131 and R42 790 respectively.

Figure 2.2: Livestock grazing in Leliefontein Communal rangeland (Samuels, 2013).

Dovie et al. (2005) estimated a net monetary value of R4 172.16 per household per annum from direct use of livestock in Thorndale, a Communal Area in Limpopo province of South Africa. A study by Shackleton et al. (1999) in Bushbuckridge, South Africa, showed a direct net annual value for livestock production of R4 682 per cattle owning household and R483 per goat owning household. However, it should be noted that valuation of livestock production in a communal systems could only capture about one quarter of the use values (Shackleton et al., 2000b).

Other contributions of livestock such as traction for soil formation, dung for fuel and manure are not usually accounted for. Thus, services which are usually not monetized or exchanged in a market are left unaccounted. It should be noted that under communal production systems, livestock are predominantly raised on rangeland, thus the value and contribution of livestock to the human well-being are directly related to rangeland resources of the commons.

2.2.2.2.2 Fuelwood production

Woodland as a natural resource plays important role in delivery of ecosystem services. Common ecosystem goods derived from woodland include fuelwood, wild fruits, medicinal plants, vegetables, fodder, reeds, construction woods and other non timber products.

Shackleton et al. (2002) reported that three woodland products namely fuelwood, wild edible herbs and fruits contribute a significantly large proportion of total value of woodland products used in three communal rangelands in South Africa; 89.3 percent at Mogano, 80.4 percent at Ha-Gondo in Northern Cape Province and a lesser percentage of 49.8 at KwaJobe communal rangelands in KwaZulu Natal Province. Fuelwood, edible herbs and thatch grass contributed a combined gross direct use value of R5 181 per household per year or about 81 percent of the total direct use value (R5 886 per household per year) of all resources used in Thorndale village, South Africa (Dovie et al., 2002).

In communal rangelands of South Africa, woodland resources, particularly fuelwood have been reported to contribute significantly to households' livelihood. Fuelwood use is a critical component of livelihood strategy in Communal Areas of Namaqualand as it accounts for 75 percent of the energy source utilized in the area (Solomon, 2000). In southern Africa, more than 80 percent of the population make use of fuelwood either as a primary or secondary source of energy (Priddle, 2002).

Figure 2.3: Harvested fuelwood from Leliefontein Communal rangeland (Samuels, 2013).

Solomon (2000) reported an estimated annual fuelwood use of 2.18 tons with an estimated net value of R366 271.75 per annum in Paulshoek village of Namaqualand. Similarly, James et al. (2005) reported the total value of R113 634 for fuelwood use in Paulshoek, Namaqualand, South Africa. The mean gross values of fuelwood uses for Mogano, Ha-Gondo and KwaJobe communal rangelands were estimated at R1 736, R1 569 and R726 per household per year respectively (Shackleton et al., 2002). Shackleton and Shackleton (2000) estimated the value of fuelwood use to households in Bushbuckridge village at R465 per year per household. Annual use of fuelwood in Thorndale village was 4.343 tons per user household worth an estimated R2 005.95 per household per year (Dovie et al., 2004).

In many rural communities in South Africa except areas where trees are naturally scarce or wood resources have been depleted, fuelwood generates between 80 percent and 99 percent of households' energy needs, with vast amount of the wood derived from rangelands of savannas and forests (Williams and Shackleton, 2002). In 1990, about 17 million people in South Africa depend on fuelwood derived from the woodlands to meet their energy demands (Gandar, 1991). Fuelwood collection is an important livelihood strategy for rural households. Even though the woods are freely collected from woodlands in most cases, some of the local population do engage in collecting and trading in fuelwood within or outside the communities (Shackleton, 1996).

The gross direct use value of fuelwood as energy across South Africa rural households was estimated at R165 per month; an equivalent cost of electricity use in peri-urban settlements (Williams and Shackleton, 2002). This implies that a rural household will be well-off saving R165 monthly by using fuelwood for energy. This is a significant contribution to livelihood considering majority of the households in rural settlements live below the poverty line of R740 per month per family of five persons (Tapson, 1996).

Shackleton et al. (2000a) reported that gross annual direct use value of woodland products range from R1 348 to R7 742 per household in Communal Area of South Africa. With 9.8 million tons of fuelwood consumed annually in South Africa, mainly in the savanna biome, a gross direct use value of R3 billion per year was estimated for fuelwood consumed nationally (Williams and Shackleton, 2002).

2.2.2.2.3 Medicinal Plants

Medicinal plants contribute to livelihood particularly in rural areas where there is little or no access to modern healthcare facilities. Rural dwellers have over the years evolved a traditional knowledge on how to cure or prevent different ailments with medicinal plants. Nortje (2012) identified 101 plants in Kamiesberg, Namaqualand of South Africa with medicinal values used in the treatment of various ailments such as stomach ache, body pain, fever, flatulence, influenza, cough, tooth ache, diabetes and a host of minor illnesses.

The total direct use value of medicinal plants in Paulshoek, Namaqualand of South Africa was R21 370 per annum (James et al., 2005). Shackleton et al. (2002) estimated the mean gross value of medicinal plants use in three communal rangelands of Mogano at R149 per household per annum, Ha-Gondo at R105 per household per annum and KwaJobe at R37 per household per annum. Medicinal plants in Bushbuckridge village were valued at R383 per household annually (Shackleton and Shackleton, 2000).

Medicinal plants are important natural resources particularly in rural communities. They can be easily accessed on the rangelands; more so, its use for treatment of minor illnesses does not require skilled knowledge which is lacking in most rural population. A study by Dovie et al. (2001) showed that all households (100 percent of household surveyed) in semi-arid village of Thorndale collect medicinal plants from rangelands. The direct use value was estimated at R353.83 per household per year. This represents a significant value in terms of cost saved on medicinal treatments and loss of man-hour due to illness.

2.2.2.2.4 Wetlands and water resources

Water is an important component of ecosystem. It is essential for sustainability of livelihoods as well as social and economic developments in all sectors (Beekman and Pietersen, 2007). Wetlands and other water ecosystems cover an estimated 1, 280 million hectares (MA, 2005) and about 1.5 to 3 billion of the world's population directly dependent on the groundwater, mainly recharged through wetlands (Shiklomanov, 1993). Although water varies in forms, quality and quantity, it is the most widely distributed resource on the planet and forms the basis of life on earth (Shiklomanov 1998; 2000).

Water is a scarce natural resource; out of the estimated 1 386 million cubic kilometres of water on earth, only 2.5 percent is fresh water and a lesser 0.3 percent of the freshwater are made up of lakes, reservoirs and water systems mostly accessible and essential for water ecosystems (Shiklomanov, 1998).

South Africa, like many nations faces challenge of water shortage. More than 33 percent of the world's population; an estimated 2.4 billion people in 40 countries live in water stressed regions and these figures are expected to rise (DWAF, 2012; Xie, 2006). South Africa is one of the countries faced with severe challenge of water scarcity with water availability ranging between 500 m^3 and 1000 m^3 per capita per year (Ashton, 2002). It is ranked 30th driest nation in the world with less water per capita than countries such as Namibia and Botswana which are widely considered to be drier (DWAF, 2012).

Figure 2.4: Wetland in Leliefontein Communal rangeland (Samuels, 2013).

The importance of water underlies the fact that water scarcity is associated with prevalence of disease, hunger and poverty in developing countries (Ashton and Haasbroek, 2002). A huge number of people die each year from water-related disease and 98 percent of water-related deaths occur in the developing nations (DWAF, 2012). Thus, water scarcity represents a major challenge to economic development in South Africa (Le Maitre et al., 2002; Turpie et al., 2008) and in particular, the arid and semi-arid region such as Namaqualand.

In spite of the water scarcity in South Africa, a major factor militating against water availability is invasion by alien species (Le Maitre et al., 2000; Turpie et al., 2007). The invasive species negatively impact quantity of catchment run-offs and disrupt stream flow when close to water courses (Turpie et al., 2008). An estimated 10.1 million hectare or 6.8 percent of South Africa rangelands have been invaded by alien plants which are mainly woody shrubs or trees (Versfeld et al., 1998).

The total incremental water use of these invasive plants are estimated at 3 300 million m^3 yr^{-1}; an equivalent of 75 percent of the mean annual runoff (MAR) of Vaal River system (Le Maitre et al., 2000).

Invasive plants account for about 33 percent of total water in volume in Western Cape. Seventeen percent of total water use in KwaZulu-Natal is taken up by invasive plants, 17 percent in Eastern Cape and 14 percent of total water use in Mpumalanga (Le Maitre et al., 2000).

In view of this challenge, Government established a public agency in 1995 named Working for Water (WfW) with the proposed mandate of clearing invasive plants from the country's scarce water resources and in turn, generate jobs for economic empowerment (Turpie et al., 2008). Marais and Wannenburgh (2008) reported that clearing of invasive plants under WfW programme increases water yield per condensed hectare by 2250 m^3 ha^{-1} yr^{-1} for perennial and 750 m^3 ha^{-1} yr^{-1} for non-perennial catchments. Clearing of invasive plants in riparian areas led to increase of run-offs as much as twice in Mpumalanga and Limpopo uplands and more than three times in the Western Cape (Görgens and VanWilgen 2004).

The Working for Water programme adopted a Payment for Ecosystem Service (PES) scheme where users of water resources pay for the removal and control of invasive plants particularly around the catchment areas. A major indirect benefit of rangelands is the maintenance of watersheds (Anderson, 1993). However, alien plants absorb some of the water otherwise needed as base flows and catchment run-offs (Turpie et al., 2007). The value of water resources can therefore be assessed from the economic losses due to disruption or reduction of water flows by alien plants (Turpie et al., 2007).

2.3 Challenges of valuing non-marketed ecosystem services

Generally, the indirect use and non-use or passive use values of ecosystem services pose a more difficult task to scientists and sometimes, the outcomes are controversial. However, there is a growing consensus on the need to include other values components for better decision making on natural resource use. Most of the benefits derived from ecosystems under regulating, supporting and cultural services classifications (MA, 2005) could be described as having indirect use values or non-use values. In order to quantify those services which are not traded in the market or with no proxies, a stated preference approach was developed.

The Stated preference approach is a method commonly used in environmental valuation to elicit willingness to pay for improvement in environmental services or willingness to accept a compensation for damage to environmental services (FEE, 2002). The willingness to pay (WTP) and willingness to accept (WTA) are measures that can be revealed in exchanges (Dziegielewska, 2013). Most exchanges of goods and services take place within a structured market which only reveals the direct use values of such goods and services (Dziegielewska, 2013). However, for natural resources, economists have developed techniques to extend monetary measures to other non-marketed services of natural resources in recognition of the indirect and non-use values (option, bequest and existence values) derived from them (Tietenberg, 1992).

Dziegielewska (2013) reported that the total value of protecting 15 rivers in Colorado was R1 156 800 000 annually, only 20 percent of the value was related to the rivers' recreational (use) benefits and the other 80 percent to non-use benefits. This finding highlights the importance of including the non-use value component in the assessment of total economic values for natural resources. Albeit, the quantification of non-use values in monetary terms may be difficult and sometimes controversial, however some studies show that rural communities rank non-use values as more important than use values (Campbell et al., 1997).

2.3.1 Choice of valuation method to estimate values of ecosystem services

The choice of method used to value a given ecosystem service depends on the available data, budget, expertise and time available (FEE, 2002). Figure 2.6 shows classification of valuation methods commonly used to value ecosystem services. All valuation methods set out to determine willingness to pay (WTP) or willingness to accept (WTA) monetary values for changes in ecosystems services (FEE, 2002).

The maximum amount of money an individual is willing to pay to improve or preserve the quality of benefits derived from the ecosystems constitutes willingness to pay (WTP). Conversely, the minimum amount of money an individual will accept as damages or compensation for forgoing the benefits derived from ecosystems constitutes willingness to accept (WTA). Market prices are best adopted for valuation when markets are available for exchange of a particular ecosystem service.

Valuation of ecosystem services

Revealed preference approach | **Stated preference approach**

Direct proxy | **Indirect proxy** | **No proxy**

Direct proxy	Indirect proxy	No proxy
Productivity change	Travel cost	Contingent valuation
Replacement cost	Hedonic price	Choice modelling
Substitute cost	Residual value	
Opportunity cost		
Market price analysis		
Damage avoided cost		

Figure 2.5: Classification of ecosystem valuation methods (adapted from FEE, 2002).

There are broadly two approaches to estimating non-market values of ecosystem services; a revealed preference approach and stated preference approach. Under the revealed preference approach, monetary values of ecosystem services are derived from information on actual behaviour of consumers to pay for environmental attributes of the ecosystem where direct market exist. In cases where direct markets do not exist, the economic value of ecosystem services are valued from surrogate market which indirectly reveal the individual preference for the service. This approach is based on evaluating consumer's choice within the existing markets that are closely related to the ecosystem service to be valued (Pascual et al., 2010).

Conversely, the stated preference approach adopts a survey method and construction of hypothetical market to elicit willingness to pay for given ecosystem service where no proxy is available. The common valuation methods used for estimating ecosystem services are discussed in details in chapter four of this thesis.

2.4 Typology of ecosystem services

The Millennium Ecosystem Assessment reviewed global ecosystem services and categorised them into four classes, namely provisioning, regulating, cultural and supporting services (MA, 2005). The classifications, though comprehensive only provided a generalised idea of ecosystem processes as most of the services listed are basically ecosystem functions that leads to benefits or end products enjoyed by humans (Wallace, 2007). Figure 2.7 shows MA's classification of ecosystems services.

De Groot (1992) defines ecosystem functions as "the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly". The end point, at which human derive utility from consuming the goods and services provided by the natural resources should be termed ecosystem services (De Groot, 1992). This assertion was supported by Brown et al. (2006) that defines ecosystem services as flow of services from natural ecosystems that are relatively of immediate benefits to humans.

Ecosystem services

Provisioning	Regulating	Cultural	Supporting
Food	Erosion control	Recreation	Soil formation
Forest resources	Climate regulation	Aesthetics	Primary production
Natural medicines	Waste disposal and assimilation	Spiritual well being	Energy cycle
Water resources	Flood attenuation	Education	
Biological materials	Disease and pest Control	Ethical values	
Genetic resources	Water purification		

Figure 2.6: Typology of ecosystem services (adapted from MA, 2005; Layke, 2009).

Boyd and Banzhaf (2007) and Wallace (2007) reported that such broad classifications are not very useful from economic point of view, because several attributes are lumped together. Ecosystem products (such as food, fiber, or water), ecosystem functions or processes (such as nutrient cycling or habitat provision), and benefits (the economic value of service, such as flood control or aesthetic beauty) are lumped together the broad classication.

In response to Wallace (2007), Fisher and Turner (2008), argue that functions and/or processes are ecosystem services as long as there are human beneficiaries. They emphasize that simple linear relationships do not often exist in ecosystems and as such, same service can generate multiple benefits, and services are often a reflection of beneficiary’s perspective, and the point of interest is the point at which benefit is derived from the ecosystem.

Wallace (2007) stresses that the classification provided by Millennium Ecosystem Assessment (MA,2005) and by leading practitioners such as Costanza et al. (1997), De Groot et al. (2002) and Farber et al. (2006) mix processes (means) for obtaining services and the services themselves (ends) within the same category. The major problem inherent in such classification is the issue of double counting (Wallace, 2007; Fisher et al., 2007). Most of the ecosystem functions serve as intermediate input into the final benefits that are enjoyed by humans and their values are reflected or add up to the total values of benefits derived from the ecosystem (Wallace, 2007). Fisher et al. (2007) describe a scenario double counting could occur in decision making analysis of ecosystem services. Under MA (2005) classification, regulation of water flow is a regulating service, nutrient cycling is classified as supporting and recreation as cultural service. For example, if a decision maker proposes the conversion of wetland using cost-benefit analysis including the three services, error of double counting could be easily committed. This is due to the fact that water regulation and nutrient cycling (means) help to produce quality water (ends) which in most cases, is used for recreation for human benefit.

The valuation concept proposed by Wallace (2007), Boyd and Banzhaf (2007) and Fisher et al. (2007) is perfectly synonymous with net economic output valuation that disregards the value of intermediate goods which serves as input to production of final goods (Goulder and Kennedy, 1997).

For valuation purposes, (De Groot et al., 2002; Brown et al., 2006; National Research Council, 2005; Chan et al., 2006) emphasize that there is need for clear distinction between ecosystem functions and services, the distinction being that services require involvement of human beneficiaries. It is thus clear that the human well being is the focal point of ecosystem services.

The point at which services are delivered through interaction of various components of ecosystems should form the basis for economic valuation. In view of this, this research seeks to identify and quantify end points of main ecosystem services provided by Leleiefontein communal rangeland.

As pointed out by Fisher and Turner (2008), same ecological resource can generate multiple benefits, this is observed in rangeland resource as it generate multiple benefits of grazing, energy, pharmaceutical, construction and aesthetics to humans. The valuation concept, therefore adopted in this research is to measure the use values of each constituent natural resource using an appropriate valuation method and thereafter, aggregating the sum of the values. To avoid double counting, the non-use values were elicited for the whole ecosystems to arrive at the total economic value of Leliefontein communal rangeland of Namaqualand.

Chapter Three: Description of the study area

3.1 Historical background of Namaqualand

Namaqualand was reputed to be firstly inhabited by groups of people with domestic stock about 2000 year ago (Smith, 1999) before the advent of the European settlers in the 17th century (Rohde et al., 2003). These groups were made of two distinct but related tribes which are the Bushmen/San and the Khoikhoi/Namaqua. The Khoikhoi practised pastoral farming in Southern Africa moving constantly in search of favourable climate and quality pasture for their livestock. Conversely, the San did not exhibit any definitive pattern of movement. They were traditionally hunter-gatherers and lived in smaller groups in comparison to the Khoikhoi.

Namaqualand derives its name from the Nama-speaking Khoikhoi pastoralists who occupied the area and the Atlantic coastal region of Southern Africa over two millennia ago (Rohde et al., 2003). The livelihood of the Khoisan (a term loosely used for Khoi and San tribes) involves nomadic livelihood, hunting game and gathering wild fruits, hence, they roamed and cultivated the large expanse of Namaqualand. However, the advent and the subsequent settlement of the Dutch immigrants often led to conflicts between the indigenous people and the European settlers over land and natural resources.

The Europeans first settled and established a colony in the Cape in 1652 (Samuels, 2006). They began farming in 1659 to reduce their dependence on the Khoisan for food (Samuels, 2013). The establishment of farms by the Europeans became a contested issue as the indigenous population were gradually deprived of their land. In 1750, the first European farmers settled in the Namaqualand, continued their expansionist farming agenda and by 1771, Governor Plettenberg had to intervene in a farm dispute between a European farmer, Herman Engelbrecht and a Khoikhoi leader, Captain Wildschut. The European farmer was asked to vacate the farm because it belonged to the Khoikhoi leader (May et al., 2003).

In 1816, Captain Wildshut of the Namaqua approached Reverend Shaw of Wesleyan Missionary Society asking for the establishment of Mission stations in Leliefontein to act as a fortress against the Europeans settlers. In the late 18th century, the colonial government began to grant the rights to the Europeans settlers to own land and establish private farms (Boonzaier et al., 1996). This development further alienated the Khoisan from their ancestral lands. Due to the gradual dispossession of the Khoisan from their land, they began to move towards the mission stations to ensure they retain some parcel of lands (Samuels, 2013). Presently, Leliefontein is occupied by the descendents of the Namaqua, who have retained their historic user rights but the land is owned by the state.

3.2 Geographical location of the study area

Leliefontein Communal Area is located within Kamiesberg Local Municipality in the Namaqualand region of the Northern Cape Province in South Africa. The Communal Area occupies a total of 192 000 ha of land (Samuels, 2006) with total households of 1 680 across ten villages that make up the communal area.

Leliefontein Communal Area falls within the succulent karoo biome, a biodiversity hotspot of global significance. This study focuses on the 192,000 ha of the Leliefontein Communal Area which consist of ten villages namely; Paulshoek, Kharkams, Kamassies, Leliefontein, Kheis, Tweerivier, spoegrivier, Rooifontein, Klipfontein and Nourivier.

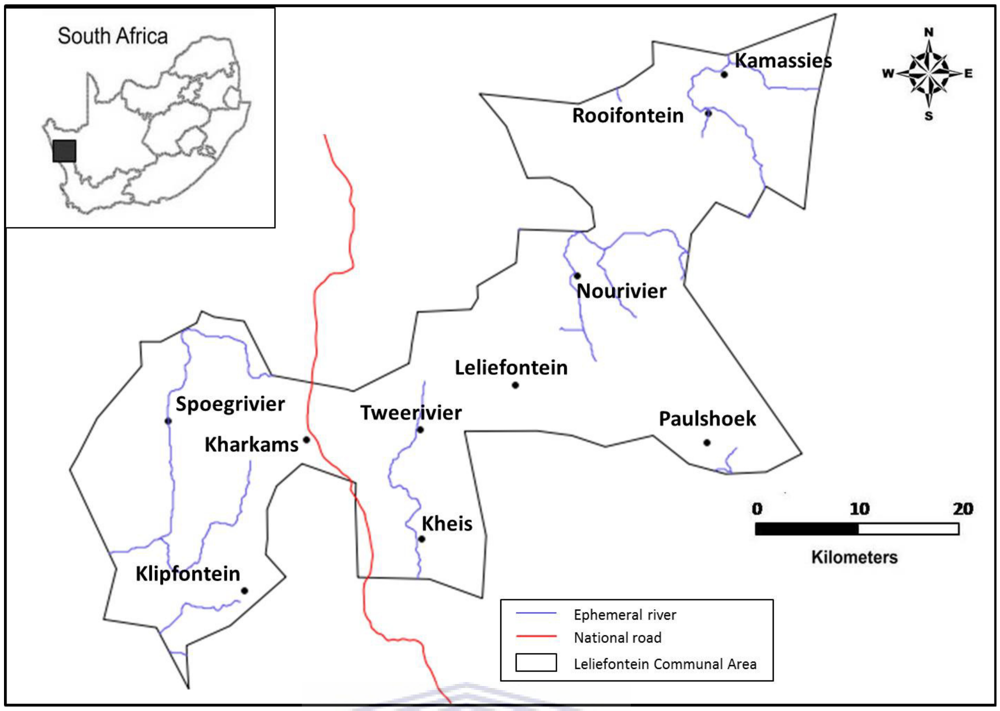

Figure 3.1: Map of Leliefontein Communal Area showing the ten villages (Rohde et al., 2003).

3.3 Biophysical description of the study area

3.3.1 Climate

Namaqualand is largely a winter rainfall semi-arid ecosystem (Mackellar et al., 2007) having most of its rain from May to September particularly in the western part of the region (Benjaminsen et al., 2006) while the east of the mountains experiences occasional summer rainfall (Kelso and Vogel, 2007; Mackellar et al., 2007).

The mean annual rainfall ranges from 50 mm in the North West to about 400 mm in the Kamiesberg region (Cowling et al., 1999). It is characterised by cold and wet winter, and dry and warm summer (Allsoppp et al., 2007) with a very predictable low annual rainfall (Hoffman and Cowling, 1987).

Desmet (1996) reported a moderate temperature occurring throughout the year, more especially, along the coast of Namaqualand. This phenomenon is largely due to the cold Benguela ocean current system that causes fog to occur frequently (Desmet and Cowling, 1999; Mackellar et al., 2007).

3.3.2 Vegetation

Namaqualand is home to about 3 500 plant species in 724 genera and 135 families, 25 percent of which are endemic to the region (Desmet, 2007; Desmet and Marsh, 2008). It also has a diverse fauna with high level of insect and reptile endemism (Desmet and Marsh, 2008). It is therefore the most biological diverse arid environment in the world (Cowling et al., 1999; Desmet, 2007).

With 6 356 plant species in 168 families and 1 002 genera (Driver et al., 2003) of 40 percent endemism (Cowling et al., 1999), the concentration of species in Succulent Karoo is about four times that of a similar winter rainfall arid environment elsewhere on earth (Cowling et al., 1998). More remarkably, succulent karoo supports highest number of succulent plants on earth comprising about 35 percent of the succulent flora population (Desmet, 2007).

Vegetation types in South Africa are categorised into nine biomes or eco-regions; Albany Thicket, Desert, Forest, Fynbos, Grassland, Nama-Karoo, Savanna, Succulent Karoo and Wetlands (Rouget et al., 2004). The Succulent Karoo biome which constitutes the larger part of Namaqualand covers less than 10 percent of South Africa but has a significantly high number of vegetation types. Sixty eight vegetation types had been identified in the Namaqualand region (Rouget et al., 2004).

Leliefontein Communal Area in Namaqualand straddles Kamiesberg Mountains with diverse vegetation types. Nine vegetation types have been identified in the Leliefontein Communal Area (Fig. 3.2) (Mucina and Rutherford, 2006). At an altitude of 200 m, west of the Kamiesberg is Namaqualand Heuweltjieveld which is dominated by Succulent shrubs of Aizoaceae family (Mucina and Rutherford, 2004). Klipkoppe Shrubland is found between an altitude of 300 and 800 m (Mucina and Rutherford, 2004). It contains shrubs and woody plants unlike Heuweltjieveld which is predominantly made up of leaf succulents.

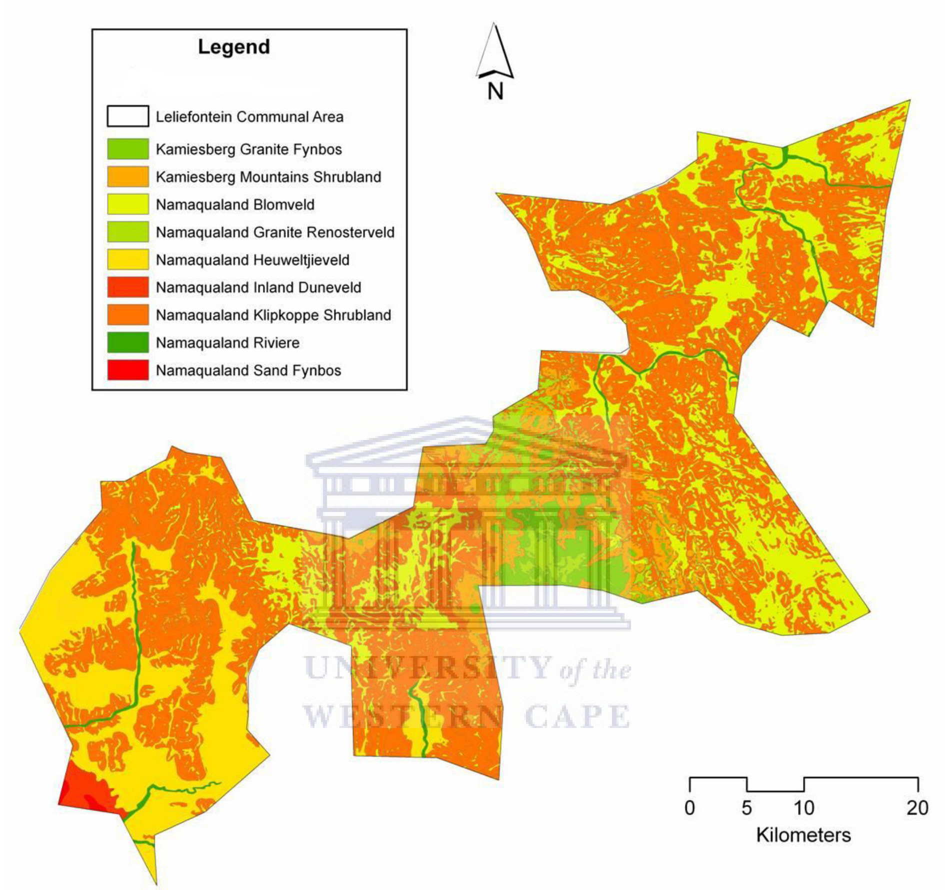

Figure 3.2: Distribution of the vegetation types of Leliefontein Communal Area (modified from Samuels, 2013).

Kamiesberg Mountain Shrubland is found on the western slopes of the Kamiesberg. Larger woody shrubs are predominant in this vegetation and lies at an altitude of 800 m and 1 300 m (Mucina and Rutherford, 2004). At an altitude of 1 500 m on the peak of the mountain is Namaqualand Granite Renosterveld which is characterised by *Elytropappus rhinocerotis* (Mucina and Rutherford, 2004). At the eastern slope of the mountain, 1000 m above sea level is another Klipkoppe Shrubland (Mucina and Rutherford, 2004). This vegetation type is the most abundant in the study area; it covers about 53 percent of the entire Leliefontein Communal Area (Mucina and Rutherford, 2006).

A distinctive feature of the study area (Leliefontein Communal Area) is that the west-east gradient follows a rainfall pattern; rainfall decreases eastward along the Kamiesberg (Desmet and cowling, 1999). Also, the eastern gradient of the Kamiesberg adjoin with Bushmanland arid grassland which denote a shift from Succulent Karoo's winter rainfall region to the summer rainfall of the Nama-Karoo biome (Anderson and Hoffman, 2007).

Table 3.1: Vegetation types in Leliefontein Communal Area and their relative percent covers of the study area (Samuels, 2013).

Vegetation types	**Relative size (percent) in the study**
Namaqualand Klipkoppe Shrubland	52.0
Namaqualand Blomveld	20.3
Namaqualand Heuweltjieveld	11.2
Namaqualand Granite Renosterveld	6.8
Kamiesberg Mountains Shrubland	6.0
Kamiesberg Granite Fynbos	1.8
Namaqualand Riviere	0.9
Namaqualand Inland Duneveld	0.6
Namaqualand Sand Fynbos	0.1

3.4 Socio-economic conditions of Namaqualand

Namaqualand is a sparsely populated region with an estimated population of 66 000 (Rohde et al., 2003). It has a population density of 1.32 people per km^2. The arid Northern Cape Province in which Namaqualand is situated has the lowest human population in South Africa (Statistics South Africa, 2012). With a remarkable 372 889 km^2 or 30.5 percent of landmass making it the biggest province in South Africa, it only houses an estimated 1 145 861 people or 2.2 percent of the entire population (Statistics South Africa, 2012). This phenomenon of sparse population density is consistent with most arid or desert regions of the world. Figure 3.3 shows the distribution of households across the ten villages in Leliefontein Communal Area. Livestock production remains the most extensive land use in Namaqualand; majority of the household owns livestock mainly small stocks (sheep and goats). Mining was a major source of income before some of the mines were closed down. This development led to emigration of the active population to other parts of South Africa where there are job opportunities while contributing to their household economies via remittances. Government welfare grants and remittances are major sources of income for many households in Namaqualand. Households owning livestock do keep their livestock for various objectives. Livestock are mainly kept as safety net and are considered mainly for sale as a last option during emergency, exchanged for other goods and sometimes for socio-cultural purposes.

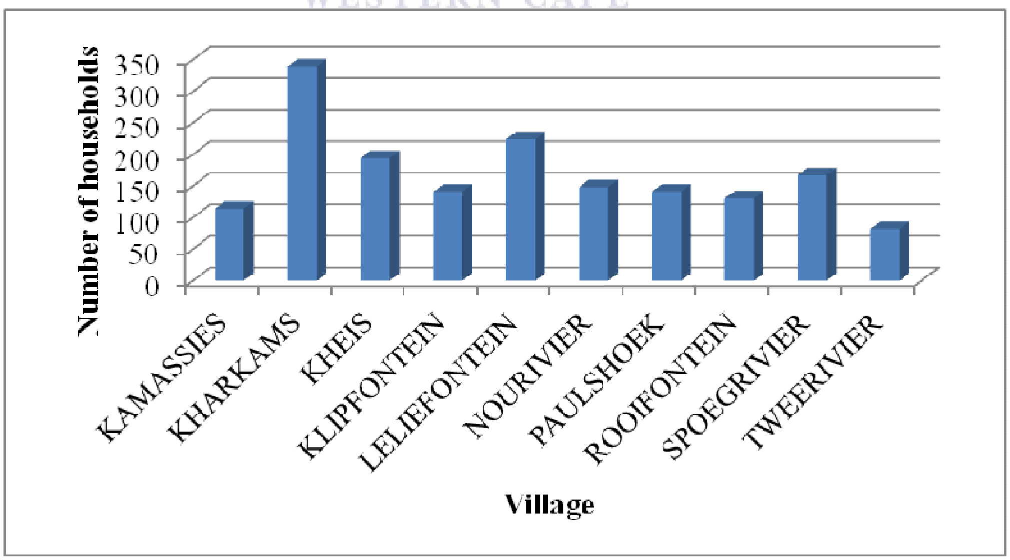

Figure 3.3: Distribution of households in Leliefontein Communal Area

(Kamiesberg Municipality, 2010).

3.5 Historical Land use and tenure regimes in Namaqualand

3.5.1 Pre colonial land use

Historical and archaeological evidence show that the earliest forms of land use amongst the first inhabitants of Namaqualand were hunting and herding (Webley, 2007). The San people who occupied the Namaqua region about two millennia ago were traditionally hunter-gatherers who depend on gathering wild fruits and hunting game animals for their subsistence. Their similar, but distinct group of Khoikhoi people who lived in fairly large groups were predominantly pastoralists who travelled extensively in search of water and forage to graze their livestock.

The San or Bushmen were groups of independent people who often lived in smaller units to facilitate their hunting and gathering activities. They also depended on their Khoikhoi counterpart for livestock and other livelihood activities. Historical records show that they were far more isolated group than the Khoikhoi thus having fewer encounters with the Europeans travellers.

Conversely, the Khoikhoi were living in larger group. They owned cattle and sheep and they move extensively in search of favourable pasture and water to graze their herds. In winter when forage is sparse, they split into smaller groups and spread across the grassy plains to graze their herds. They however converged and moved around water points and/or few perennial rivers during summers when grazing conditions are more favourable (Archer, 1994). They often exhibited systematic and organised transhumant movements across the rangelands to optimise seasonally rich pastures or in search of other wild resources at different seasons (Klein, 1986).

Evidence suggests they relied on multiple livelihood strategies for survival such as herding, trading, pottery, hunting and copper smelting (Klein, 1986; Sadr, 1998; Kelso, 2010). Although the Khoikhoi were culturally distinct from their San co-dwellers (Parkington 1984; Smith, 1990; Smith et al., 1991), they lived together harmoniously and had a mutual working relationship (Kelso, 2010). In most instances, the Khoihhoi provided protection for the San due to their military prowess in return for the San to herd their livestock. However, the relationship became competitive and turned violent during the 17^{th} and 18^{th} centuries due to limitation of land and natural resources. The relationship grew worse when the San resorted to stealing livestock from the Khoikhoi. This was occasioned by the advent of the European settlers to Namagualand in the 17^{th} century who had disposed the indigenous tribes of their lands.

3.5.2 Land use under colonial regime

In the early 17^{th} century, European travellers initially bartered with the Khoikhoi people; trading foods, tobacco, alcohol and other European merchandise for livestock from the native pastoralists. In 1652, the Europeans established their first permanent settlement by Dutch East India Company in Table Bay, Cape of Good Hope (Klein, 1986; Samuels, 2006). The company was established to meet the increasing demands for meat by ships passing through the Cape. Hence, the Dutch were actively trading with the native Khoikhoi for their livestock (Kelso, 2010). Trading was initially done at the Cape whereby the natives moved the stock to the travellers; however the Dutch travellers became dissatisfied with the quality and quantity of stock sold to them by the Khoikhoi. They decided to move inland to the native's region to visually inspect the stock and subsequently select better and healthier stock. This often times led to coercion or theft of the Khoikhoi's livestock by the Europeans (Kelso, 2010).

This unfair trade condition, together with the outbreak of smallpox epidemic introduced by the European voyagers in early 18^{th} century resulted in the drastic reduction of livestock numbers and the population of the Khoikhoi (Elphick, 1972a; 1972b). The traditional way of life and pastoral economy of the Khoikhoi were subsequently weakened by these two factors. Dutch settlers who had previously been visiting the Southern parts of Namaqualand for trade since the establishment of Cape colony however decided to establish permanent settlement in the Namaqua region when the loans farms were established around 1750 (Hoffman and Rohde, 2007).

The productive parts of the rangelands were allocated to the Europeans for grazing (Klein, 1986). Many of such lands in Kamiesberg area of Namaqualand were granted for stock farming between 1760 and 1780 by the Cape Colonial Government (Webley, 1992). This development resulted in the dispossession of the Khoikhoi of their lands, thus they sought help from the missionaries to retain some portions of their lands.

Under the colonial rule, mission stations provide some set of benefits to the local population such as granting them access to land, protection and acting as link between the local interest and the Cape Colonial Government (Kelso, 2010). The Khoikhoi migrated towards the mission station and developed small villages around it during the late 18th century (Samuels, 2006). This led to the establishment of Leliefontein reserve in 1816 by the missionaries to preserve access to land by the natives.

Communal land tenure system was introduced by the missionaries to allow access to land and grazing of their remaining stocks but at a lesser extent compared to their traditional nomadic system (Samuels, 2006). The colonial government officially recognised the tenure system by issuing the occupants ticket of occupation but fell short of recognising the ownership claims to the lands (May and Lahiff, 2007).

Land use until the 18th century remained predominantly livestock production. From about 1750 and two and a half centuries later, commercial livestock production and mining became the mainstay of the region with the larger and more productive portions of the lands allocated to the Europeans settlers (Hoffman and Rohde, 2007). Mining in Namaqua region intensified in the mid 19th century (Kelso, 2010). The mining exploration gradually replaced economic dependence on livestock production with some of the active population searching for job opportunities at the mines (May and Lahiff, 2007).

The Cape Colonial Government enacted Communal Reserves and Mission Stations Act in 1909 which ended the secular authority of the missionaries over the lands and the independence of the reserves (Samuels, 2006; May and Lahiff, 2007). The Act maintained the principle of communal tenure system in the reserves (May and Lahiff, 2007) but the authority over such lands were transferred to the government (Rohde et al., 1999). Shortly after in 1913, the colonial government enacted the Natives Land Act which racially divided South Africa into White and Non-White settlements.

In 1936, The Natives Trust and Land Act of 1936 was promulgated (Thompson, 1990). The Act legally reserved 13 percent of the territorial land to non-white population for occupation which essentially make up a staggering 87 percent of the population in 1994. The remaining 87 percent of South Africa territorial lands was reserved for the white’s ownership which make up just 13 percent of the country’s population (May and Lahiff, 2007).

3.5.3 Post colonial land use under Apartheid regime

After South Africa became a republic in 1962 under an apartheid rule, The Coloured Rural Areas Act of 1963 was promulgated. The Act among other things divided the communal lands of Namaqualand into six coloured reserves which are Leliefontein, Richtersveld, Concordia, Steinkopf, Komaggas and Pella. The rural areas were managed from 1963 under the Coloured Rural Areas Act of 1963 which empowered management boards to administer the allocation of occupation and use rights, collection of grazing fees and effective management of communal resources in the areas (Smit, 2005). The 1963 legislation also made provision for introduction of betterment schemes (a form of privatisation) whereby communal lands could be divided into ‘economic units’ and allocated to individual farmers for better productivity (Boonzaier, 1987).

In 1978, a betterment scheme to divide the communal lands of Namaqualand into economic units was initiated (Rohde et al., 1999). The implementation of the privatisation scheme during the 1980s was however protested by residents of the rural areas because majority were further dispossed of having access to the lands (Smit, 2005; Samuels, 2006; May and Lahiff, 2007). The scheme was challenged in court by the residents of Namaqualand. On 21 April, 1988, the Supreme Court in Cape Town ruled in favour of the complainants and ordered return to the communal land tenure system existing before the implementation of the privatisation scheme (Smit, 2005; Samuels, 2006; May and Lahiff, 2007).

3.5.4 Land use and land reforms under democratic regime

The democratisation of South Africa in 1994 ushered in a new set of land policies which aims to redress the injustices of the colonial and apartheid land policies. Before 1994 land reform programme of the democratic government, 2 726 322 ha or about 52 percent of the Namaqualand agricultural lands were owned by only 385 commercial white farmers while the previously disadvantaged non-white population of more than 1 650 households occupied (not owned) an estimated 1 188 670 ha or 23 percent of the land. Mining accounted for about 8 percent of the land use and land designated for conservation was 3.8 percent of the total land mass in the region (May and Lahiff, 2007).

The new democratic government abolished the Rural Area Act promulgated in 1979 and instead, introduced a land reform programme which was aimed to address three fundamental principles

1). Restitution, which provides compensation or restoration of claims from disposed land under the apartheid regime

2). Redistribution including transfer of lands from white commercial farmers to the previously disadvantaged groups under a market-driven incentives and

3). Land tenure reforms to secure access to lands and consolidate the tenure rights of lands held in the reserves

However, the implementations of these reforms had faced many challenges and disappointingly slow. Hall (2004) reported that less than 4 percent of the white commercial farmland was transferred to the previously disadvantaged people (non-white) in the first ten years of democracy. By 2007, about 5 percent or 4 million hectare of lands had been transferred to historically disadvantaged population under the reform programmes (Lahiff, 2008).

Under the state new land reform programme, The Transformation of Certain Rural Areas Act, Act 94 of 1998 (TRANCRAA) was promulgated to reform communal land tenure in South Africa. This Act aims to transfer land ownership in the 23 coloured rural areas across the country to local institutions as determined by residents of such areas (Wisbrog and Rohde, 2003). Three entities were proposed for ownership of land under this act

1). Municipalities

2). Communal Property Association (in terms of the CPA Act, Act 28 of 1996) or

3). Individuals approved by the minister

The transitional phase of the legislation was undertaken in Namaqualand rural areas between 2001 and 2003 and referendums on choice of ownership of land were held in five of the six rural areas. The poll results showed that the majority of the respondents across Namaqualand (58 percent) favoured land ownership under Communal Property Association (CPA) while 39 percent voted in favour of municipal ownership. Two percent of the votes were regarded as spoilt with just 1 percent opting for individual ownership of the commons (Wisbrog and Rohde, 2003). The idea of individual ownership was roundly rejected because residents considered it socially unacceptable and economically disadvantageous to the less privileged. It was viewed as similar to the privatisation scheme which was earlier challenged in law court.

There was an exception to the poll result in Leliefontein Communal Area. The majority of the residents (59 percent) voted in favour of municipal land ownership. The communal land is held by Kamiesberg Municipality while the remaining rural areas are in custody of the Communal Property Associations. The final decision for the transfer of ownership under TRANCRAA however lies with the Minister of Agriculture and Land Affairs.

Chapter Four: Valuation methods and statistical analysis

4.1 Overview of valuation methods for ecosystem services

Several valuation methods have been developed over the past years to measure welfare benefits and estimate economic values of earth's ecosystem services (Hufschmidt et al., 1983; Freeman, 1993; Dixon et al., 1994; Pascual et al., 2010). Recently, there had been a growing increase in the use of economic valuation methods to assess the impacts of environmental projects in other developed economies, transitional economies as well as in developing countries (Rietbergen-McCracken and Abaza, 2013).

The concept of economic values for ecosystem or environmental services is based on economic theory of utilitarianism; a study of neoclassical welfare economics (Dziegielewska, 2013). Human preferences for goods and services can be measured by the utility derived from such goods and services which are often expressed in monetary terms. The underlying principle of all methods of economic valuation of ecosystem services as is the case in private market goods is to measure welfare changes which are reflected by people's willingness to pay or willingness to accept compensation for changes in level of consuming ecosystem services (Alcamo and Bennett, 2003).

The choice of economic method to use depend primarily on the nature of the ecosystem service to be valued, information available, time, budget and expertise available (FEE, 2002). For instance, if the ecosystem service to be valued is directly traded in the market, the market price reveal consumers' preferences for such goods and that can be taken as an estimate of economic value of the resource. When ecosystem service is not directly traded, price information could be derived from a surrogate market with direct relationship to the ecosystem service. In cases where market or surrogate is not available for services, then a hypothetical market is constructed to elicit consumers' behaviours for such ecosystem services.

Box 1 gives a summary of the valuation methods commonly used to estimate values of ecosystem services. The methods used in this study; production function analysis, market price analysis, substitute cost method and contingent valuation method are discussed in this chapter.

Box 1: Summary of valuation methods for ecosystem services

Market price analysis: It is used to estimate the economic value of ecosystem services that are traded in market. Market price analysis is mainly applicable for valuation of provisioning services (tangible goods such as fuelwood) derived from natural ecosystem.

Substitute cost method: The method is used to estimate the value of non-marketed ecosystem services from the exchange value or market price of its substitute good.

Replacement cost method: The method is applicable when a man-made environmental project is needed to replace the services provided by natural ecosystem. The cost of such project represents the economic value of the replaced ecosystem service.

Damage cost avoided: It estimates the value of ecosystem service based on the cost incurred to avoid or prevent damages to the ecosystems.

Production function Analysis: It derives the economic value of an ecosystem service from its contribution to marketed economic outputs. It is based on input-output relationship in the production process of economic activities.

Travel cost method: It estimates the economic value derived from environmental attributes of a natural landscape. The amounts of money people are willing to pay to travel to such landscape for a change in their welfare reflect the economic value of such landscape. The method is mainly applicable to estimate the cultural services (recreational benefits) of natural ecosystem.

Hedonic price method: It measures the economic value of an ecosystem service from their direct effect on market price or exchange values on other assets such as land and property. For instance, presence of environmental attributes such as clean air, trees, scenic and aesthetic landscape, mountains or ocean view will reflect on the market price of surrounding lands and property.

Contingent valuation method: The method can be used to estimate economic value of almost any form of ecosystem service. It is the most widely used method to estimate non-use value of ecosystem service. It adopts a hypothetical scenario to elicit people's preferences for environmental improvement by stating their willingness to pay or willingness to accept compensation for change in welfare from the use of ecosystem services.

4.2 Production function analysis

In neoclassical economic framework, production function relates physical inputs or factors of production in a production process to the physical goods or outputs. Production function analysis is thus based on estimating the economic value of an ecosystem service used in the production of marketable economic output (Chee, 2004).

Under practical application of the economic method to valuing ecosystem services, environmental attributes or natural resources (such as soil fertility, water resources or rangelands) are considered as primary inputs for production of marketed outputs (for example crop yields, fish catches or livestock products).

The effect of change in the environmental attributes or natural resources on production process reflects the contribution of ecosystem services to economic activities. For instance, rainforests provide watershed protection service. The economic benefit of the rainforest in terms of watershed protection can be measured by the treatment (purification and filtration) cost avoided for improving municipal water quality obtained from the watershed catchments.

Production function analysis is fairly a straightforward method because it adopts the scientific knowledge of cause-effect relationship between ecosystem services to be valued and the output levels of the marketed products (Chee, 2004).

The production function can be expressed in its simple form as:

$Q = f\ (E, V_{1......}V_n)$

Where Q represents the quantity of the physical marketable output

E is the ecosystem product (Input)

f is the function relating input to output and

$V_{1......}V_n$ represent other input variables.

Taking natural resource as the primary factor of production, changes in the quantity of the resource will lead to changes in the production cost, and other factor inputs. This will invariably lead to changes in the quantity of physical output. However, assuming there is no other costs incurred or no change in the market price of the output is induced by change in the price of the resource (input), then the change in quantity of output Q which is due to change in resource E could be expressed as $\delta Q/\delta E$.

The valuation of the change in the price of the physical output Q could be approximated as the change in unit quantity of the resource E.

Production function analysis generally consists of two-step procedure (Barbier, 2000). The first step involves the determination of effects of changes in a natural resource or the environmental attributes on an economic activity. In second step, the effect of changes in the environmental attributes is valued according to the corresponding change in the marketed output. Box 2 presents a case study where production function analysis was applied to value ecosystem services.

Box 2: Valuation of wetland ecosystem service using production function analysis

Case study: Hadejia-Nguru wetlands in Northern Nigeria are important sources of water supply for agricultural production during the dry season of the year. Floodwaters from the region's main rivers (Hadejia and Jama'are) constitute the Hadejia-Nguru wetlands.

The rivers exhibit a seasonal flow patterns; flowing only during the rainy/wet season. About 80 percent of annual runoffs occur during August/September of rainy/wet season. Waterlogged areas are formed during this season thus constituting important source of fishing and other agricultural production as well as recharging the underground water resources of the region. There are schemes in the area which are designed to divert floodwater from the wetlands and channelled into irrigation farming during the dry season. The aim of the study therefore was partly to value water recharge function of the wetland as an input in the production of irrigated dry season agricultural outputs using production function analysis.

Result: The area (Madachi fadama) within the wetlands where irrigation with the use of groundwater resources take place was estimated around 6 600 hectare. Data on agricultural production was derived from field surveys conducted in the study area between November 1995 and march 1996. Major irrigated crops grown in the area are Tomatoes, Wheat, Rice and Onions with a predominantly subsistence agricultural practice.

The value of irrigation-dependent agriculture within the study area (6 600 ha) was 36 308 Naira or approximately R2 870.35 ha^{-1}. The economic value of irrigated agricultural outputs from the study area as a result of groundwater recharge function of the wetlands was estimated at 239 630 776 Naira or R18 925 385.15

Acharya and Barbier, 2000

4.3 Market price analysis

Market price analysis is often used to measure the economic values of ecosystem services that are directly traded or tradable in a market. When market exist for a particular ecosystem service, the exchange value of such service is reflected in the price people are willing to pay to buy the service or willing to accept for selling the service. That is, the market price represents the value individuals attach to the good or service.

This method is based on the principle of demand and supply of economic goods. Demand for natural resources is influenced by consumers' income, price of the resource (where market exists), price of related goods or services, and individual's preferences (Ulibarri and Wellman, 1997). Market price analysis measures the economic benefits derived from marketed good or service based on quantity consumers buy at different prices and quantity producers are willing to supply at different prices.

Consider, for instance, the maximum amount a consumer is willing to pay for first ten units of good Q is R20. As a result of decreasing utility, the consumer is willing to pay R15 for the next 10 units and R10 for the third 10 units. The total willingness to pay for the 30 units of good Q will be (R20 x 10) + (R15 x 10) + (R10 x 10) = R450. However, if market price for each unit of good Q is R10, the total price of 30 units will be R10 x 30 = R300. The consumer surplus could be calculated as maximum willingness to pay less the market price. In this instance, consumer surplus is R450 – R300 = R150.

Consumer surplus denotes the net economic benefit to the consumer in terms of differences in what the consumer is willing to pay and what is actually paid. That is, the consumer is well off by the amount saved. Graphically, the area above the market price and under the line in a demand curve represents the consumer surplus (see figure 4.1).

Similarly in the course of production, producers derive benefit from economic goods if the total revenue accrued is greater than the total variable cost of producing it. The difference between the total revenue received by the producer and the total cost incurred is termed producer surplus.

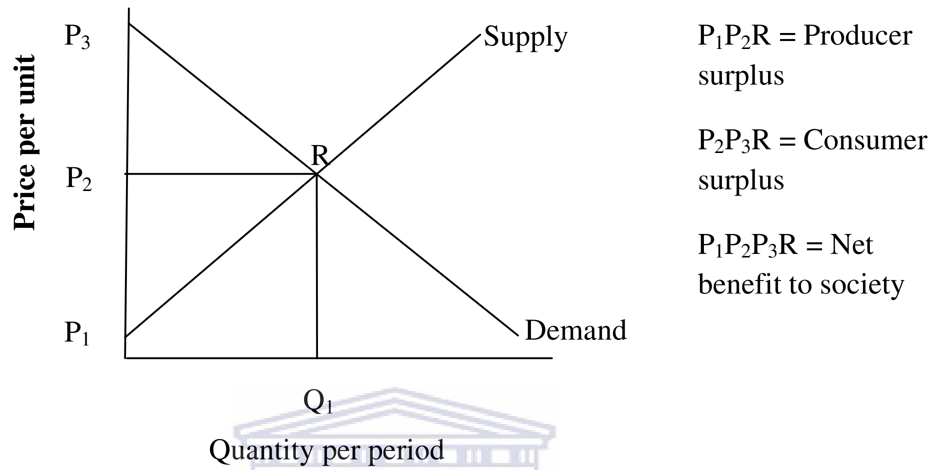

Figure 4.1: Consumer surplus, producer surplus and net economic benefit.

The aggregation of producer and consumer surplus represents the net benefit of any economic activity to the society (see figure 4.1). Thus, market price analysis of natural resources sets out to estimate the economic benefits of ecological or environmental service using the price and quantity data obtainable from sales of such goods or services. Box 3 presents a case study where market price analysis was applied in the valuation of ecosystem services.

Box 3: Estimating the use value of non-timber forest products from tropical deciduous forests of India.

The focus on benefits from forests has primarily been centred on economic values of timber products. Forest timber's production is adequately documented and their values reflected in national economy. Non timber products such as fuelwood, fodder and other resources however, receive little or no attention. Their economic values are often underestimated or outrightly ignored. Collection and use of most of the non timber forest products are done at subsistence level, thus they contribute significantly to rural livelihoods.

The study aimed to measure the economic values of non-timber forest products from the tropical deciduous forests of India in order to assist in decision making regarding land use change.

Different valuation methods were used to estimate use values of various goods and services obtained from forest resources. Based on the estimates, the total annual flow values of non-timber resources were in the range of Rs 6 594 or R718.75 and Rs 10 712.5 or R1 167.39 ha^{-1}. Using market price method, the value of fodder from the forest ranged between R73.25 and R117.65 ha-^{1} yr^{-1}.

Chopra, 1993.

4.4 Substitute cost method

This valuation approach is based on the principle that the values of non-marketed natural resources could be derived from the value or cost of the next best alternative marketed products. In this method, ecosystem products are considered as perfect or close substitutes to marketed inputs in the production process or to final outputs of an economic activity depending on the stage of production at which valuation is needed.

An increase in demand for a specific natural resource having similar function with a marketed good will invariably lowers the demand for such good and vice versa.

In this case, the resource and the marketed good are regarded as substitutes and consumers can replace the consumption or use of one with another. It is thus assumed that the market price of the marketed substitute reflect at least, the use value of the non-marketed resource. Box 4 presents a case study where substitute cost method was applied to value ecosystem service of medicinal plants.

The measure of economic benefit from using the ecosystem service is represented as the money saved by using the natural resource rather than consuming or using the marketed substitute good. However, factors such as consumer's taste and preference may influence the substitutability of the resources. For example, a consumer may prefer a conventional drug to medicinal plant even though they are similarly potent for curing a specific illness. Thus the marginal rate of substitution of the goods or services compared had to be determined when using substitute cost method for ecosystem valuation.

Box 4: Values of medicinal plants in Paulshoek village of Namaqualand

The use of medicinal plants to treat illnesses is a common practise among the residents of Paulshoek village in Namaqualand. About 97 households or 560 individuals making up 97 percent of the village population make use of medicinal plants on regular basis. The plants are freely collected from the village rangelands and are mainly self-administered as majority of the households tend to have a basic knowledge of medicinal plant use.

As medicinal plant is a non-marketed resource, its economic value and benefit to the society could be derived from the cost of its substitute goods. Conventional pharmaceutical medicine is assumed to be a perfect substitute for medicinal plants. In Paulshoek village, fifteen medicinal plants were identified as commonly used. Nine of the fifteen plants could be replaced with non-prescription medicine which could be obtained over the counter. Three plants could be replaced by prescribed medicines which require a visit to mobile clinic operating every two weeks. The remaining three medicinal plants were not analyzed because there were no known substitutes.

The economic values derived from using medicinal plants in term of its substitutes was estimated as R1.09 ha^{-1} yr^{-1} and a total gross value of R21 369.60 yr^{-1}. By using medicinal plants, the annual economic benefit to society was estimated as R222.60 per household; an amount saved by households from utilizing the ecosystem service of medicinal plant resources.

James et al., 2005

4.5 Contingent valuation method (CVM)

4.5.1 Background to contingent valuation method

Contingent valuation is a survey-based method used to elicit willingness to pay (in case of improvements) or willing to accept (in case of damages) a stated amount of money for specified ecosystem services under a hypothetic market scenario (Hanemann, 1994; Portney, 1994; Alberini and Cooper, 2000; Carson, 2000). Contingent valuation remains the only method which can be used to estimate the non-use or the passive use values components of ecosystem services particularly when the services to be valued is outside available market data (Alberini and Cooper, 2000).

Contingent valuation was first proposed by Ciriacy-wantrup (1947) when he observed the incremental benefits generated by preventing soil erosion. He noted the extra non-marketed benefits were public goods in nature and hence, suggested the best way to determine the benefits and demand for such public goods is to elicit individual willingness to pay for the goods. However, his idea was not implemented directly and never formed part of academic discussion until two decades later before the method was first applied in academic research (Portney, 1994). Davis (1963) carried out the first empirical contingent valuation study when he attempted to estimate the value of a recreational area to hunters and wilderness lovers.

Contingent valuation method as a valuation tool gained prominence and became popular in the 1960s after non-use or passive use values were regarded as important value components of natural resources (Ninan, 2008). Krutilla (1967) identified what is known as existence value of natural resources or environmental attributes in his seminal paper "conservation reconsidered". He defined existence value as value individuals attach to species, natural environmental attributes or other commodities due to the knowledge of their mere existence even without making direct use of such commodities. Since then, contingent valuation has been used to estimate various environmental attributes.

Contingent valuation had been used in more than 1 600 studies relating to environmental issues (Gregory, 1999). It has also been used severally for valuation of non-environmental studies (Ninan, 2008). The method is applicable to value ecosystem services in practically any context (Pearce et al., 1989). Contingent valuation method is effective and reliable when used alone or combined with other valuation methods to estimate the total economic value of environmental or natural resources (Alberini and Cooper, 2000).

4.5.2 Willingness to pay (WTP) and willingness to accept (WTA) as a measure of contingent valuation method

Contingent valuation is designed to elicit willingness to pay for environmental improvements or willingness to accept compensation for damages to environmental quality as a measure of value individuals place on such environmental attributes.

In a market structure, the amount of money an individual is willing to pay for a commodity reflects his or her lower bound of the maximum willingness to pay. That is, people will only be willing to pay for commodities if there is increase in their utilities or at least, their utilities do not reduce beyond the original point (level of utility before buying the commodity). Conversely, the amount of money individual will accept as compensation for damages reflect the upper bounds of the minimum willingness to accept for such commodity. In the case of environmental damages, the individual utility will fall below the original level hence; he or she will only accept a stated amount to return him or her to the original level of utility before the damages.

In practical situations, the willingness to pay (WTP) and willingness to accept (WTA) a stated amount of money for ecosystem services should be closely the same. For instance, if an individual's stated willingness to pay for an improved water quality is R100, his or her willingness to accept compensation for the reduction in the water quality should be significantly close or equal R100. The differences between the compensating surplus of willingness to pay and the equivalent surplus of willingness to accept are hardly significant in ideal practical situations (Randall and Stoll, 1980).

Hanemann (1991) however, reported contrary result to the theoretical proposition that willingness to pay and willingness to accept show negligible differences. Empirical studies conducted using contingent valuation method to elicit willingness to pay (WTP) and willingness to accept (WTA) for a particular environmental attribute always show large differences between such values (Knetsch and Sinden, 1984; Hanemann, 1991). Knetsch and Sinden (1984) attribute such irrational behaviours where people are more averse to loss than the equivalent gain could be explained by a psychological theory termed "loss aversion". Several contingent valuation studies have shown willingness to accept (WTA) is always higher than willingness to pay (WTP) when both measures are used to estimate same environmental change (Willig, 1976; Knestch and Sinden, 1984; Coursey et al., 1987; Hanemman, 1991).

Willig (1976) argues that the observed differences between willingness to accept (WTA) and willingness to pay (WTP) could be attributed to income effect. In economic theory, Income effect refers to the change in individual's income and how such changes affect demand for quantity of specific commodity purchased (Venkatachalam, 2004). This explains why willingness to accept is usually higher because it is not constrained by income while willingness to pay is largely constrained by income an individual could spend for additional utility.

Hanemann (1991) further posits that the differences between these measures are not due to income effect only but also substitution effect. He argues that substitution effect has greater effect on divergence between WTP and WTA than income effect. If an environmental attribute has a perfect marketed good substitute, then WTP should be equal or close to WTA. Conversely, if there is no substitute for such environmental attribute, the disparity between WTA and WTP will be infinite (Braden and Kolstad, 1991).

Other factors which could be attributed to the wide disparity between WTA and WTP are psychological effect of "prospect theory" developed by Kahneman and Tversky (1979) in their modification of the expected utility theory (Coursey et al., 1987). This could be explained by the loss aversion whereby an individual considers loss of a commodity far greater than the benefits derived from buying same commodity. Endowment effect, which could be related to prospect effect, also explains the wide disparity between WTA and WTP (Thaler, 1980).

Thaler (1980) found that participants in a survey were more willing to accept a higher amount as a compensation when exposed to a deadly disease (probability of contracting the disease is 0.001) than they are willing to pay for a cure of same disease. The differences in the response to WTA and WTP in the survey were in the order of a magnitude or more with responses ranging from R156 to R7800.

Kahneman et al. (1990) reported in an experiment with market goods (coffee mug and ballpoint pen), participant expressed median selling prices twice as high as the median buying prices for items they own. This shows that people attach greater value to item by simply owning them (endowment) and are loss averse. Horowitz and McConnell (2002) further posited that the ratio of disparity between WTA and WTA is higher for non-market goods than ordinary market goods.

The susceptibility of WTA to various effects has made it a less favourable measure of estimating values in contingent valuation surveys. In view of this, WTP is considered more suitable as a measure of value in contingent valuation studies. The mathematical equation underlining willingness to pay (WTP) could be expressed thus:

An individual will prefer and consume a good or service (x) if his utility (u) increases with the consumption of such goods (x).

$$U=u(x)$$

1. The amount of the goods consumed depends on the price of the goods (*Px*) and the individual's income (*Y*).

   Therefore utility can be expressed as:

   $$U=u\ (Px,\ Y)$$

2. Adding an ecosystem goods (*E*), we have:

   $$U=u\ (Px,\ E,\ Y)$$

3. If there is an ecosystem good E^0, by paying *A*, we could get $E^0<E^1$

   $$U=u\ (Px,\ E,\ Y\text{-}A).$$

4. To elicit the amount (*A*) an individual will be willing to pay for obtaining E^1, then:

   $$A= u\ (Px\ E,^{0}\ Y)\leq u\ (Px,E^{1},Y\text{-}A)$$

4.5.3 Design, biases and guidelines for contingent valuation method

One of the criticisms of contingent valuation survey stems from its design (Bate, 1994; Harvard Law Review Association, 1992). Due to the hypothetical nature of the contingent valuation survey, opponents of the method have argued that the method does not reflect the actual preferences of the respondents for the environmental attributes to be valued and the biases associated with the survey makes it untenable in a legal dispute or to elicit the true non-use economic value of natural resources (Harvard Law Review Association, 1992; Hausman, 1993).

Albeit there is no standard format for contingent valuation surveys (Portney, 1994), nonetheless, as with every scientific research, details always do count (Hanemann, 1994). The implementation of contingent valuation survey should adhere strictly to a set of well defined elements from outlining of the objectives of the study to the structure of the questionnaires, wording of the questions, sampling techniques, elicitation formats and to the data analysis.

Critics of contingent valuation method have based their arguments on vague or somewhat confusing manner in which respondents are asked hypothetical questions to elicit their preferences. In a paper titled "ask a silly question..." (Harvard Law Review Association, 1992), it argues that contingent valuation is speculative in nature and respondents are simply stating imaginary numbers or exhibiting an embedding effect when they are confronted with assigning values to changes in natural resources in which they are not familiar to trading in a market.

The validity and reliability of contingent valuation surveys have been questioned in various literatures (Harvard Law Review Association, 1992; Kahneman and Knetsch, 1992; Hausman, 1993; Bate, 1994; Diamond and Hausman, 1994). However, critical reviews of contingent valuation studies indicate the main issues confronting the method are due to poor development and implementation of the survey. It nonetheless remains a reliable method for eliciting and estimating economic values of natural resources if properly designed and conducted (Cummings et al., 1986; Arrow et al., 1993; Hanemann, 1994; Portney, 1994; Carson et al., 2001)

The use of Contingent valuation became pronounced in 1986 when it was adopted by the United States Department of Interior (DOI) as a tool for measuring and assessing damages to natural resources (Harvard Law Review Association, 1992). Hcwever, in 1989, the litigation over Exxon-Valdez oil spill in Alaska, U.S.A marked a major turnaround in the use of contingent valuation to estimating damages to natural resources (Portney, 1994).

Due to concerns raised over the accuracy of contingent valuation method to reliably estimate damages to natural resources, The National Oceanic and Atmospheric Administration (NOAA), United States submitted a report to determine the feasibility of using the method for natural resource damage assessment (Arrow et al., 1993). The report, co-chaired by two Nobel laureates Kenneth Arrow and Robert Solow was commissioned to provide answer to the question **"**is the contingent valuation method capable of providing estimates of lost non-use or existence values that are reliable enough to be used in natural resource damage assessments?" (Portney, 1994).

In awareness of the susceptibility of contingent valuation to various errors and biases, the report authors recommended guidelines for conducting a credible contingent valuation studies (Arrow et al., 1993; Venkatachalam, 2004). Arrow et al. (1993) concludes that "....CV (Contingent Valuation) studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use (non-use) values."

The NOAA report authors (Arrow et al., 1993) developed guidelines to be followed to produce a valid and reliable Contingent Valuation studies. Cummings et al. (1986) and Bateman and Turner (1993) also developed guidelines for successful implementation of contingent valuation surveys (Venkatachalam, 2004). The major guidelines recommended in the NOAA report will be discussed in this chapter. The guidelines deal with the format for eliciting response, structure of the questionnaire, population sampling method and other issues relevant for making contingent valuation survey a credible method for estimating economic values of natural resources. Below are the recommended guidelines for conducting contingent valuation surveys.

Clear and precise description of the scenario

The objectives of the proposed study should be clearly defined to the respondents. Critics of contingent valuation argue the objectives are too vague and broad leaving respondents confused on what to actually value. Albeit hypothetical in nature, the scenario should be presented in form of actual market transaction and the respondent should be reminded that spending for such policy will affect his or her spending on other commodities.

Values elicitation format

The success of a contingent valuation studies largely depend on how values are being elicited from the respondent. Willingness to pay (WTP) should be used to elicit values instead of asking respondent their willingness to accept compensation for damages to natural resources. The former reflects conservative estimates of the resources measured while the latter clearly overstates values of such resources.

Open-ended or continuous valuation questions are described as posing a difficult situation for the respondents whereby they have to assign monetary values to commodity that is not traded in market transactions. The open-ended approach could also introduce a strategic bias; respondent simply states values which are higher or lower than his or her real WTP/WTA to influence the outcome of the survey. However, Kristrom (1993) found that there is no disparity between the mean and median of open-ended valuation question and close-ended questions.

Sampling and sample size

Probability sampling is most appropriate for contingent valuation surveys used for damage assessment. The determination of sample size and specific design is quite arduous for contingent valuation survey. For a single dichotomous question of the yes-no format, a sample size of 1 000 is considered appropriate. NOAA report suggests sample sizes will vary according to the elicitation format used, the panel therefore recommended the service of professional statistician for a survey intended for policy-making or legal purposes.

Minimizing non-responses

High rates on non-responses will render the result of contingent valuation survey unreliable. The wording of the valuation question should be carefully crafted and simplified to ensure the respondents understand what they are asked to value. Wrongly crafted wordings increase the possibility of higher protest votes or zero votes.

Interviewing method

Arrow et al. (1993) recommended face-to-face interview as the most preferable method of interview for contingent valuation surveys. Face-to-face interview offers respondents and interviewer a relaxed atmosphere for conducting the survey and graphic supplements could be used. The response rate is high in face-to-face interview as compared with mail survey.

It also provides opportunity for the interviewer and respondents to share perspectives on other natural resources and environmental issues which could not be captured by mail survey or telephone interview. However, it remains the most expensive method of conducting interview. Arrow et al. (1993) noted that telephone interview can be a third and a half less than the cost of conventional face-to-face interview.

A critical component in the design of contingent valuation study is the payment vehicle used to elicit values for natural resources. A pilot study is necessary to determine the most appropriate payment vehicle for the conduct of the survey. The analysis of the pilot study will give a clear indication which payment vehicle the respondents are more familiar with and most suitable for such survey. Examples of payment vehicles include contribution of funds to protect endangered species or habitat (existence value), taxation for waste pollution, charges for water use or grazing right, fees for national parks or reserves.

It is clear from literature contingent valuation remains a controversial method for estimating non-use values for ecosystem services. However, it can produce a valid and reliable result if the surveys are properly implemented to minimize or eliminate the inherent bias associated with the method.

More so, it is the only method that can estimate the non-use value component of ecosystem services. This is of particular interest as most of the livelihoods strategies in rural communities are based on the use of natural resources and most of the transactions are not captured in a direct market structure.

4.6 Data collection and statistical analysis

Interviews were conducted based on household as a consumption unit (Hunt, 1991). Respondents were interviewed using structured and semi structured questionnaire (Bernard, 1994; Britten, 1995; Martin, 1995) to obtain information on their pattern of natural resource use within the commons. One hundred respondents were selected from three villages in Leliefontein Communal Area namely Leliefontein, Kharkam and Spoegrivier. Ethics clearance to conduct the interview was approved by the university ethics committee and a consent form detailing the purpose, nature and structure of the interview was signed by each respondent.

The questionnaire was subdivided into various sections on natural resource use within the Communal Area. Interviews were conducted on a face-to-face basis to minimise non response (Arrow et al. 1993) and facilitate a more quality and robust response (Britten, 1995). Respondents were earlier communicated to seeking the most convenient time to conduct the interview.

Respondents were visited in their homes or at the kraal early in the morning or late in the evening depending on their preferred time for the survey. Each interview took approximately 45 minutes however, respondents were allowed time to discuss on other issues they considered important to use and governance of natural resources in their communities.

The format adopted for contingent valuation survey was open-ended or continuous valuation question. Open-ended valuation question was chosen due to the length of the interview, low level of literacy among the residents and the perceived mistrust between the residents and their local government.

The use of dichotomous or close ended valuation question whereby respondents are asked to either accept or leave a stated number followed up with a lower or higher bidding raises the fear among the respondents that the local government actually intended they pay for the ecosystem services.

The bidding game associated with dichotomous valuation question further poses a challenge to the interview process as it is time consuming; bidding could extend for hours before particular amount is agreed upon. Respondents were rather informed that the valuation survey was merely for academic purposes and they were free to state values that truly reflect their preferences for the natural resources bearing in mind their budget constraint (here, the existence value of the communal rangeland was to be estimated).

The payment vehicle adopted was in form of contribution to a fund. The choice of contribution was decided after a pilot study carried out in the area. Many residents feel averse to tax or levies. Thus strategic bias could be introduced if those payment vehicles were chosen.

As majority of the Leliefontein Communal Area residents are Afrikaans speaking population, the questionnaire was designed in Afrikaans. The interview was also conducted in Afrikaans and transcribed into English language with the assistance of an interpreter. See Appendix 1 for the questionnaire in Afrikaans and appendix 2 for the English translation of the questionnaire.

The survey was carried out to determine the total annual economic value (flow of services) of Leliefontein natural resources from January 2012 to December 2012. Information obtained was coded and analysed using IBM SPSS statistical package version 21. Where values obtained were non-normal, the median values which provides a more robust measure of central tendency (Burke, 2001; FEE, 2002; Park and Cho, 2003) to estimating the economic values of such ecosystem services.

Chapter Five: Results and discussions

5.1 Value of rangeland forage in Leliefontein Communal Area

To determine the value of forage to human welfare in Leliefontein Communal Area, I used the production function analysis also known as productivity change method (FEE, 2002). Rangeland forage as an ecosystem product is not exchanged in the market however; it is the main input together with other inputs used in production of livestock which are commercially marketed.

Seventy six percent of the sampled households (n = 100) do own livestock. This is equivalent to 1 277 households in the Communal Area. Small stock (sheep and goats) are more prevalent with fewer households owning size stock (cattle). Only 6 percent of the respondent households owned cattle with the number ranging from two to 15 heads of cattle.

The mean number of cattle owned per respondent was 5.33 ± 5.50 (stdev) and a median of two. Ownership of sheep was 42 percent with herd size ranging from as low as two to a higher size of 200. Mean herd size was 28 ± 34 (stdev) and a median size of 20 while the greatest number of households own goats. Sixty-four percent of respondents own goats with a herd size ranging from one goat to a maximum of 80 goats. The mean size of herd was 25.00 ±19 (stdev) and a median size of 20.50.

Livestock owners usually provide crop residues to their herd as a supplement when during the time of the year when forage is low in the veld. Sixty-one percent of livestock owners provided supplemental feed for their herd while the remaining 39 percent did not provide supplements. It is noteworthy that the supplements provided are not commercial grains but residues from the cultivated plots of the Communal Area which have mostly remain unploughed due to poor yield as a result of drought.

5.1.1 Valuation method to calculate forage value

The production of livestock in the Leliefontein Communal Area is based on pastoral mobility where animals are raised on extensive rangelands for nutrients with occasional supplementary feeding. It is assumed an increase in input (forage) will result in increase in output thus an increase in forage consumption will result in increase in body weight and milk produced.

The production function is represented as $Q = f(E, V_{1......}V_n)$

Where Q is the marketed output

E is the ecosystem product (Input)

f is the function relating input to output and

$V_{1......}V_n$ represent other input variables.

The number of livestock in the study area was estimated from the questionnaire data. The obtained figures were 202 cattle, 14 112 sheep and 22 575 goats for the Leliefontein Communal Area. Table 5.1 shows livestock numbers and their corresponding market prices.

Table 5.1: Monetary value of livestock in Leliefontein Communal Area (2012 monetary value).

Stock	Numbers	Price of livestock (ZAR)	Total (ZAR)
Cattle	202	3 250	656 500
Sheep	14 112	650	9 172 800
Goat	22 575	650	14 673 750
Total			24 503 050

Sales of livestock are done for the purpose of meat consumption. However, farmers and herders derive tangible amount of milk from their livestock as a source of protein. Data result shows that 74 percent of livestock owning respondents obtained milk from their livestock. Average annual quantities of 90 litres of milk were derived for domestic consumption. The estimated value of milk production in the study was R626 130 at a market price of R9 per litre.

The total monetary value of marketed/marketable output (Q) is calculated thus;

Total monetary value of meat + total monetary value of milk

R24 503 050 + R626 130 = R25 129 180

Labour is a significant input factor in production of livestock. There are three distinct forms of labour identified in the study area namely self labour, hired labour, family or relative labour. Forty percent of respondent households who own livestock engage in self labour for herding their livestock, 37 percent engage the service of hired or paid labour while 23 percent engage the services of family or relatives within the Communal Area (see appendices A and B).

The average monthly cost of herding derived from the survey in the study area was R800 (see appendices A and B). This amount is higher than the nationally stipulated monthly minimum wage of R713 in South African rural areas (Shackleton et al., 2007). To determine the total labour cost for livestock production, the average monthly wage of R800 for hired herding (labour) was taken as the opportunity cost for livestock owners who engaged in self and/or family labour.

Total estimated labour cost in the study area for one production year was therefore R12 259 200. Treatment and vaccination of livestock also contributed as an input in the production of livestock in the study area with 98.6 percent of livestock owning respondents treating and vaccinating their herds against disease outbreaks. An annual estimated R800 was spent per household on treatments and vaccinations giving a total cost of R980 800 in the study area.

The monetary value of rangeland forage can be calculated thus

$$Q = f(E, V_1, V_2)$$

$$Q = E + V_1 + V_2$$

$E = Q - V_1 - V_2$

E = R25 129 180 - R12 259 200 - R980 800

E = R11 889 180

The economic value of rangeland forage is therefore R11 889 180 per annum. This value represents the economic benefit of rangeland grazing on the Namaqualand commons which comprises 192 000 hectares. The value of forage per hectare is calculated thus:

R11 889 180/192 000 hectares = R61.92 per hectare

A hectare of rangeland forage in Namaqualand thus yields an estimated economic value of R62 per annum.

The application of production function analysis for estimating economic value of natural resources and ecosystem is based on few assumptions (FEE, 2002). Average product is assumed to be equal to the marginal product of rangeland forage. That is, an additional unit of input will lead to a corresponding increase in output. The incremental production of forage does not affect the price of the output (livestock products). This means the price of output remains constant and does not fall due to increased supply of input.

Annual direct use value of rangeland forage for user household is calculated as:

Economic value of rangeland forage/number of user households

R11 889 180/1 277 = 9310.24

The average value across all households per annum is calculated as:

R11 889 180/1 680 = R7 076.89

The benefit of rangeland forage to livestock owning household could be explained in terms of cost saved by grazing the livestock on the natural rangeland resource. To determine this benefit, the following procedure was carried out

The livestock numbers in Namaqualand were standardized and converted to large stock unit equivalents (LSU). Large stock unit equivalents is a measure of the quantity of forage needed for metabolism of an animal annually, compared with forage consumption of one 450 kg cattle unit and an approximate daily weight gain of 500 g (Meissner et al., 1983; Esler et al., 2006). The values obtained were recorded in Table 5.2.

A large stock unit equivalent (LSU) is thus calculated from the metabolic weight of an animal as follows:

Large stock unit equivalents = Body weight of an animal (kg) $^{0.75}$/ 450 (kg) $^{0.75}$

Where 450 kg is the standard weight of a cattle unit

$^{0.75}$ is a fractional power representing the basal metabolic rate of an animal in relation to its body weight.

Table 5.2: Number of livestock and the corresponding Large Stock Unit (LSUs).

Livestock	Estimated number	Large Stock Unit (LSUs)
Cattle	202	202
Sheep	14 112	3 669
Goat	22 575	6 773
Total	36 889	10 664

The annual feed (forage) requirement of a standard large stock unit is 3 650kg/yr (du Toit, 2006). The livestock in the study area will therefore require

10 664 LSU x 3 650 kg yr^{-1} = 38 923 600 kg yr^{-1}.

Value of a kilogram of rangeland forage in Namaqualand can be estimated as the economic value of forage in the area divided by quantity of forage consumed annually. The kg value of forage will therefore be calculated thus:

R11 889 180/38 923 600 kg = R0.31 kg^{-1}

The non-marketed, ecosystem service value of rangeland grazing (input) in the production of marketed livestock products (output) is R0.31 per kg of forage. A standard large stock consumes 10 kg of forage daily for growth and maintenance (du Toit, 2006). This means a livestock farmer will graze a standard large stock unit of herd daily on R3.10 worth of rangeland forage; an amount a farmer will expend if rangeland forage is not freely available. However, this value does not represent the total economic value of rangeland forage as an ecosystem service.

Other services such as ground cover, erosion control, microhabitat and other regulating and supporting services were not reflected in the estimation. The derived value only represents rangeland forage as an input in the production of livestock. Rangeland forage remains the backbone of sustainable livestock production in Communal Areas including Namaqualand commonages. Thus the economic gains from livestock production could be directly attributed to the natural rangeland resource.

5.1.2 Discussion

Livestock production in Namaqualand is a land based livelihood option widely practised on the communal rangelands. Livestock owners in Namaqualand depend on the natural rangelands for raising their animals. Shackleton et al. (2010) reported a similar scenario in the arid and semi-arid region of Southern Africa where over 95 percent of livestock and game farming are extensively managed on natural rangelands. Rangelands provide forage for over 70 million livestock in the region (Shackleton et al., 2010).

Blignaut et al. (2008) estimated the annual grazing value of rangeland in the grassland of South Africa to R66.08 per hectare. This figure is slightly higher than the R62 per hectare value of rangeland estimated in this study for Namaqualand region. This could be explained by the relative abundance of forage in the grassland biome compared to arid or semi-arid ecosystem. Forage production in arid lands is usually constrained by low rainfalls (Hoffman and Cowling, 1987); rainfall, being the major determinant of forage production (Palmer and Ainslie, 2006a). This phenomenon highlights the significance of rangelands for livestock production as most of the arid lands in Namaqualand region are too marginally productive for arable farming (Shackleton et al., 2010). Rainfall and temperature constitute the predominant factors influencing land-use in Namaqualand (Rohde and Hoffman, 2008).

Sixty one percent of livestock owners in this study provided feed supplements in form of crop residues to their stocks. The residues were products of failed crop production due to low rainfalls in the region. Unlike cultivation of forage crops in ecological regions with rainfalls exceeding 500 mm (Bennett and Lent, 2007), the cultivation of forage crops on arid rangeland is constrained due to limited rainfall (Hoffman and Rohde, 2007).

The direct economic benefit from livestock production per annum in this study averaged across livestock owning households was R9 310. The value derived from this study is higher than values obtained from previous studies on communal rangelands.

Shackleton et al. (2005) estimated an annual economic benefit for livestock owning household in communal rangelands of Southern Africa at R3 180 per household. Similarly, Dovie et al. (2006) estimated an annual value of R4 434.56 per household as accruals from livestock production. Govender-van Wyk and Wilson (2006) reported an annual value of R6 753.68 per livestock owning household in the commonages of Namaqualand. Davenport et al. (2012) recorded an annual value of R3 567 per household in commonage of Eastern Cape Province of South Africa.

The differences in the values from different studies could be attributed to the valuation method used (FEE, 2002) and the production year under valuation. For instance, James et al. (2005) estimated a total livestock production value for Paulshoek communal rangeland using two different valuation methods. The production value using Household Income Approach was R75 130.68 whilst a total of R42 790.08 was estimated using Natural Habitat Value (NHV).

From the result, it is evident that rangeland forage contributes significantly to the local economies of Communal Areas. Livestock production remains an important component of livelihood strategy in Leliefontein communal rangelands. Seventy-six percent of the household own livestock (cattle, sheep and goat), this is somewhat similar to findings by Dovie et al. (2006) whereby 64 percent of household in Thorndale, a Communal Area of the Limpopo Province South Africa, own livestock (cattle and goats but excluding sheep). Some other studies that highlight importance of the less capital intensive, subsistence livestock production to rural livelihoods are Allsopp et al. (2007), Behnke (1985; 2006), Boonzaier et al. (1990), Cousins (1999), Dovie et al. (2006), Shackleton et al. (2000; 2001).

Livestock production on communal rangelands is assumed to be unproductive leading to over grazing, degradation and constitutes "a tragedy of the commons" (Hardin, 1968). Individuals are believed to maximize off-take at the expense of other users (Brown, 1977; Horowitz, 1979; 1981; 1982; Diergaardt, 1989). However, this assumption remains untested and unchallenged (Allsopp et al., 2007; Boonzaier et al., 1990).

Govender-van Wyk and Wilson (2006; 2009) suggested sustainable tourism as an alternative livelihood option to livestock production on the commons. They reported that the economic returns on tourism in Namaqualand far exceeded the returns on livestock production. However, Boonzaier (1996) cautions that communal farmers are sceptical about tourism development, not necessarily due to economic incentives, rather the ambiguity of messages they get from the local authorities on conservation and ecotourism.

Govender-van Wyk and Wilson (2006) reported an economic benefit of R549 000 to R1 774 500 from tourism projects against R445 743 generated from livestock production in Namaqualand commonages during the same period. Their study however pointed out that the accruals from the tourism project were only confined within few wealthy individuals who are two shop owners, two guesthouses and the municipal-run conservancy. This is in contrast to my findings where majority of the Communal Area (76 percent of households sampled) are involved in livestock production as a livelihood option.

Tourism development on Namaqualand commonages had been greeted with mixed feelings as communities perceived it as a way of excluding them from their already constringed lands. This view is supported by Boonzaier (1996) whereby communal farmers are generally sceptical of tourism development projects in the commonages

Eighty seven percent (n = 69) of the livestock keepers interviewed in Leliefontein Communal Area said they will not substitute livestock farming for other land based livelihoods. This is in contrast to Govender-van Wyk and Wilson (2006) where the majority (23) of respondents in Eksteenfontein, Namaqualand rated tourism as much valuable and important than livestock keeping, 19 respondents rated tourism as equally important as livestock keeping while a few believed it will negatively impact the communities than livestock keeping. They however, reported that participation in a community conservancy development is relatively low. Of the 42 people involved in a conservancy development, 13 were found to be actually participating in the project. The remaining 29 people raised several issues impeding the development of conservancy in the area. Some of the issues raised are the uncertainty in terms of the future of conservancy in the Communal Area, inadequate or complete lack of information about what the conservancy project represents and apathy from community members to be involved in such project.

From the foregoing, it is evident that livestock production remains a viable and acceptable means of livelihood in arid and semi-arid rangelands which are marginally productive at best, for crop production. Eco-tourism as a livelihood option is directly beneficial to the wealthy few in the Communal Areas who have the required capital to establish such venture.

5.2 Valuation method used to calculate fuelwood resources

Market price analysis was used to estimate the quantity of fuelwood used in the Communal Area. Fuelwoods are sold within the community; therefore it is imperative to evaluate the quantity based on the market price data of the fuelwood used. Where an environmental attribute to be measured have a market price, the amount of money a consumer is willing to pay for such environmental attribute can be taken as the value the consumer places on the attribute assuming market distortions such as taxes, levies, rights and subsidies are minimal.

5.2.1 The economic value of fuelwood

Ninety percent of respondents in the Communal Area use fuelwood for energy generating purposes. The uses range from cooking, heating, and baking some household pastries. A household used on average 6 kg of fuelwood daily. Various species of fuelwood are used in Leliefontein however; *Searsia undulata* (taaibos) is the most commonly used specie. It is regarded as a good quality wood product because it produces better coal and burns longer than other species. The list of commonly used plants as fuelwood is presented in Table 5.3.

There is no restricted access to collection of wood in the communal rangeland however, due to scarcity of some species, villagers have to walk extra distance to get preferred species or out rightly buy from the wood vendors.

Searsia undulata is the only fuelwood collected for sales purpose hence, it is used in this analysis as a baseline for quantification of fuelwood values in Leliefontein Communal Area.

Pick-up vans or 'bakkies' and donkey carts usually serve as transportation mediums for fuelwood. The approximate weight loads of bakkie and donkey cart are 112kg and 70 kg respectively (James et al., 2005). The woods are packaged and sold in bundles. A bundle is made up of 14 kg of wood sold at R20.

Economic value of fuelwood is therefore $E = Q_f \times Mp$

Where:

E is Economic value of the fuelwood used in Leliefontein Communal Area

Q_f is quantity of the fuelwood used

Mp is the market price of the fuelwood used in Leliefontein Communal Area

The economic value of the fuelwood used in Leliefontein can be calculated thus:

Number of households using fuelwood is 90 percent of the total households

90/100 × 1680 households = 1 512 households

Average quantity of fuelwood used daily is 6.1 kg per household and annual usage is 2 226.5 kg per household.

Annual quantity of fuelwood used is 1 512 × 2 226.5 = 3 366 468 kg

A unit bundle contains 14 kg of fuelwood. Therefore, annual quantity in bundle is 3 366 468/14 = 240 462 bundles used annually.

Economic value (E) = Quantity of fuelwood used (Q_f) x Market price (M_p)

240 462 bundles × R20 = R4 809 240

Economic value of fuelwood = R4 809 240.

This figure represents the gross economic value of fuelwood thus, highlighting its contribution to livelihood strategy in the Communal Area. However, not all the fuelwood collected and used are traded. The obtained R4 809 240 represents the proximate value of fuelwood used in the study area assuming they were all traded at a market price of R20 per bundle (14 kg of fuelwood). The implication is that household will have to pay R20 or closer to that amount if they have to buy all the fuelwood they need.

Direct use value of fuelwood per user household is calculated as:

R4 809 240/1 512 households = R3 180.71 per household

This is approximately R3 181. Economic value of fuelwood averaged across all households in Leliefontein Communal Area is calculated as:

Economic value of fuelwood/total number of households

R4 809 240/1 680 households = R2 862.64 per household

Economic value of fuelwood per household is approximately R2 863.

The economic value of fuelwood on Leliefontein rangelands is calculated thus; R4 809 240/192 000 ha = R25.04 ha^{-1}. This represents approximately R25 per hectare.

Table 5.3: Plants commonly used as fuelwood in Leliefontein Communal Area.

Scientific names	Local names of plants used as fuelwood	growth form
Searsia undulata	Taaibos	Woody shrub
Acacia gerrardii	Rooidoring	Tree
Galenia africana	Kraalbos	Woody shrub
Calobota sericea.	Fluitjiesbos	Woody shrub
Aloe melanacantha	Ghorie	Dwarf succulent
Tamarix usneoides	Dabbaboom	Tree
Elytropappus rhinocerotis	Renosterbos	Woody shrub
Hermannia amoena	Jeukbos	Woody shrub
Stoeberia utilis	Rooi-t'kooi	Succulent shrub
Euphorbia muritanica	Melkbos	Succulent shrub
Olea europaea africana	Olienhout	Tree
Aloe variegata	Kanniedood	Dwarf succulent
Euryops multifidus	Rapuis	Woody shrub
Polymita albiflora	Muis-oor	Succulent shrub
Didelta spinosa	Perdebos	Woody shrub

5.2.2 Discussion

Ninety percent of households in Leliefontein Communal Area use fuelwood to meet their energy needs. This finding agrees with Pote et al. (2006) which estimated 88 percent of households surveyed in communal lands of Crossroads village in Eastern Cape utilize fuelwood to meet their energy needs.

Priddle (2002) also estimated that more than 80 percent of Southern African population depend solely or partly on fuelwood consumption to meet their energy needs. Similarly, Borchers et al. (1990) reported over 80 percent of household in Namaqualand commonages utilize fuelwood for energy. Williams and Shackleton (2002) reported that between 80 and 99 percent of rural households in South Africa depend on fuelwood as source of energy, except in areas where fuelwood had been degraded or outrightly scarce.

The use of fuelwood as source of energy is a common practise among the rural households in South Africa. Several studies have highlighted the importance of fuelwood to rural livelihoods (e.g. Liengme, 1983; Borchers et al., 1990; Archer, 1994; Shackleton, 1996; Solomon, 2000; Shackleton and Shackleton, 2000; Shackleton et al., 2000a; Williams and Shackleton, 2002; Shackleton et al., 2002; Dovie et al., 2004; Makhado et al., 2009).

Daily consumption of fuelwood in the study area is 6.1 kg per household. This figure is similar to the findings by Makhado et al. (2009) in the woodland depleted villages of North-Eastern Limpopo whereby daily consumption of fuelwood is 6.8 kg per household. However, this result is in contrast to study by Liengme (1983) in Gazankulu, North Eastern Transvaal where daily consumption of fuelwood per household was estimated at 14.9 kg. Archer (1994) similarly reported 15 kg of fuelwood used daily per household in Richtersveld, Namaqualand.

Solomon (2000) suggested that the 15 kg weight of fuelwood daily consumption in some rural Communal Areas in Namaqualand reported by Borchers et al. (1990), Archer (1994) and Mander and Quinn (1995) may be due to total dependence on fuelwood for energy without supplementing with gas. More so, there was no electricity in the rural villages of Namaqualand when the studies were conducted. However, a study by Solomon (2000) before electrification of Namaqualand (Price, 2005) reported a daily consumption of 8.7 kg of fuelwood per household.

The daily consumption of 6.1 kg in this study shows a decline in fuelwood use compared to 8.7 kg reported by Solomon (2000) in Namaqualand. However, the electrification of the Communal Area did not result in total halt or drastic decline in fuelwood use. Madubansi and Shackleton (2007) reported an insignificant decline from 97 to 94 percent in the number of household that primarily depend on fuewood in rural villages in the Bushbuckridge region of South Africa during eleven year period (1991 to 2002). They noted that the mean consumption rate of fuelwood in the rural villages remained the same between 1991 before introduction of electricity to the villages and 2002 when majority of the households have access to electricity; regardless of 6 kWh of free electricity enjoyed monthly by the residents. White et al. (1997) pointed out that the majority of the poor households could not afford to completely substitute electricity for fuelwood due to cost of buying electricity or electric appliances. Fuelwood use, especially for cooking in rural areas is still linked to cultural fulfilment and age-old tradition. For instance, there is a commonly held belief among the VhaVenda and Shangaan elderly people that fuelwood cooked food (porridge) tastes better than porridge cooked with electricity (Makhado et al., 2009). Table 5.4 shows a comparative direct use value of fuelwood per household in rural and Communal Areas of South Africa.

Table 5.4: Direct economic values of fuelwood per annum from selected studies in South Africa.

Location	Value per household (ZAR)	Source
Leliefontein villages, Northern Cape	2 863	This study
Thorndale, Limpopo	1 910	Dovie et al. (2004)
Rural households across South Africa	2 000	Shackleton et al.(2004)
Mogano, Limpopo	1 736	Shackleton et al. (2002)
Ha-Gondo, Limpopo	1 569	Shackleton et al. (2002)
KwaJobe, KwaZulu Natal	726	Shackleton et al. (2002)
Paulshoek, Northern Cape	2 616	Solomon (2000)
Bushbuckridge, Limpopo	465	Shackleton and Shackleton (2000)

Economic value of fuelwood in the study area was estimated at R4 809 240 per annum for the entire communal rangelands of 192 000 hectares. The gross economic value per household per annum was estimated at R2 863. There are varying degrees of economic values of fuelwood to rural households in literature ranging from R600 to R4 400 (Shackleton et al., 2004). The value obtained in this study falls within this range; however it is higher than the mean value of R2000 reported by Shackleton et al (2004).

The discrepancies in economic values of fuelwood are largely due to valuation techniques and parameters used. For instance, using a derived demand approach to estimate economic value of fuelwood in Paulshoek village, Solomon (2000) reported a net value of R366 291.75. Conversely, James et al. (2005) reported a lower fuelwood value of R178 670 for the same village using household income approach and natural habitat value valuation techniques. Some studies presented the net economic values in their findings (e.g. Campbell et al., 1997; Solomon, 2000) whilst others in gross values (e.g. Shackleton and Mander, 2000; Shackleton et al., 2002). However, it is clearly evident from this study and other literatures, fuelwood together with other non-timber forest products contribute importantly to livelihoods and act as safety nets for rural households in times of critical needs (Paumgarten, 2005). The use of fuelwood is a cost saving measure of relatively scarce incomes in the rural economies. It thus affords rural households opportunity to save money to meet other household needs and to procure assets which can be engaged in income generating activities (Shackleton and Shackleton, 2004).

5.3 Valuation method for quantifying medicinal plant use

Medicinal plants are freely available in the Communal Areas hence placing an economic value on them may be somewhat difficult. Albeit some villagers do visit bossiedoctors for treatment of more complicated ailments, this only occur in rare cases as most of the ailments treated with medicinal plants require a general knowledge of medicinal plants use. In order to derive a market value of this resource, a cost based approach was adopted.

Substitute cost method (FEE, 2002) was used to evaluate the benefit derived from medicinal plants because it has a close substitute of conventional drugs which have a direct market price. Where natural resources are not traded for the ecosystem services provided, the cost of a substitute product which have a direct market are often taken as the best alternative if the environmental resources are not available. These prices represent a proxy prices because they reflect the amount of money the ecosystem services are valued in terms of expenditure saved. For instance, the value of medicinal plants used in treating an ailment could be deduced from what it will cost to treat a similar ailment with conventional marketed drugs.

In using substitute cost valuation method, it is assumed environmental attribute to be valued is a perfect substitute for a marketed product hence, the marginal rate of substitution is taken as equal to 1.

If the price, P of a marketed good M is P x M, then the price of the non-marketed environmental good N could be calculated thus:

P (N) = P (M) x Rs where;

P (N) is the price of the non-marketed environmental good, P (M) is the price of the marketed substitute good and Rs is the marginal substitution rate.

5.3.1 Value of medicinal plants

Seventy one percent of the respondents (n = 100) indicated they use medicinal plants. This figure translates to 1 193 households (4 472 persons) use medicinal plants. Ninety-three percent of the respondents said they self-administer the medicinal plants while the remaining seven percent visit a "bosiedoctor".

Ailments treated with medicinal plants include influenza, stomach ache, body pains, flatulence, and headache, treatment against ticks in animals and for prophylactic purposes. Most of the ailment treated with medicinal plants could also be treated with over-the-counter drugs which are available at pharmaceutical shops. However, due to basic health care as welfare services by the government, consultation and medical care services are free in clinics located in the rural areas. More complicated or severe medical cases involving surgical operations or other intensive monitoring are referred and treated in hospitals located in bigger towns such as Garies or Springbok.

The majority (93 percent) of the respondents have basic and general knowledge of medicinal plants use to treating common illnesses. Since this knowledge is relatively ubiquitous, it can be assumed that the value for consultation is zero.

The clinics are open twice in a week with a nursing sister in attendance. On average, at least a member of household visits the clinic once a week for medical check up. Most medical conditions reported can be treated with administration of analgesic and antipyretic drugs such as Paracetamol. Albeit the treatments and drugs are free, the recommended maximum daily dose of Paracetamol (4 gram) (Claridge et al., 2010) taken at 1 gram (2 x 500 mg) every six hours will cost approximately R7.

Taking conventional drugs as perfect substitute for medicinal plants, the value of yearly dosage per household will be R7 x 52 weeks = R364.

The amount of equivalent medicinal plants used per annum could be calculated thus:

$M = P_d \times N_h$

Where M = medicinal plants value

P_d = price of conventional drugs per annum

N_h = number of households using medicinal plants.

M = R364 x 1 193 households = R434 252. Therefore, the value of the medicinal plants in Namaqualand derived from substitute cost method is R434 252.

The value per hectare will translate to the value of medicinal plants divided by the total hectare of the study area. That is R434 252/192 000 ha = R2.26 ha^{-1} yr^{-1}.

Annual direct use value per user household is calculated thus:

Economic value of medicinal plants/number of user households

R434 252/1 193 households = R364 per household per annum

Economic value averaged across all households is:

R434 252/1 680 households = R258.48 per household per annum

5.3.2 Discussion

Using a substitute cost method, the economic value of medicinal plant per household in Leliefontein Communal Area was estimated at R364. This value is similar to R350 reported by James et al. (2005) as the direct use value of medicinal plants in Paulshoek, one of the coloured settlements in Leliefontein Communal Area. In a comparative study of values of natural resources in rural households, Shackleton et al. (2001) reported a gross direct use ranging from R37 to R521 in seven studies across communal rural households in South Africa. Value obtained in this study falls within the range of documented medicinal values per household across the country.

Medicinal plants are commonly used natural resource in South Africa's health delivery system, especially in rural households and among African population (Wiersum et al., 2006). In this study, 71 percent of respondent households use medicinal plants. This finding agrees with Goldberg (1998) that reported 70 percent of household in Paulshoek village of Namaqualand use medicinal plants regularly for treating various ailments. It contrasts findings by Dovie et al. (2001) that reported all households (100 percent) in Thorndale village of Limpopo, a predominantly African population use medicinal plants.

The relatively higher percentage of households using medicinal plants in Thorndale as compared to Namaqualand rural communities could be explained by assertion of Wiersum et al. (2006) that the use of medicinal plants is more widespread and prominent among the African population of South Africa. Up to 80 percent of African people in South Africa regularly use traditional or herbal medicine (Dold and Cocks, 2002). This is due largely to cultural and traditional beliefs that medicinal plants are potent in curing "spiritual" illnesses and protect against misfortunes which cannot ordinarily be cured by conventional medicines (Wiersum et al., 2006).

Trade and commercialization of medicinal plants have been well documented in the predominantly African settlements of KwaZulu-Natal, Gauteng, Mpumalanga and Eastern Cape (Dold and Cocks, 2002). About 20 000 tonnes of medicinal plants from over 700 species are used and traded across South Africa annually with an estimated value of R270 million (Dold and Cocks, 2002; Mander, 2004; Wiersum et al., 2006). Dlamini and Geldenhuys (2009) reported an annual average value of R270 282 000 for medicinal plant use in Swaziland. Medicinal plant use in the Southern African region is estimated at a value R1 263 000 000 with an annual consumption of 700 000 tonnes of plant material (Mander and Le Breton 2005).

These economic values highlight the significant contribution of medicinal plants to local and national economies. However, the values represent conservative estimates of medicinal plants resource as national accounting could only reflect values of medicinal plants traded in formal and informal markets. In most cases such as in this study, the use of medicinal plants are largely not traded hence, its value not reflected in the local or national accounts. Assigning economic values to the non-marketed medicinal plant will provide a better perspective of its importance to sustainable livelihood and a well guided policy for conservation of the natural resource.

5.4 Valuation of water resources

Due to lack of surface water, the only source of water supply to Leliefontein Communal Area and the entire Namaqualand region is groundwater (Pietersen, 2007). The communities depend heavily on groundwater for domestic, agricultural and industrial water use (Van Wyk et al., 2012). Water is supplied to households via reticulated water systems from abstraction boreholes located across the communities.

Although there have been considerable numbers of studies on hydrology and management of groundwater in Namaqualand (e.g. Pietersen, 2004; 2007; Pietersen et al., 2009; Titus et al., 2009; Van Wyk et al., 2012), relatively few studies documenting the economic value of water resources have been published. Valuation of water is a controversial subject due to the indispensable role it plays in sustaining all forms of life (O'Farrell et al., 2011).

All the respondents in Communal Area use water. The quantity of water used was not uniform across households. Hence the median value was taken as measure of central tendency. The median water use by the respondents daily is 50 litres. An average monthly charge of R90 per household was derived from the municipal bill records of each household. This monthly charges (direct use values) only reflects the lower estimates as water is a subsidized commodity by the government in line with recognition of access to water as a basic service enshrined in the constitution of South Africa through the adoption of Bill of Rights (Pietersen et al., 2009). The upper limit of water value is a value of life with moral and cultural dimensions that cannot be easily reduced to monetary commodification (O'Farrell et al., 2011).

Market price analysis was used to estimate economic value of water resources in the study area. Consumptive and non consumptive use values are usually determined market valuation method, based on estimates of input and price data and quantities produced (Turpie et al., 2010). To derive the total annual water use in the Communal Area, the monthly charges were multiplied by the number of households for a given year. The water value is calculated thus:

90 litres x 12 months x 1 680 households = R1 814 400, therefore the estimated value of water in the Communal Area is R1 814 400.

Direct value of water use per household per annum is R1 814 400/1 680 households = R1 080 per household per annum. Economic value of water per hectare annually is given as

Economic value of water resources/total landmass in the study area

R1 814 400/192 000 ha = R9.45 ha^{-1} yr^{-1}

The annual value per hectare therefore is R9.45.

Annual direct use value per user household is calculated thus:

Economic value of water resources/number of user households

R1 814 400/1 680 households = R1 080 per household per annum

Economic value averaged across all households is:

R1 814 400/1 680 households = R1 080 per household per annum

The values for user and all households are the same since all the respondents use water to meet their basic needs.

5.5 Non-use value of Namaqualand ecosystem services

Non-use value of ecosystem service was estimated using a hypothetical market to elicit the willingness to pay (WTP) for naturally free environmental services through a questionnaire (see appendix A and B). The median individual willingness to pay for non-use (existence) value of Leliefontein communal rangeland was R60 per month. The aggregate willingness to pay for ecosystem services in a geographical area can be derived by multiplying the median WTP by the household population for the area (FEE, 2002). Aggregate WTP = median WTP x Population size (N)

R60 x 1 680 households = R100 800

Therefore, the aggregate willingness to pay monthly for the non-use value of the natural resources is R100 800. Respondents were asked their willingness to pay in form of contribution to a fund managed by trusted conservation agency because they are more familiar with monthly payment in terms of charges, wages, and grants hence it was easy for them to relate payment on monthly basis to elicit their preferences. The study was conducted to estimate the total economic value of ecosystem services derived from Leliefontein natural resources over a production year. The non-use value of the communal rangeland per annum will therefore be calculated thus:

R100 800 x 12 months = R1 209 600

The annual non-use value of Leliefontein communal rangeland is therefore R1 209 600.

Annual non-use value of Leliefontein Communal Area per hectare is therefore:

R1 209 600/192 000 ha = R6.3 ha^{-1}

Non-use value per user household per annum is calculated thus:

Economic value of non-use/number of respondent households

R1 209 600/1 579 households = R766.05 per household per annum

Annual economic value averaged across all households is calculated thus:

Economic value of non-use component/number of all households

R1 209 600/1 680 households = R720 per annum

5.5.1 Discussion

The response rate for valuation question (n = 100) was 94 percent. High rate of response enhances the reliability of the contingent valuation survey (Arrow et al., 1993). To minimize non responses, interviews were conducted on face to face basis which allow respondents to express their views on natural resource use within the communities. Other key guidelines that facilitate reliability of the contingent valuation results are also adhered to (see Arrow et al., 1993 for detailed guidelines on contingent valuation method).

There is a weak negative correlation between the WTP and the educational levels of the respondents (r = -265). This implies respondents who have no form of formal education tend to state higher value than respondents with some form of formal education. Age does not show to have effect on the respondents' willingness to pay (WTP). The adult population (respondents 50 years and over) and the younger population (below 50 years) do not show any difference in the preferences for non-use value of the ecosystem services in the communal rangeland.

There is a positive correlation between the income levels of the respondents and their willingness to pay (WTP) for ecosystem services (r = 0.561). Respondents whose monthly income are R2 000 and above tend to state higher preferences for non-use value of the environment than respondents with monthly income lower than R2 000. This finding is consistent with Jacobsen and Hanley (2009). In a meta-analysis of 46 contingent valuation studies across 6 continents, Jacobsen and Hanley (2009) found that respondents stated income influence the willingness to pay for conservation of environmental services. That is, Respondents with higher income expressed higher degrees of willingness to pay for environmental services. A similar meta-analysis of 30 contingent valuation studies of wetlands in the temperate regions showed that the richer North American (U.S.A and Canada) respondents stated higher willingness to pay (WTP) than the European respondents (Brouwer et al., 1999).

It is evident, from the foregoing discussion, individual's income or socio-economic well being of societies influence the non-use (existence) values attached to ecosystem services. The value of R1 209 600 estimated for the non-use value of Leliefontein communal rangeland which represent 6 percent of the total economic value could be higher if the study was carried out in a high income community. However, the non-use value derived from this study represents a substantial component of the ecosystem services which enhance people's well being.

From policy perspectives, it shows a sizeable value of the communal rangeland is being overlooked when the non-use value of the natural resources is not taken into account. This could result in formulation of policy which does not adequately reflect on the role of natural resources in sustaining livelihoods and subsequently leading to wrong decisions on land use.

Chapter Six: Conclusion and recommendation

Leliefontein Communal Area is of strategic importance to decision making in terms of land use practise to be adopted. It falls within a biodiversity hotspot where there is need to conserve some of the endemic species in the area. The semi arid nature of the rangeland equally presents a challenging situation where the seemingly viable land use is livestock farming. Policy direction towards biodiversity conservation have been in favour of promoting alternative land based livelihood to livestock farming with the proposition that livestock farming reduces biodiversity, degrades the environments by reducing vegetation cover and generally an unproductive means of communal rangeland utilisation. This study however presents that livestock farming remains a viable livelihood strategy in the arid and semi arid region of Namaqualand. Albeit the present stocking rate is higher than the government recommended rate, it is still sustainable at the present rate for 30 years (James et al., 2005).

From the estimated values in this study, it is evident that the economic value of rangeland forage is over 50 percent of the total economic value of ecosystem services derived from natural resources in Namaqualand. Table 6.1 shows the economic values of each ecosystem service assessed in the study area. The annual flow of ecosystem services per hectare on communal rangeland is R99 per annum. However, if the non-use component is taken into account, the value represents R105 per annum. The latter value should form a basis for making decision on communal rangelands.

The non-use value component represents about 6 percent of the total economic value of the Communal Area. The relatively low value presented by the non-use component could be related to the low income of the Leliefontein's population. This however shows a sizeable value of the communal rangeland is being overlooked when the non-use value of the natural resources is not taken into account.

Tourism development is an interesting initiative to conserve and protect the ecological features of the land. However, development of any tourism should be designed whereby the population are not excluded from using the land. An ecosystem approach should be adopted to manage the natural resources of Namaqualand for efficient and optimal delivery of ecosystem services.

Table 6.1: Economic characteristics of natural resources in Leliefontein Communal Area (2012 monetary value).

Ecosystem services	Valuation methods	Economic values (ZAR)	Value per household (ZAR)		Value per hectare (ZAR)	Values (percent)
			User households	All households		
Rangeland forage	Production function	11 889 180	9 310.24	7 076.89	61.92	58.98
Fuelwood	Market price analysis	4 809 240	3 180.71	2 862.64	25.04	23.86
Medicinal plants	Substitute cost	434 252	364	258.48	2.26	2.15
Water	Market price analysis	1 814 400	1 080	1 080	9.45	9.01
Non-use component	Contingent valuation	1 209 600	766.05	720	6.3	6
Total		20 156 672	14 701.65	11 998.01	104.97	100

The ecosystem approach, as adopted by the Convention of Biological Diversity (CBD) is a strategy to manage the earth resources; living and non living components in a sustainable and equitable manner that enhances careful balance among the interacting components. This approach recognises human as an integral part of the ecosystems.

It is therefore recommended that decision making should take into account the socio-economic conditions of a community when determing the total economic value of ecosystem services. Sustainable and equitable utilisation of natural resources for the purpose of maintaining a sustainable flow of critical ecosystem services should form the basis for formulating policies on land use and sustainable development.

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Appendix A: Questionnaire used for the survey in Afrikaans

UNIVERSITY OF THE WESTERN CAPE

BIODIVERSITY AND CONSEVATION BIOLOGY

Hierdie vraelys is saamgestel om te assesseer wat die ekomiese waarde van die natuurlike hulpbronne binne die Leliefontein Kommunale gebied is. Die informasie wat versamel word is streng vertroulik en sal vir geen ander rede gebruik word nie. U sal op geen wyse na gespoor kan word deur die inligting wat u sal gee wat in enige verslag wat opgeskryf word nie.

Beantwoord asseblief die toepaslike so akkuraat as moontlik. Baie dankie.

1. Naam... (Optioneel)

2. Geslag:

    1. Manlik

    2. Vroulik

3. Ouderdom:

    1. Bo 60 jaar
    2. 50 - 59 jaar
    3. 40 - 49 jaar
    4. 30 - 39 jaar
    5. Onder 30 jaar

4. Opvoedingsvlak:

    1. Post-Matriek

    2. Graad 10 - Graad 12

    3. Graad 8 - Graad 9

4. onder Graad 9

5. Geen

5. Grootte van familie...................................

6. Bron (ne) van inkomste

1. Formele werk
2. Informele werk
3. Toelaes

7. Maandlikse inkomste

1. Onder R 2000
2. R2001 – R4000
3. R4001 – R6000
4. Bo R6000

VELD HULPBRONNE

8. Gebruik u brandhout?

1. Ja

2. Nee

9. Kry u brandhout uit u gemeenskap?

1. Ja

2. Nee

10. Wat is die gemiddelde hoeveelheid brandhout wat u daagliks gebruik?

................kg

11. Gebruik u hout/bossies/riete vir konstruksie?

1. Ja

2. Nee

12. Wat is die hoeveelheid hout wat u gebruik vir konstruksie?

.... (In bondels)

13. Koop u hout vir konstruksie?

1. Ja

2. Nee

14. Indien u Ja geantwoord het, wat is die totale bedrag wat u spandeer op die aankoop van hout?

R..................

15. Gebruik u medisinale plante?

1. Ja

2. Nee

16. Behandel u uself met kruie?

1. Ja

2. Nee

17. Verkies u medisinale plante bo konvensionele medikasie?

1. Ja

2. Nee

WATER HULPBRONNE

18. Wat is die bronne van water vir u huishouding?

1. Munisipale water

2. Putte

3. Beide

19. Wat is die gemiddelde hoeveelheid water wat u daagliks gebruik?

....................liters/drom/gallon

20. Hoeveel betaal u maandliks vir water?

R.......................

21. Is u bewus van enige vleilande, waterpunte en ander bronne van water in u gemeenskap?

1. Ja

2. Nee

22. Waar het u water gekry voordat krane aangebring was?

1. Putte

2. Ander gemeenskappe

3. Beide

VEEBOERDERY

23. Besit u enige vee (bv. bees, skaap en/of bok)?

1. Ja

2. Nee

24. Vir hoeveel jaar boer u al met vee?

....

25. Hoe het u u kennis oor veld- en veebestuur opgedoen?

1. Tradisionele kennis

2. Formele opleiding

3. Beide

26. Wat is die grootte van u trop(pe)?

Bees..................

Skaap.....................

Bok.......................

27. Voorsien u byvoeding aan u vee?

1. Ja

2. Nee

28. Hoe word u vee bestuur?

1. Tree self op as wagter

2. Huur iemand as wagter

3. Familielid is wagter

29. Indien u iemand huur as wagter, wat is die koste per dag?

R......................

30. Wat beskou u as die mees belangrikste faktor in veebestuur

1. Ligging van waterpunt
2. Beskikbaarheid van hoe kwaliteit voer
3. Nabyheid van ander troppe

4. Vermyding van giftige plante
5. Predators / veiligheid
6. Kondisie van vee
7. Ander

31. Behandel u u vee teen die uitbreek van veesiektees?

1. Ja

2. Nee

32. Watter bedrag spandeer u gemiddeld per jaar om u vee te behandel teen siektes?

R..........................

33. Wat is die gemiddelde aantal diere wat u jaarliks verkoop?

Bees.....................

Skaap.....................

Bok...................

34. Hoeveel diere slag u gemiddeld per jaar vir huishoudelike / kulturele gebruik

Bees..........................

Skaap.........................

Bok….........................

35. Hoeveel diere word jaarliks gevang deur predatore / gesteel?

....

36. Kry u enige meld van u diere?

1. Ja

2. Nee

37. Indien Ja op vorige vraag, wat is die gemiddelde hoeveelheid melk wat u per jaar kry uit ‘n melk seisoen?

...................................liters

38. Vir watter bedrag verkoop u u vee gemiddeld?

Bees R........................

Skaap R........................

Bok R.........................

39. Sou u bereid wees om veeboerdery te verruil vir enige ander vorm van inkomste?

1. Ja

2. Nee

GEWASVERBOUING

40. Is u enigsinds gemoeid met gewasverbouing?

1. Ja

2. Nee

41. Hoeveel jaar is u al betrokke by gewasverbouing?

...........................jaar / jare

42. Hoeveel huurgeld betaal u jaarliks vir u area wat u verbou?

R..............................

43. Wat is die grootte van u area wat u verbou?

................................ha

44. Voeg u enige kompos tot die grond?

1. Ja

2. Nee

45. Indien ja, hoeveel kompos dien u toe per seisoen?

....

46. Hoeveel spandeer u op kompos toediening op u grond per jaar?

R.............................

47. Hoe oes u u gewasse op u grond?

1. Self

2. Arbeid van familie

3. Huur arbeid

48. Indien u arbeid huur, hoeveel betaal u vir arbeid daagliks?

R.............................

49. Hoeveel dae neem dit om te oes?

...........................dae

50. Wat is die hoeveelheid gewassse wat geproduseer word per hektaar op u grond?

.......................kg

51. Wat is die verkoopswaarde van u gewasse per jaar?

R......................

SCENARIO:

52. In die lig van die verskeie voordele wat kommunale weiveld bied in terme van brandhout wat vrylik beskikbaar is, waterbronne vanaf vlei-areas en putte, gratis weiding vir diere, medisinale plante om verskillende siektes te behandel en die estetiese skoonheid van die landskap tydens die blomseisoen wat toeriste aanlok, kyk ons na die volgende stelling: Om die volhoubaarheid van hierdie hulpbronne te verseker word 'n bedrag versoek wat elkeen moet bydra. Wat is die maksimum bedrag wat u bereid sal wees om maandliks te betaal vir die verbetering van hierdie hulpbronne. Neem in gedagte u vlak van inkomste.

R....................................per maand

Appendix B: English translated version of the survey questionnaire

UNIVERSITY OF THE WESTERN CAPE

BIODIVERSITY AND CONSEVATION BIOLOGY

This questionnaire is designed to research the economic values of the natural resources in the Leliefontein Communal Area. It is not intended to store or use the information supplied therein for any other purposes other than the research. The information you will provide will be completely confidential and it will not be traceable to you when writing the project report.

Please answer applicable questions as accurate you can. Thank you.

1. Name... (Optional)

2. Gender:

    1. Male

    2. Female

3. Age:

    6. 60 years above
    7. 50 - 59 years
    8. 40 - 49 years
    9. 30 - 39 years
    10. Below 30 years

4. Education level:

    1. Post-Matric

    2. Grade 10 - Grade 12

    3. Grade 8 - Grade 9

4. below Grade 8

5. None

5. Family size...................................

6. Source(s) of income

4. Formal employment
5. Informal employment
6. Grants and Remittances

7. Monthly income brackets

5. R 2000 and below
6. R2001 – R4000
7. R4001 – R6000
8. Above R6000

VELD RESOURCES

8. Do you use fuelwood?

1. Yes

2. No

9. Do you get the fuelwood from your community?

1. Yes

2. No

10. What is the average quantity of fuelwood you use daily?

................kg

11. Do you use wood/shrubs/reeds for construction purposes?

1. Yes

2. No

12. What is the quantity of wood you use for construction purposes?

.... (In bundles)

13. Do you buy the wood used for construction purposes?

1. Yes

2. No

14. If you answered yes to the question above, what is the total amount spent on buying wood?

R..................

15. Do you use medicinal plants for curative purposes?

1. Yes

2. No

16. Do you administer the medicinal plants yourself?

1. Yes

2. No

17. Do you prefer medicinal plant to conventional drugs?

1. Yes

2. No

WATER RESOURCES

18. What are the sources of water for your household?

1. Municipal supplies

2. Wells

3. Both

19. What is the average quantity of water you use daily?

....................litres/drum/gallon

20. How much do you pay monthly as water charges?

R.......................

21. Are you aware of the wetlands, watering points and other sources of water in your community?

1. Yes

2. No

22. Where did you get water from before taps were installed?

1. Wells

2. Other communities

3. Both

LIVESTOCK FARMING

23. Do you own livestock (e.g. cattle, sheep, and/or goat)?

1. Yes

2. No

24. How many year(s) have you been in livestock farming?

.......................year(s)

25. How did you gain your veldt and livestock management knowledge?

1. Traditional knowledge

2. Formal training/knowledge

3. Both

26. What is the size of your herd?

Cattle...................

Sheep......................

Goats........................

27. Do you provide your herd with supplemental feeding?

1. Yes

2. No

28. Tick below the mode of herding your stock

1. Self herding

2. Hired labour

3. Family labour

29. If you use hired labour for herding, what is the amount charged per month?

R.......................

30. Tick below the factor you consider most important when herding your stock

8. location of water
9. Availability of high quality forage
10. Proximity to other herds

11. Avoiding toxic plants
12. Predator/safety
13. Physical/health condition of the herd
14. Others

31. Do you vaccinate/treat your stock against any disease outbreak?

1. Yes

2. No

32. What is the average amount you spend on treating an animal in a year?

R.........................

33. What is the average number of animals you sell in a year?

Cattle.....................

Sheep.....................

Goats..................

34. Write below the numbers of animals you slaughter annually for domestic/cultural purposes

Cattle..........................

Sheep.........................

Goats.......................

35. How many animals caught by predators or stolen per year?

....

36. Do you derive milk from your animal?

1. Yes

2. No

37. If you answered yes to the question above, what is the estimated quantity of milk derived from your stock in one milking season?

...................................litres

38. Write below the average amount you sell your stock

Cattle R........................

Sheep R........................

Goat R.........................

39. Would you be willing to substitute livestock farming for other enterprise?

1. Yes

2. No

CROP FARMING

40. Do you engage in any cropping activity?

1. Yes

2. No

41. How many years have you been in crop farming?

...........................year(s)

42. What is the amount payable on the rent of your farming plot annually?

R..............................

43. What is the size of land you were allocated for cropping?

................................ha

44. Do you apply manures to your crops?

1. Yes
2. No

45. If you answered yes to the question above, what quantity of manure do you apply in a season?

....

46. How much do you spend on manure application on your farm in a year?

R.............................

47. Tick below the modes of harvesting your crops from the farm

1. Self harvesting
2. Family labour
3. Hired labour

48. If you ticked hired labour for the question above, how much is payable for daily labour?

R.............................

49. How many days do you spend harvesting your crops in one harvesting period?

...........................days

50. What is the quantity of crop produced per hectare of your farm?

.......................kg

51. What is the sales value of your harvested crops in a year?

R......................

SCENARIO PRESENTATION:

52. In view of the multiple benefits derived from the communal rangeland such as the fuelwood freely collected from the veld, water sources for wetland and wells, forage grazed freely by livestock, medicinal plants used for different health conditions and the aesthetic beauty of the landscape during flowering season that attracts tourist to your community. The sustainability of these resources for future use require contributing towards a fund, what is the maximum amount you will be willing to pay monthly for the improvement of these resources bearing in mind your level of income?

R....................................per month