The impact of urban expansion and population growth on productivity of forestlands

Study area: Rustenburg Local Municipality

By

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DECLARATION

I Modise Seokwang declare that the information provided in this document is my own, except where sources have been specified or mentioned. No perceptive information has been publicized without knowledge of the sources.

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ABSTRACT

The survey has been carried out in North West Province within Rustenburg Local Municipality. This is an Urban Forestry research in which six sites including peri-urban, urban, suburban and semi-rural areas were selected for the study. The aim of the study was to determine the relationship between households and their local trees and forests. Forest in this context included community gardens, vegetation cover, open spaces, soil, water, productive sites and animals that form part of forest. Data collection was mainly based on questionnaires and covered sample of 272 households. Statistical Package of Social Sciences (SPSS) 15.0 using 5% sampling intensity (confidence level) was used in which the data has been represented by numbers. Analysis was based on determining households' relationship with their trees and local forest, and how they influence forest productivity or development.

With SPSS two techniques, regression model and descriptive statistics were applied to analyze quantitative and qualitative data. Regression model was significant in prediction of the dependent variable (Y) using independent variables (X), and proved to be a good model to analyze data for fuelwood, timber and forest food production. Descriptive statistics was important in counting number of times each category or variable is used. Participants had varying perceptions regarding the use of forest due to factors such as availability of forest resource, type of residence, and their living standard. Generally, households in suburban and urban areas value the forests for economic and environmental benefit, while the peri-urban and semi-rural households utilized their trees and forest to meet their energy demand. A large number of households consume forest food as compared to timber and fuelwood due to the availability of the resources.

The Municipality as a whole is undergoing rapid development expected to continue throughout years. These developments are stimulated by mining activities and influx of people in the area. All these factors threaten the existing natural resources especially forest areas and water. Areas of these resources are declining due to the current demand for housing, new mining sites and continuous establishment of informal settlements.

Trees and forest within peri-urban and semi-rural areas are in poor conditions as compared to urban and suburban areas. Poor waste management and poverty are issues aggravating the situation especially in poor developing sites that have been studied. Most agricultural sites have been transformed into residential areas, and thus exacerbating problems of food insecurity in the whole country. Household size has major influence in fuelwood, timber and forest food production as an increase or decrease in the size will determine the amount of consumption, production or development. Value for forest, access to forest, level of interaction and restrictions regarding the use of forest are also significant aspects contributing to forest productivity and development as they show the relationship that exists between forest and households.

ABBREVIATIONS

ANOVA- Analysis of Variance

AIDS- Acquired Immuno-Deficiency Syndrome

BAR- Basic Assessment Report

CBE- Community Based Educator

CBO- Community Based Organization

DEAT- Department of Environmental Affairs and Tourism

DWAF- Department of Water Affairs and Forestry

EIA- Environmental Impact Assessment

FAO- Food and Agricultural Organization

FTFA- Food and Trees For Africa

GAA- Group Areas Act

GIS- Geographical Information System

HIV- Human Immuno Virus

HSRC- Human Science Research Council

IUCN- International Union for Conservation of Nature

MDGs- Millennium Development Goals

NCA- Native Consolidation Act

NEMA- National Environmental Management Act

NFA- National Forest Act

NFAP- National Forestry Action Programme

NGOs- Non-Government Organizations

NLAA- Native Laws Amendment Act

RDP- Reconstruction and Development Programme

RLM- Rustenburg Local Municipality

SAIRR- South African Institute of Race Relations

SAMP- Southern African Migration Project

SAPPI- South African Pulp and Paper Industry

SPSS- Statistical Package for the Social Sciences

UNESCO- United Nations Educational Scientific and Cultural Organization

UNFF- United Nations Forum on Forests

UNFPA- United Nations Population Fund

VAIR- Value, Access, Interaction and Restriction

WOA- World Overpopulation Awareness

Ge, m- Gender specifically male.

Ht/f- Have trees or forest

Intac- Interaction

Acctf- Access to forest

Pr- Permanent residence

Hhext- Household extension

Restrict- Restriction

Valffore- Value for forest

Hh size- Household size

Gin/hh/yr- Gross Income per household per year

Emp/hh/yr- Employment per household per year

Tt/hh/yr- Tons per household per year

N- Number of household

Std.- Standardized

GLOSSARY

Analysis of Variance- A test difference between mean scores of two or more groups with one or more variables.

Confidence level- Amount of error allowed for the model, for example 95%.

Correlation Coefficient- Measure the strength of linear relation between two l values.

df- Degree of freedom indicates number of values that can vary independently of one another.

Dependent Variable- The variable in regression that cannot be controlled, Y.

Positive Relationship- Relationship between X and Y in which an increase in X causes increase in Y values.

F Statistics- The ratio of Mean Square and Mean Square Error.

P-value- The value that helps in determining statistical significance of F Statistics.

Independent variable- The variable in regression that can be controlled, X.

Negative Relationship- Relation between X and Y in which an increase in X causes a decrease in Y.

Predictor- The independent variable, X.

Predicted values- Values predicted by regression model.

R- Correlation between observed and predicted values of dependent variable.

R Squared- The percent of the variance in the dependent variables that can be explained by all predictors together.

Residual- Amount of variation on the predictors not explained by independent variable.

Standardized Coefficient or Beta- The coefficient used to make comparison between regression coefficients.

Standard Error of Estimate- The standard deviation of observed Y values about predicted Y values.

Semi-rural- Rural areas within a short distance from urban and provided by all services available in urban areas.

T value- The value used to determine the importance of each variable in the model.

Unstandardized Coefficient- Coefficient of estimated regression model.

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Chapter 1

1.2 Background of the study

In South Africa, the National Forestry Action Programme (1997) through the Department of Water Affairs and Forestry (DWAF) defined Urban Forestry as "an integrated approach to the planting, caring and management of trees in urban and peri-urban areas in order to secure economic, environmental and social benefits for urban dwellers". Konijnendijk ***et al*** (2004) also defined Urban Forestry as a complicated process dealing with the woodlands, groups of trees, individual trees where mass of people live; and have a variety of habitats like streets and parks. Urban Forestry is one of the components of urban greening, focusing mainly on planting, caring and management of all vegetation in cities, towns, townships and informal settlements in urban and peri-urban areas. Other components of urban greening include urban agriculture and urban agroforestry.

During the apartheid period, Urban Forestry has been based on uplifting the lives of affluent urban dwellers in most South African cities and towns. In case of peri-urban and informal settlement, the local government only focused on providing people with water, housing, sanitation and other services. Increase in population within these areas had a major impact as more resources were needed to support people. These included using more money to alleviate poverty and dealing with housing shortage rather than establishing forestry programmes. Park (2000) also emphasized that the reasons for slow process of Urban Forestry in South Africa resulted from limited financial resources to support the programme. In addition, more people are not competent in implementing the programme in urban and peri-urban areas.

The Urban Forestry programme involves number of stakeholders including municipalities of which is the most vital service provider of Urban Forestry; provincial government departments like DWAF, Department of Agriculture and Non-Government Organizations (NGOs) such as Food and Trees For Africa (FTFA) and Community Based Organizations (CBO). FTFA has played a major role in South Africa's Greening process. An estimated

1.2 million trees have been planted through FTFA projects, which involved thousands of communities in Environmental Awareness and education programs (Mathiane, 2004).

According to Park (2000), Urban Greening in South Africa has not yet reached mature stage of development due to unfair distribution of resources during the past 13 years. Urban areas of this country were provided with all forestry services while townships were left in poor environmental conditions of no or less vegetation. Currently, the process of Urban Greening in the country focuses on areas like townships and informal settlements (Mathiane, 2004). The process contributes to making cities more liveable and is the most important component for healthy and sustainable urban settlements.

Urbanization in South Africa has occurred initially along coastal towns and cities, following discovery of minerals (diamonds and gold) in Kimberly as well as Johannesburg city. Moreover, urbanization has been fueled by apartheid legislations that restricted movement of people from rural to urban areas in the country (Beukes ***et al***, 1991). Current growth of urban areas far exceeds that of rural areas in developing countries such as South Africa and account for 90% of the projected world population. South Africa's urban population continues to increase at a fast rate causing congestion in cities, townships and establishment of informal settlements. Most of the people moving into urban areas of the country are migrants searching for good opportunities. The current population of South Africa is estimated as 48 million people (Lehohla, 2006). Much of the population reside in low cost houses and squatter settlements such as Sondela in Rustenburg area. The population is growing at a faster rate than the economy of the country and unemployment rate is increasing.

1.2 Description of the study area

The study has been carried out in the North West Province within Rustenburg Local Municipality. The Province is known as the "platinum province" and lies between 800 and 1100m above sea level (DWAF, 2006). This is a site of attraction for tourists to places like Sun City near Rustenburg, and Madikwe Game Reserve situated towards Kopfontein border near Botswana (Refer to map 1, page 9). The most populated part of

the Province is in the east, where most mining activities take place. About 50% of formal employment is from mining sector (Bembani Sustainability Training, 2005). The dominant ethnic group in North West Province is the Batswana with smaller groups including the Xhosas, Afrikaans speaking and Sotho. About 80% of these groups are found in Rustenburg and other towns like Brits. The population of the province has been estimated at 3 374 200 people, which was about 8% of the country's population. These figures are based on the new provincial boundaries (Lehohla, 2006).

According to Mangold and Kalule-Sabiti, (2002), about 30% of people staying in the Province are illiterate with the number of women being unable to read or write in excess of 50%. Unemployment rate in the Province is estimated at 38%, which is higher than the overall rate of South Africa. Much of the areas in the province are privately owned and the land is mainly utilized for cattle and game farming. Moreover, even though the province is prone to drought and environmental degradation, large pieces of land are used for irrigation-based activities. These include wheat, sunflower and maize farming.

Settlement patterns of the North West Province had long been influenced by factors such as availability of water, land for grazing and farming, mineral resources and group homogeneity (ethnic). The Province is a former "Bophuthatswana"[1] homeland in which most of the towns were under white authorities. The main economic activity was farming. "Bophuthatswana" was renamed the North West Province following the success of 1994 democratic elections. This opened more opportunities of employment and investment especially in former white towns, leading to more urbanized and heavily populated towns.

Rustenburg Local Municipality (RLM) which is also known as NW 373, is amongst the fast growing areas in terms of economy and population in the North West Province. The Municipality is named after Rustenburg town found between 27°25'151" E Longitude and 25°59'641" S Latitude areas, and has been established in 1851 as an administrative centre (Refer to map 2, page 10). This is a former farming area situated 112 km north west of

[1] Place for Batswana or gathering of Batswana

Johannesburg. Rustenburg is characterized by low cost houses and informal settlements about 5 km to the east. The Municipality's population has been estimated as 395, 345 in 2006 (Lehohla, 2006). These figures were based on mid-2006 census and are expected to rise due to the new mining construction and developments within the area. Most people in the area work in the mines and come from all over South Africa and neighbouring countries. The town is ranked number 27262 in the world in terms of its population. The economy of Rustenburg is strongly dependent on mining and is growing tremendously with an estimated rate of 4.9% annually. Mining is the major industry contributing to growth which is lead by Anglo Platinum, Impala Platinum, Lonmin and Xstrata[3]. About 96.7% of South African platinum as well as 25% of gold are mined here and is the main employment sector in the Municipality (Thomas, 2005). RLM is amongst the world's top platinum producing areas with many employment opportunities as well as tourism sites.

The current settlement pattern of the Municipality is mostly based on the economic activities from industries such as mining. The results are urban expansion and generate problems such as overcrowding within peri-urban and suburban areas. Overcrowding stimulated by continuous increase in number of people from rural to urban areas. These in turn give rise to generation of wastes, pressure on resources and increased pollution in urban areas and their periphery.

- **Climate**

The North West province experiences both dry and rainy seasons, with an estimated 71% under arid and semi-arid regions. The area has a yearly ground mean water recharge of about 32.1 to 65.0 mm. The province receives low summer rainfall with the 'maximum ranging from about 500 to 600 mm and minimum of 200mm per year' (Mangold and Kalule-Sabiti, 2002). The western part of the Province receives low rainfall resulting in arid conditions. Central part is semi-arid while the eastern is subtropical. Due to high variation in rainfall distribution within the Province, some areas are vulnerable to drought

[2] http://rainforests.mongabay.com/deforestation/2000/South_Africa.htm
[3] Rustenburg Local Municipality, State of Environment 2007

and floods during heavy rainfalls. Evaporation rate have been recorded as high with temperatures varying from being very hot in summer and mild to cold in winter.

✧ **Vegetation type**

The Province as a whole comprises of flat areas with natural vegetation of grassland and scattered individual trees under savanna biome. This is defined by "grassy layer at the surface with woody plants at the upper layer. Area of woodlands are more denser than shrubland with the upper layer being near surface. Bushveld develops at intermediate stages" (Grundy and Wynberg, 2001).

Semi-arid and arid regions comprise of kalahari thornveld and shrub bushveld, with addition of sourish mixed bushveld on the northern part. The central part of the Province is dominated by dry *Cymbopogon and Themeda* species. The eastern part of the area has a variety of species including turf thornveld and sourveld mixed bushveld (Mangold and Kalule-Sabiti, 2002). Growth and habitats of these species are due to geology of the area mainly the igneous rock layer in nature. Dominant species of Rustenburg area are *Acacia caffra* and *Acacia erioloba.*

Figure 1.1: Common types of trees found in Rustenburg area.

✧ **Geology**

According to DWAF (2006), soils in the North West Province are leached resulting from low rainfall. These soils are largely yellowish brown sandy loams. Ground storage rocks include igneous and metamorphic rocks. Mangold and Kalule-Sabiti (2002) also added

that the area is rich in mineral resources that are exploited from these rocks. These include gold, diamonds, iron, chrome, uranum, platinum as well as manganese. These rocks are made up of the upper zone of gabbro, olivine, diorite and grandiorite with some anorthosites and magnetites. At a level of 5 200m elevation, there is a layer of gabbros giving rise to topographic features such as hills. Deep down into the ground surface are norites, anorhosites, pyroxenites and chromites, with a continuous layer of pyroxenite and peridotite. Generally, mining in Rustenburg targets of platinum and chromite from these layers of rocks.

1.3 Problem statement

Africa's developing countries continue to experience drastic problems associated with the rural-urban migrations. Policies within these countries have been proven to be ineffective due to prevailing unsustainable lives of the residents. For example, South Africa's National Forest Act 1998 (Act 84 of 1998) has been implemented to promote sustainable management and development of forest for the benefit of all. However, due to substandard quality of life in some areas, the country's forests, especially those in growing towns and cities are under a threat by continuous influx of rural-urban migration. Increase in population not only gives rise to environmental degradation due to high demand for land for new developments, but also inhibits economic growth and employment opportunities in other sectors such as agriculture. Land has become scarce and more valuable as the demand exceeds the supply. The vast impacts of urbanization and population growth on vegetation are usually common in urban and highest in peri-urban areas. This is due to people preferring to be close to workplaces. Squatter settlements are then established in areas not preserved for that purpose of which vegetation will be removed to provide space for shanty houses. As people living in these areas have various needs, they perceive few negative impacts or don't see any impact on the environment as employment is their most important concern.

Urban Forestry is an ongoing programme in South Africa and is amongst other initiatives that are used to tackle environmental problems in urban areas. The programme has not yet been implemented in most of the disadvantaged communities of the former

homelands. These areas are undergoing rapid urbanization associated with increased population growth. Natural forests and woodlands in these areas are under threat as they are either over-exploited for use as fuelwood or removed for other land use purposes. Natural forests mostly found in dry areas like North West province continue to be under pressure as they are over-exploited to meet people's demand. These types of forests are still less valuable as compared to plantation forests in high rainfall areas. Rustenburg Local Municipality is one of the small and fastest growing areas in the North West Province in terms of development and population. This results from industries such as mining within the Municipality. This industry benefits the country by maintaining a balance between the economy and life of people; while creating enormous problems to the environment. Rustenburg Local Municipality accommodates both South Africans as well as people from neighbouring countries.

Despite certain improvements, there is still a need for more relevant and important information in order to deal with environmental problems especially related to our forests at present and in the future. Such a resolution will not only ensure the sustainability of natural resources, but contribute to the health of the community. As more trees and forests are planted, secured and protected, more hazardous gases produced in the industries are absorbed. These reduce lungs related diseases and deaths amongst poor communities.

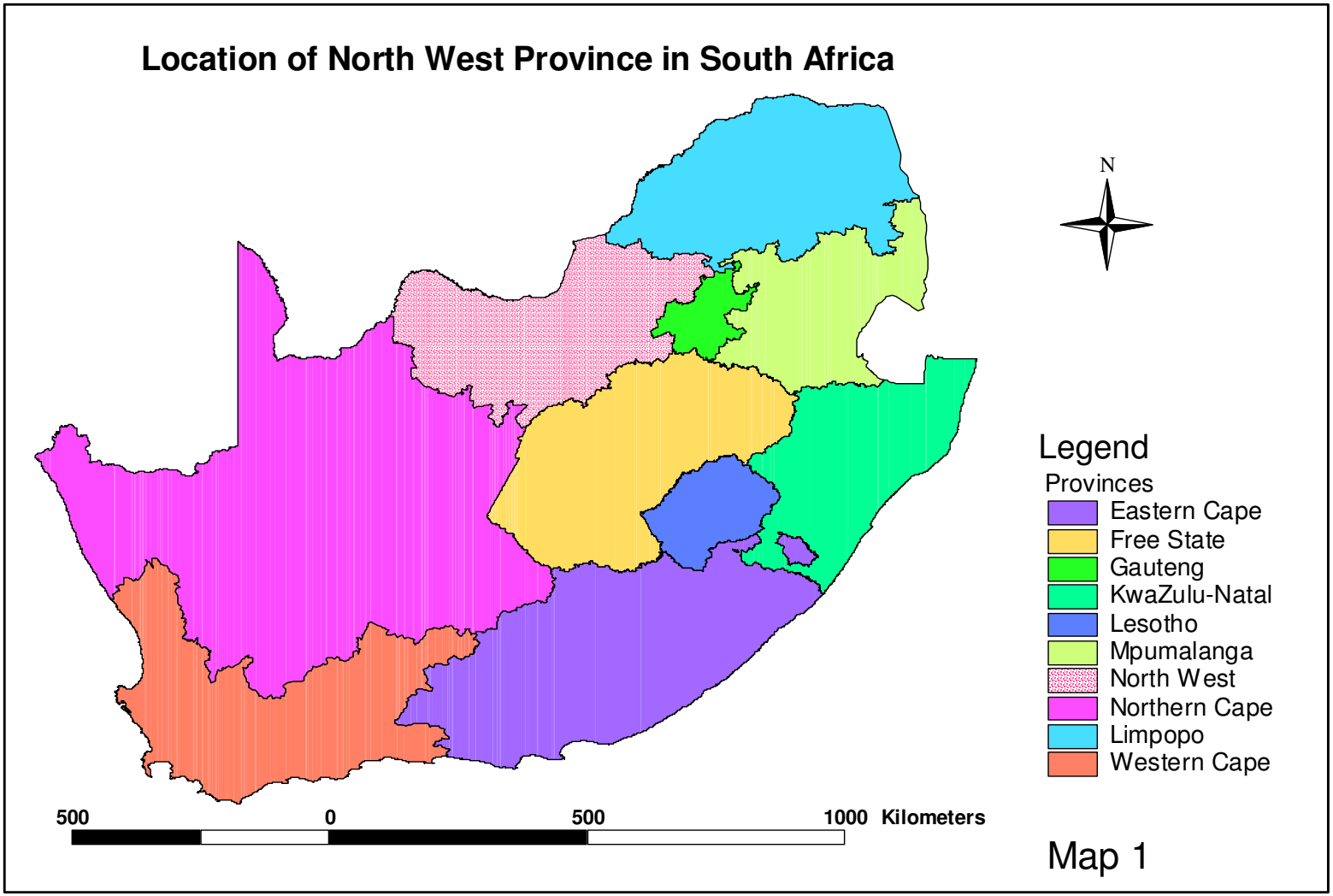
The main aim of the present study is determining the role played by trees and forests in the community of Rustenburg Municipality.

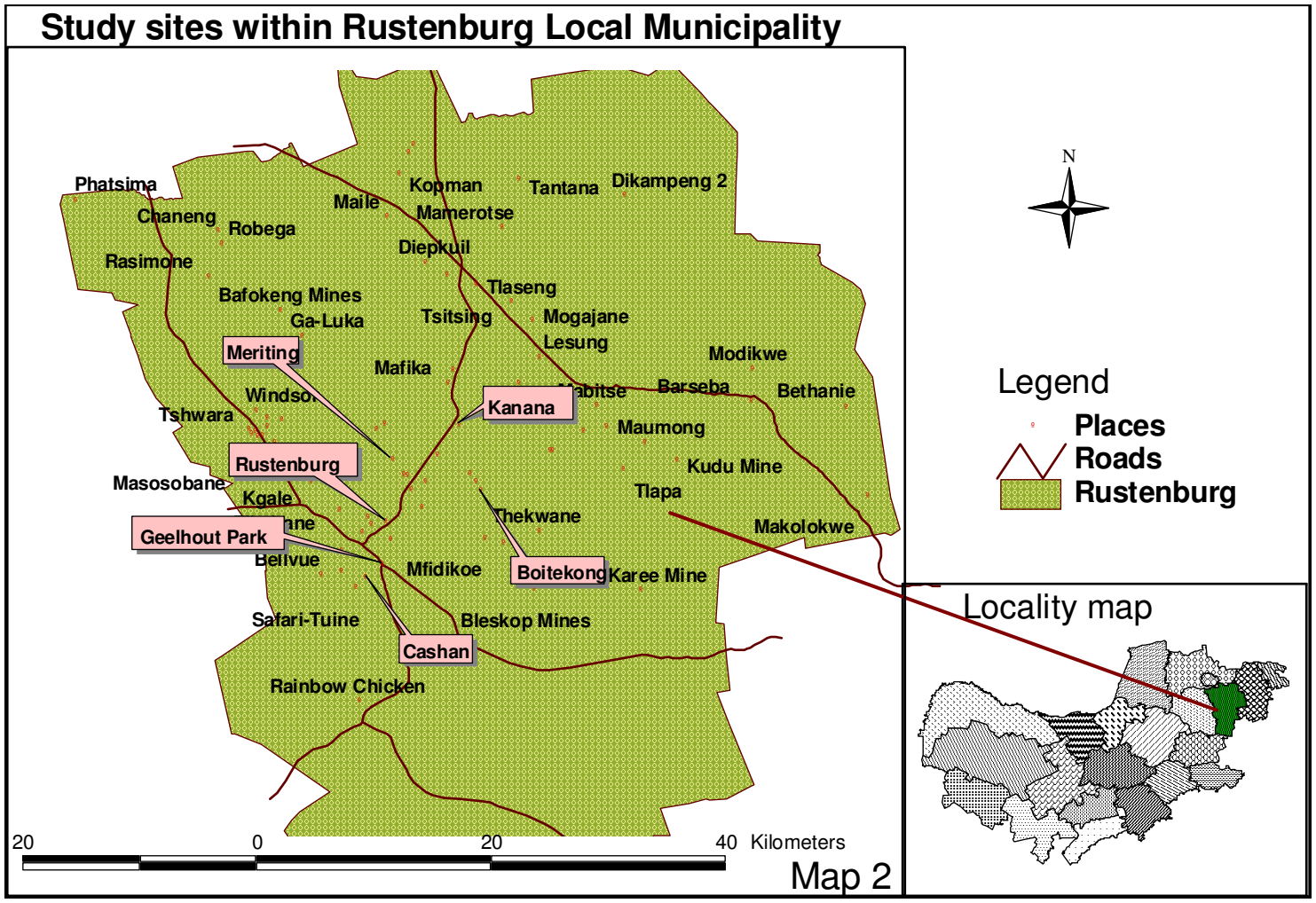
1.4 Objectives of the study are mainly to

1. Determine the extent and state of forests in the study area,
2. Determine the current land use and forest management strategies,
3. Determine how communities interact with their trees and forest,
4. Examining core of urban forests deterioration
5. Developing some preventative forestry measures to improve urban livelihood and urban environment.

1.5 Conclusion

Population growth as well as urban expansion can be viewed as main source of depletion of natural resources especially forests. Therefore, by determining the relationship between the community and these resources the actual nature of the problem can be predictable. In addition key preventative measures can be developed to deal with environmental issues related to our trees and forests.


Location of North West Province in South Africa
N
Legend
Provinces
Eastern Cape
Free State
Gauteng
KwaZulu-Natal
Lesotho
Mpumalanga
North West
Northern Cape
Limpopo
Western Cape
500
0
500
1000 Kilometers
Map 1


Study sites within Rustenburg Local Municipality
Phatsima
Chaneng
Robega
Rasimone
Maile
Kopman
Mamerotse
Tantana
Dikampeng 2
Diepkuil
Tlaseng
Bafokeng Mines
Ga-Luka
Tsitsing
Mogajane
Lesung
Meriting
Mafika
Modikwe
Barseba
Bethanie
Windso
Tshwara
Kanana
Maumong
Rustenburg
Kudu Mine
Masosobane
Kgale
Tlapa
Thekwane
Geelhout Park
Bellvue
Mfidikoe
Boitekong
Karee Mine
Makolokwe
Safari-Tuine
Bleskop Mines
Cashan
Rainbow Chicken
N
Legend
Places
Roads
Rustenburg
Locality map
20
0
20
40 Kilometers
Map 2

Chapter 2

Literature Review

2.1 Introduction

Population growth and urban expansion are both local and global issues with negative relationship with the environment. The latter is mainly fueled by the needs to sustain the growing population at the expense of the environment. Consequences are the reduction in availability of resources which is a major problem of poor nations. Human population in urban areas not only comprises of urbanites having different ideas towards current and future of the country's economy, they also have the needs to ensure that their demands will be met, including a sustained growth in their wealth. The world is currently becoming more urbanized with more people moving to cities and towns for job opportunities and better living standards. Other people are forced to move from rural to urban areas because of poverty resulting from decline in resources they depend on (United Nations Population Fund (UNFPA), 2001).

Developing countries are experiencing rapid urbanization that increasingly concentrates both population and economic growth into urban areas. The phenomenon will contribute to at least 90% of future population growth in urban centers. Even though urban areas are a source of jobs to the growing population, they have the capacity to exclude, marginalize, and reinforce the pattern of inequality experienced by the poor. In these urban areas the difference in the distribution of wealth is so great that poor people settle in marginal sites. Urban areas are vulnerable to natural and man-made disaster. These include fluvial erosion, air, water and noise pollution (Abraham, 2006).

According to Bendix and Fabricius (2001), South Africa has drastic problems in terms of sustainability especially when screening our natural resources, water and forests. However, the country's Department of Water Affairs and Forestry (DWAF) has implemented some policies dealing with conservation, protection, and proper usage of these resources. Despite the availability of policies, problems still persist as there is lack of capacity to manage and develop resources in a sustainable manner. DWAF is working

on the problem in partnership with World Conservation Union (IUCN), to work effectively through Community Forestry Programme. The programme has been adopted from the country's National Forestry Action Programme (NFAP) that encourages community involvement in order to ensure sustainability of their local resources. The success of community forestry is determined by the community and other stakeholders (NFAP, 1997).

2.2 Urban Population Growth

2.2.1 Characteristics of urban environment

Urban areas are characterized by the continuum of buildings separated by streets. People living in these areas vary according to culture, skills, educational status, and occupation. Some of these are refugees from different economic levels including the rich and the poor, while others come from neighbouring rural and peri-urban areas (Grey and Deneke, 1992).

2.2.2 Factors influencing urban population growth

Urban areas are the most productive sites of every country worldwide with distinctive features such as government, industrial sites, the legal system, and education institution. They comprise of large number of poor people who migrated as a result of either 'pull' or 'push' factors. The former one refers to all opportunities available in urban areas including employment, good health facilities, and high standard of education that may not be found in rural areas. Push factors refer to situations in which people are driven away from their homes due to prevailing political issues, poverty and wars. Other migrants leave their place because the area is already overpopulated; therefore the land they heavily depend on for survival is unproductive and may not support the existing population. This has a major influence on migration of people to urban areas with hope of better living. The large number of people migrating is usually middle-aged, more productive and with ability to increase urban population (UNFPA, 1996).

Rural areas experience higher birth rate than urban areas due to poor health facilities, lack of knowledge on family planning methods and poverty. African countries have been recorded to be the highest in terms of population growth as compared to the rest of the

world. The problem arises from people's belief that it is a privilege to have many children, more than they can support. They do not only drain the ecosystem, but also deprive other countries freedom to have healthy and productive environment by filling spaces not reserved for them (WOA, 2007)

2.2.3 Negative and positive impacts of growth

Despite their role in providing good services and employment opportunities, urban areas are major sources of environmental disasters. Urban population growth resulting from these opportunities has both direct and indirect impacts on the environment as a whole. This includes formation of informal or squatter settlements, reduced water and air quality, pollution through wastes, desertification, increased level of crime and poverty. In developing countries, most people migrating to urban areas establish their settlements in most fragile areas. These areas are susceptible to natural disaster such as flooding, desertification and not reserved to serve settlement purposes. For example, wetlands and forestlands are to secure lives of many species living on urban periphery. This creates conflicts between the community and town planners (World Bank, 2006).

Urban population growth is a phenomenon threatening biodiversity as migrants remove vegetation in the area to establish their settlement. This limits the existence of animals, insects, as well as plant species that cannot survive other environmental conditions. Furthermore, squatter settlements are established in areas where services such as water supply, electricity and sewage disposal is very poor (Balance and King, 1999).

In urban areas, standard of living is high with the largest parts of population depending on electricity for their energy demand. As population in these areas increases, it also accelerates the amount of energy needed to sustain life of urban residents and industries. DWAF (2005) emphasized that 'some resources processes are increased even faster than the population itself'. Rate of unemployment and poverty is high in developing countries especially amongst people in peri-urban and informal settlements. For those people who cannot afford to pay for electricity, they have no alternative but to exploit out natural forest to meet their daily energy demand (World Bank, 2006).

Wood from the forest is either utilized as fuel for cooking or heating homes during cold weather. Removal of branches from the forest reduces their potential to stand windy conditions and control erosion. In this case, the forest becomes more susceptible to various diseases. Moreover, fewer branches are not capable of photosynthesizing efficiently. This means reduction in the amount of food for both wild and domestic animals (FAO, 2006). According to Little ***et al*** (1987); *Acacia* species form an important part of woodland areas and complete removal of the plant may lead to environmental disasters. These plants are leguminous and contribute to the nitrogen fixing process and thus become a source of nutrients. Acacia species grow mostly in dry areas vulnerable to draught and aid in enhancing crop yield. They help poor farmer who cannot afford mineral fertilizer by retaining soil fertility. Most ones are fodder trees and their absence will lead to grazing of the remaining vegetation in the area.

Urban population growth is a major threat to water resources as well as the ecosystem as a whole. As population increases, the availability of water resources declines. Water is the most important resource that is needed by all living creature. The problem of water scarcity is mostly experienced in developing countries. Billions of rand are spent every year with an intention of combating the problem. For example, South Africa is amongst the countries experiencing water shortage due to uneven distribution of rainfall throughout the year. High rate of population growth in urban areas aggravate the situation by settling in areas that are far to be reached by public services (Abraham, 2006).

According to Lehohla (2006), urban population growth in developing nations continues despite low economic growth. About 72% worldwide urban population especially developing countries reside in informal settlements. An estimated 28% of the overall urban population in South Africa living in informal settlement mostly prefers riversides. These people are at risk of contagious diseases like water-borne and air-borne. Water from these rivers is either utilized for drinking, bathing or other household purposes. Some people within the population just bath and wash clothes directly from polluted streams or rivers. In securing the resource and sustaining the growing urban population,

Government formed a joint partnership with Lesotho Government to stabilize the situation. The main focus of the partnership is dealing with water crises within South Africa. In exchange the country is losing money to Lesotho that could be used for other projects (DWAF, 2006).

Poor or lack of sewage system in squatter settlement increases health problem. For example, households without pit latrines or running water in their toilets leave residents with no option but to use the forest. Wastes generate environmental problems such as pollution, conflicts and increase vulnerability to disease like cholera and ultimately lead to death. Levels of water contamination in rivers and streams also go up.

2.2.4 Trends of urban population growth in South Africa

According to Kok ***et al*** (2003), population densities in South Africa are usually related to the extent of urbanization and areas with highest population growth include the former homelands. These areas are associated with the past segregationist policies such as Group Areas Act (Act No. 77 of 1957) abolished in June, 1986, and Influx Control (1948). These were used as measures preventing black people from migrating to urban areas. The results were forced settlements with lowest levels of service delivery, infrastructure and employment in the country.

Meyer and Turner (1994) pointed out that the overall urban population of South Africa was 23 million with an annual growth of 3.6%. Even though the country has high rate of HIV/AIDS patients, population figures increases at a fast rate. In 2001 the country had a population of about 44. 8 million people that increased to about 48 million in 2006 (Lehohla, 2006). The number of immigrants already in the country is estimated as 2.3 million and there is no doubt that these figures will rise (UNESCO, 2006). These statistics have added up to about 5.6% per year exacerbating the need for effective control measures. About 59% of South Africa's population lives in urban areas, with 28% allocated in squatter settlements (DWAF, 2006).

While the population increases, the rate of unemployment and depletion of the country's natural resources continues to rise. Currently about 42% of the total numbers of South Africans who are qualified for employment are unemployed. Additionally, an estimated 35 000 to 39 000 immigrants are allowed to work in South Africa. This worsens the situation instead of mitigating it as foreigners are granted opportunities of the local residents. There are still enormous imbalances between racial groups. About 30% of white South African has obtained higher education with only 5% of blacks in the same level (Lehohla, 2006). Despite its role in depleting the environment, rural-urban migration reduces pressure on the rural resources by reducing population number.

2.3 Urbanization process

Urbanization is defined as 'a process in which there is a large number and rapid influx of human population in urban areas'. Urbanization is associated with social and economic development (UNFPA, 2001). The process of urban expansion can occur by either physical concentration of population and economic activities in cities or towns. Moreover, it can occur as a way of life being urbanized in a psychological sense (Fair, 1984). The phenomenon has both negative and positive impacts. For example, expansion of residential and industrial land use areas exerts more pressure on urban forests and woodlands, while providing enormous employment opportunities to the population.

2.3.1 Factors contributing to urbanization process

Urbanization is influenced by various factors depending on the local community's perception in regard to growth or economy. In many instances, it is triggered by poor planning of cities' growth as well as migrants from rural areas who tend to reside in informal settlements (World Bank, 2006). Fair (1984) has done studies on South Africa's urbanization and concluded that the process is triggered by: 'Decision making and control on part of decision maker with reference to urban pattern. Capital flow creating various rates and pattern of urban and its development. Differences in society that influence rapid changes in terms of city's structure, and finally migration'.

In South Africa rapid urbanization occurred mainly along the coastal areas due to sugar trading, and areas involved were Port Elizabeth and Durban. For other parts of the country like Kimberley, Johannesburg (Witwatersrand) and parts of former Transvaal

discovery of diamonds and other minerals played a major role. High demand for labour which means employment opportunities lead to increased population growth and expansion of cities. The results were formation of informal settlements near the cities, urban areas in homelands, and in closer settlements with high employment and good services (Schmidt, 1973).

Other factors that contributed to rapid urbanization are apartheid laws. Included here are Native Consolidation Act (NCA) (Act No. 25 of 1945), Influx Control method of 1948 and Group Areas Act (GAA) (Act No. 77 of 1958). GAA was mainly to distribute the land depending on race and was an amendment of Act No. 41 of 1950 (van Reenen, 1962). Urban areas were allocated for Whites, rural areas for Blacks, and Indians and Coloureds were found in peri-urban areas. Native Consolidation Act together with Influx Control methods were based on control of urban expansion, as well as number of blacks in urban areas. Amendment of NCA was in 1952 and was then called Native Laws Amendment Act (NLAA) with an aim of extending control over population and urban growth. These laws exclusively restricted black people from being permanent urban residents. Movement of blacks in urban areas was forbidden especially after hours of work. The law enforced blacks to carry identity documents every time while moving around urban areas. Black women were allowed to stay in cities only if they were married, and have with them children less than 18 years. Blacks didn't have political rights and any control over urban resources (Kraayenbrink, 1984).

Influx control measures have not been successful in African countries except in South Africa. The success was through the help of police in partnership with administrative and laws of that time. In other countries controlling inflow was regarded as immoral, ineffective, and a form of colonization.

2.3.2 Past and present trends of urbanization in South Africa

Due to the past apartheid laws for example Group Areas Act, NLAA, and influx control measure, the level of urbanization was lower as compared to the current figure. Through these measures, at least population growth was reduced by 5% annually as more people

were forced to move back to rural areas. Therefore, rural areas were more concentrated than urban. Following abolishment of the laws, urbanization and population growth within urban areas increased at a high rate resulting in need for effective control measures. Levels of urbanization in South Africa have been estimated as 56% of the total population in 2001 and now have reached 59%. In figure 2.1 Indians turned to be more concentrated in urban areas and accounted (97.49%), Whites (89.87%), Coloureds (86.78%) and Africans (47.74%). Number of whites living in urban areas is low as most of them are now moving out of the country for other opportunities (Kok and Collinson, 2006).

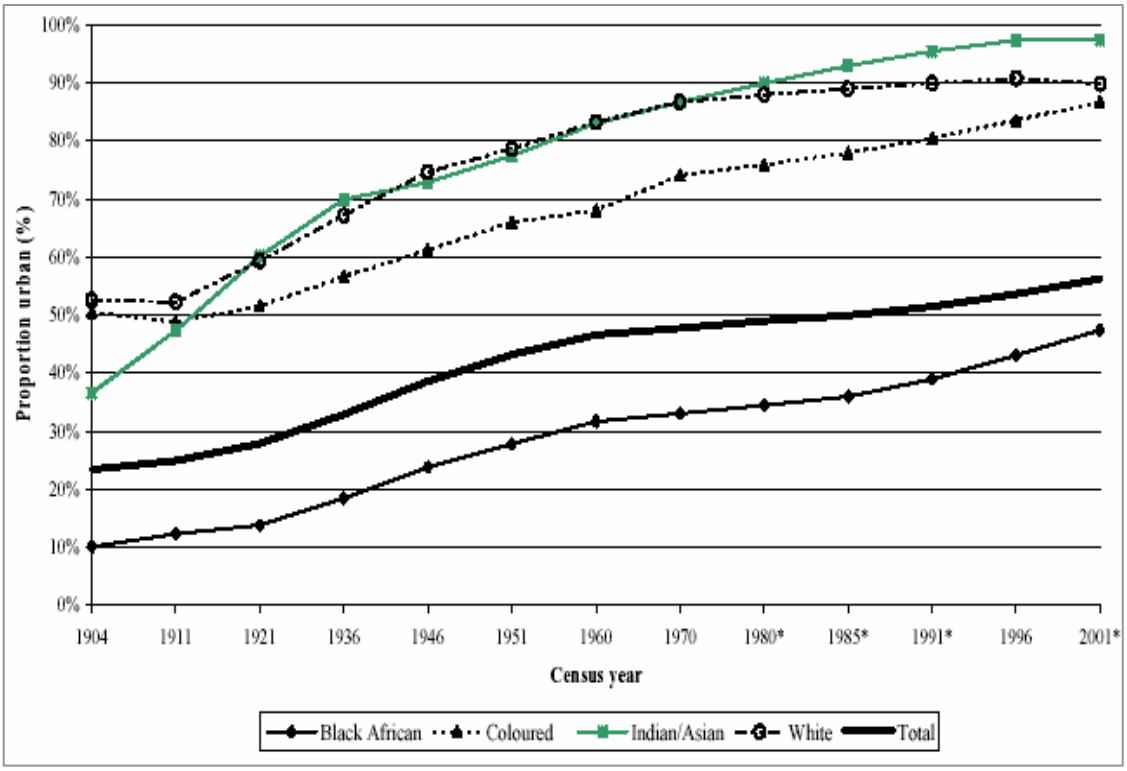


Figure 2.1: South Africa's historical urbanization trends between 1904 and 2001. *Source*: Kok and Collinson (2006), Statistics South Africa.

2.3.3 Impacts of urban expansion

Huge problems of urbanization prevail mostly in African countries undergoing developments. Growth of these nations' cities and towns is twice as population growth. The results are increased rate of urban poverty, unemployment, more pressure on resources leading to their scarcity and health problems (UNFF, 2003). Urbanization

threatens forestlands which are the most productive socio-economic and ecological resources. The process stimulates land use changes through expansion of residential, industrial and road infrastructures at the expense of forest areas. Other impacts include traffic and congestion, noise resulting from air crafts and vehicles, crime, water as well as air pollution. The latter one is a major problem in Zimbabwe and South Africa where energy use and industrial development is based on charcoal. Burning of charcoal and fuelwood, and smoke from vehicles worsen the situation (Madava, 2000).

According to Landau (2005), urbanization in South Africa has had major impact in spatial distribution of population and income. Following the abolishment of influx control methods and democratic election, huge number of people in the country made their way to urban centers. Part of the population manage to achieve their goals of migrating to urban areas, while the remaining portion created problems like crime due to unemployment and other issues. Other problems associated with urbanization are ineffective control over number of foreigners seeking jobs within the country. This creates conflicts between the citizens and the foreigners as South Africans believe that they contribute to level of crime that is going up. About 64.8% of South African living in the inner-city thought that it would be better if refugees could be sent back to their country (Crush and Williams, 2005).

Urbanization in the country also results in social problems such as high housing demand. From her speech in 2005, former housing Minister Lindiwe Sizulu stressed that ‘demand for housing is growing faster than the government can deliver’. In addition to that, about 2.4 million South Africans reside in informal settlements with only 800000 on a waiting list to receive subsidy houses (Hartleb, 2005).

2.4 An approach to sustained growth

Sustained growth refers to the reduction of imbalance between population growths and urban expansion to maintain healthy environment for future generation. Stengel (2006) suggested the need for continuous growth but in a sustainable manner. In order to achieve that, population size, population growth and urban expansion should be maintained at an

acceptable level with the changing productive potential of the ecosystem. Therefore, it is very important to consider how the number of people relates to available resources and how they manage and utilize these resources.

According to Kraayenbrink (1984), for urban area to be generative to all residents, everyone should have access to economic opportunities within the area. People need to be involved in decision making in terms of social and political issues. In forestry, Government and other stakeholders should strengthen forest rights of the poor. These include participating in decision making to remove barriers between rich and poor. Additionally, they should make safety nets through investment using forest products and not 'poverty traps'. Both community and Government should support tree planting outside forest areas including urban, peri-urban and rural areas. This can be achieved through urban greening that entails amongst other things, establishment of home gardens or agroforestry (World Bank, 2001).

Another factor that contributes to sustained growth is by ensuring that decision made about land use is based on the true value of forest. It is also important to ensure that the market for environmental services benefit the poor, support association and finance the local forest businesses. Studies done by Guilleband (2006) have shown that unless growing human population is reduced through family planning, nature will do it for us. The fast and effective means would be epidemics, violence and starvation which are problems faced by developing nations.

2.5 South Africa's current Forest Act (Act No. 84 of 1998)

Urbanization and population growth are very important factors contributing to severe environmental deterioration. Their impacts are more observable on natural resources locally than globally. Other countries have adopted policies dealing with environmental issues and ways to manage resources. Where policies exist, they are either neglected or ineffective due to social issues that persist, for example poverty. South Africa is amongst developing countries that apply policies as a measure to manage natural resources. The country is rich in terms of natural resources mainly grassland and savanna, with some

forests and woodlands. The latter has been valued following the establishment of early settlements in South Africa, but their area has been reduced by half. To sustain the remaining part of forests, the country has implemented forest policies through DWAF to protect and control the situation (FAO, 2002).

Sustainability of forest resource is based on the country's National Forest Act (NFA) (Act No. 84 of 1998). The Act ensures that people make proper use of their forests especially indigenous forest. NFA serves to sustain forests for environmental, social and economic benefits. The Act in support with the National Environmental Management Act (NEMA) (Act No. 107 of 1998), seeks to ensure appropriate utilization of resources through integration of Environmental Management; and thus giving every individual the right to an environment not harmful to their health (DWAF, 2005). Simmons (1977) emphasized that Environmental Management entails production of resources while retaining a well life supporting environment. Therefore, "long term strategies are important and should be based on reducing environmental stress and pursue short term strategies that are sufficiently flexible to preserve long term decisions". Another measure for preserving South Africa's resources includes Community Forestry Programme. The main principle of the programme is to ensure that forests and woodlands in land owned by the community are properly managed and conserved (DWAF, 2005).

2.6 Urban Forestry

Vegetation in urban areas is exposed high stress due to population growth as well as urban expansion. To reduce the impact, Urban Forestry has been implemented to maintain a healthy and accommodating atmosphere in urban areas. In addition to that, the growing urban population needs the environmental and social benefits provided by urban forests. According to Konijnendijk ***et al*** (2006), Urban Forestry dates back in the late 1800s and was based on caring of individual trees in urban space. The programme is described as 'the art, science and technology of caring and managing trees and forest resources in and around urban areas' (Shackleton, 2006).

Urban Forestry is an integral part of Urban Greening; with key objective of enhancing and ensuring a sustained production of environmental, social and economic benefits. DWAF formed a joint partnership with Food and Trees For Africa (FTFA) for Urban Greening Programme and deals mostly with Urban Forestry Programmes. FTFA is a Non-Governmental Organization which through greening projects, aims at promoting environmental management and improving environment. Another goal of this organization is to eradicate poverty and help communities develop skills related to tree planting. Urban Greening is defined as an approach incorporating planting, caring and management of all vegetation in urban and peri-urban areas. These includes townships, and informal settlements especially those in the former homelands as well as rural areas in South Africa. This approach secures multiple benefits for communities through establishment of community projects. Other components of Urban Greening include urban agriculture, permaculture and urban agroforestry (DWAF, 2006).

South Africa has various Urban Forestry Programmes of which some are not under Urban Forestry itself. For example the National Greening Programme launched through the South African National Biodiversity Institute (Shackleton, 2006). There are multiple benefits provided by Urban Forestry Programme. These include amongst others financial security, psychological and physical health benefits. Moreover, in the suburbs of low economic status planting and maintenance of trees provide income generation through sales of fruits, medicines and fuelwood (Leston and Rodewald, 2006).

2.7 Values of trees and forests in peri-urban and urban areas

Trees, woodlands and forests play an essential role for both rural, peri-urban and urban communities and their value is sometimes under-estimated. The role is more dependent on natural endowments for forest, state of its economic development, upon natural aspirations and goals for lives of people. Forests provide fundamental services without which human life won't be possible without (Markandya ***et al***, 2002).

2.7.1 Social benefits

Forests provide many services from Greening projects. Through these projects, communities involved acquire many skills of planting and growing various plants. The results improve the quality of life in terms of health and education amongst people. By involving school children in these projects we stimulate interest in environmental management and promote nature-human interaction (FTFA, 2007). Green areas such as parks, woodlands are used for spiritual purposes as urban areas comprise of people with varying ethnicity, cultures and religions. People tend to use forests and trees for either healing, relaxation or rituals (Moller, 2004).

2.7.2 Economic values

There is a wide range of benefits that forests and trees offer to urban dwellers. They have the ability to provide long and short term benefits to the residents. Trees and forests have a positive influence over the value of the property. People are willing to purchase property with a large area covered by trees than a bare area. For example, a study conducted in Philadelphia has shown that people invest more on properties with large coverage of trees. Trees are more worthy than the cost of planting or nurturing (FAO, 2003). This in turn increases tax flow to local authorities (Laverne and Winson-Geideman, 2003).

2.7.2.1 Significance of peri-urban and urban trees and forests in poverty alleviation

Roberts and Roper (2005) described poverty as a 'multidimensional condition associated with depletion of natural resources'. Consequences include unproductive lands as a result of poor soils, deforestation, poor water supply and food insecurity. In most developing countries, the condition has been accelerated by the rate of urbanization as well as population growth that causes competition over resources. An estimated 843 million people worldwide are currently malnourished and under threat of chronic diseases. A large number of people, about 1.2 million depend on less than a dollar to meet their daily needs (FAO ***et al***, 2005).

Forests, trees and woodlands play fundamental role in all aspects of life. They contribute extensively to the survival of all species in various ways. According to FAO (2005), resources from forests will contribute to the Millennium Development Goals (MDGs) declared at the 2002 Monterrey Summit. The first and foremost goal of MDGs is to 'eradicate poverty and hunger' and ensure that the number of people under malnutrition is reduced by half towards the end of 2015. Forest and woodlands products contribute to the daily dietary basics. They alleviate and prohibit development of chronic diseases by making the body resistant. Nutrients can be obtained from edible fruits, tubers and meat of animals within the forests. Other trees species are capable of producing resins, herbs and leaves of other plants can be used to prepare relish.

Other benefits from forests include harvesting of insects such as bees for honey and 'mophane' worms known for their high protein content. *Prickly pear* is a wild fruit with starch and provide fundamental dietary supplement of South Africa's population. For those people who can't access the wild spinach, mophane worms and wild fruits, can get them from supermarkets such as Pick 'n Pay and Checkers within South Africa. 'Marula' trees are some of the protected species in South Africa. Sap from fruits of these trees is used for brewing beer and if there isn't enough energy during processing, wood can be useful for making fire. Wood burns faster and has less negative effects. Poor households with less or no income can generate income through sales of Marula beer (DWAF, 2005).

In other developing nations some people cannot access and afford conventional cost, therefore forests are a source of African traditional medicine. African traditional medicines are important for both rural and urban communities especially in African countries. For example, an estimated 80% of urbanites utilize African traditional medicines particularly from indigenous forests. African traditional medicine is commonly used for various reasons, by traditional healers as well as community. Products used include tree parts like bark, roots, leaves, and tuber from other plant species to prepare mixture. Plants utilized include the tree itself, climbers, shrubs, epiphytes and parasites (DWAF, 2003). In addition, animals are also used for healing purpose and include

snakes such as black mamba and python, baboons and hyena. DWAF (2005) also added that “there is a strong informal market in medicinal plants from woodlands”.

An estimated 51% of forest in South Africa is utilized for domestic energy and annual wood consumption is about 11 million tones. Woodlands form basis of consumption as 60% of the overall consumption is from these areas. Iron Age human species has long preferred woodland areas as their livestock grazing fields, areas to access timber for housing, source of fuelwood for warming up as well as timber to build their huts and kraal. These resources are still valuable particularly in communities where electricity is a problem, and where livestock farming is practiced (Lawes ***et al***, 2004). There is also a growing commercial firewood and charcoal market in urban areas of which woodlands are the main source.

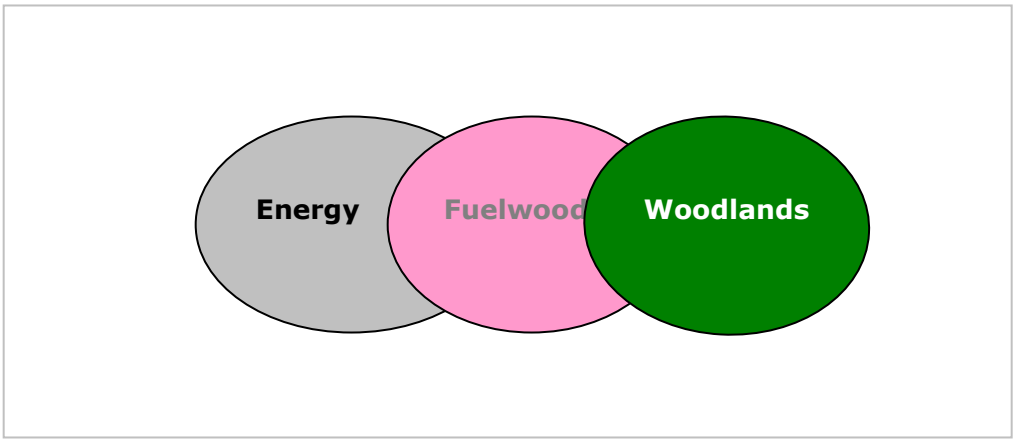


Figure 2.2: The relationship between woodlands, energy and fuelwood. *Source*: DWAF, 2005.

Trees, woodlands and forests provide various kinds of services and goods to people. For example, people benefit directly and indirectly from employment offered by different forestry companies. Thousands and thousands of people are working in companies such as South African Pulp and Paper Industry (SAPPI), Mondi, and Governmental departments like DWAF. These forest sectors contribute to socio-economic development by helping emerging foresters. At SAPPI contractors get technical advice, free seedlings

and free loans to establish trees. These people are guaranteed market for their product (Sunderlin and Thu Ba, 2005).

Programmes such as Urban Greening lead to the establishment of gardens and nurseries in schools, church, clinics and township within South Africa. The programme gained support from banks, Universities, De Beers, Anglo American, and Sasol. Urban Greening has had an influence on social interaction between communities and environment. People involved include both adults and young within the community. Food produced is used to supply those communities with poor living standards. Moreover, children within school involved in greening benefit from the programme. Urban Greening generates lots of employment opportunities within the community (FTFA, 2007). Forests can aid in food security programmes and thus reduce level of poverty. This can be achieved through transformation of forest areas to agricultural lands in order to support the growing population.

2.7.3 Environmental values

a. Climate

As level of urbanization increases, it is accompanied by more industries associated with hazardous gases and high temperatures. The results are high demand for cooling equipments such as air conditioners unaffordable in poor nations. Therefore, trees in urban sphere can improve the condition by absorbing and stabilizing temperatures. According to the Land Owner Resource Centre and the University of Toronto's Faculty of Forestry (1994), during cold seasons windbreaks can reduce winter heating costs by up to 25% by limiting amount of air circulation within the area. Urban areas with street aligned with trees are cooler than paved and bare grounds (Evans, 2001). Urban forests like all trees are important in carbon dioxide uptake and hence contribute to mitigating global warming.

b. Pollution

Air pollution is a major issue in urban areas of both developing and developed countries. This is a threat to health of both human and animal species as they are at risk of various

diseases. Urban trees and forests can improve air quality through absorption of pollutants such as carbon dioxide, ash, dust and ozone in the atmosphere. In so doing these gases remain trapped in roots, trunk, branches and leaves of trees to be utilized during photosynthesis. Oxygen is then released into the atmosphere to be used by human beings. Noise from vehicles and industries can be distressing in urban areas. Therefore, availability of trees in the streets can aid in reducing and stabilizing the situation (Muessig, 2007).

c. Soil

In portions covered by vegetation in urban environments, nutrients necessary for growth and organic matter are retained within the surface. As organic matter remain within the soil, the level of ground water rises because the surface is well aerated and drained to allow more water to slip through. Disadvantaged communities depending on ground water system can thus benefit. Trees prevent and reduce surface runoff during heavy rains and flood or windy conditions. Roots play a major role by holding soil particles together and prevent soil from being leached. Canopies are essential for reducing the force of falling rain drops. Some animals and birds establish their habitats in urban areas. Therefore, planting trees and establishing woodlots within urban periphery can attract these species. They form part of biodiversity (Evans, 2001).

2.8 Conclusion

The process of change in the forest will always persist with continues population growth and urban expansion, at a rate unacceptable for the existing planet resources. Our forests remain being the mantle of the poor providing fuel and shelter for as long as they last. Population growth is thus an element of every social concern and need to be dealt with accordingly. The problem starts with changes in population density that in turn result in overcrowding that can spread out. Sustaining resources cannot be assured under unsustainable life, therefore there is a need for development and implementation of suitable approaches to tackle current and future problems concerning forests and environment as a whole. Policy as well as decision makers should play a role in ensuring sustainability of our forests.

Chapter 3

Materials and methods

3.1 Introduction

The study has been conducted in six different sites within Rustenburg Local Municipality. Data collection has been based on questionnaires, and was to determine the relationship between households and their local forest (including trees in their yards). Even though questionnaires are difficult to design and time consuming, the method proved to be cheap. Questionnaires have been essential "devices" effective in reaching and covering extensive areas and thus making it possible to meet a large number of people. According to Peterson (2000), questionnaires improve response rate for sensitive questions through possible anonymity of respondents. The disadvantage of using this method is that it is hard to work with illiterate respondents and more time is needed to complete them especially with elders. Respondents are either impatient or don't have time to complete them. Types of questions used for the study were:

a. Open ended questions

These questions take less time and effort to construct as compared to closed end questions. No possible answers are incorporated and participants are free to provide any answers they believe are appropriate. This type of questions assists in obtaining a fundamental understanding of the topic and information on certain variables. The design of questionnaires was mainly based on collecting both quantitative and qualitative data. Through quantitative data findings can be generalized, and this type of data is dependent on qualitative judgments made by different respondents.

Secondary data was also used in the study and main source included Department of Water Affairs and Forestry (DWAF), Statistics South Africa, Rustenburg Local Municipality (RLM), and Department of Environmental Affairs and Tourism (DEAT).

b. Sampling unit

Individuals from the age of 10 to old aged were chosen in this criterion in order to have their perspectives in terms of their relationship with their local trees and forests. The underlying principle for selecting age group between 10 and above was because some of these people are involved directly or indirectly with the forests. Involving people from different age groups may offer insight into whether different subsets of community members value same plants in different ways and to what extent. Included here were people from municipality, community, relevant department like Statistics South Africa, DEAT as well as DWAF.

3.2 Sampling method

i. Stratified sampling

According to Valliant ***et al*** (2000), stratification sampling is a common method of sampling that contributes to efficient administration of large surveys. Stratification allows flexibility in the choice of data collection procedures used for various populations. Sample for the study has been stratified according to type of residence, age and occupation. The first stratum allows comparability between residents as they have different views towards forests, and use them differently. Sample stratified according to age included only a particular age stratum of the site's population. The latter one has a significant role in distinguishing between communities and their location.

Convenience method has been applied with stratification method to make data collection easier and more effective. Convenience type of sampling is fast and effective for collecting data. The method uses most readily available subjects in which an accessible group of people is chosen and everyone in that group is surveyed. It is easy to organize and quick but there is no guarantee that behaviours of these people represent the others. The method has been applied where there is restriction especially employee at work. A certain number of employees was selected to represent all in the workplace.

ii. Sample size

Sample size influences the detection of significant differences and relationships. Designing sample size minimizes alpha and beta errors in the population. Alpha errors is a means of finding differences that does not exist in the population while beta is a way in which an individual fails to find differences that exist in the population (Bartlett ***et al***, 2001). Sample of 272 people was chosen for the survey within the municipality and was estimated based on the standard deviation of about 0.5.

Sample size was calculated based on the population of the municipality and six sites including Rustenburg town, Boitekong, Kanana, Meriting (specifically Sondela), Cashan and Geelhout Park. The reason was to acquire information from various respondents based on their type of residence and living standards. However, a small percentage from a sample was surveyed from Rustenburg town, about 22 participants due to some restrictions from the Municipality. This is important as the area and location of an individual can influence the way that person feels about the environment. Some of the selected areas are urban, peri-urban and others are difficult to classify as they hold on the characteristic of either one of the above mentioned. Various programs that used during the research process include the following:

- **Microsoft Excel**

This is a spreadsheet package, and all the data collected was fed into the system to directly analyze it. Most of the data collected was prepared using this software for use in Statistical Package for the Social Sciences (SPSS).

- **Statistical Package for the Social Sciences (SPSS) 15.0**

SPSS is useful and effective in conducting statistical analyses, manipulating and management of data as compared to other programs. The program assisted in generating tables and graphs that summarize data. Through this system, an individual can use complex statistical techniques. For example, for this study two techniques have been applied including regression model for analyzing quantitative data, and descriptive statistics called frequencies for qualitative.

a. Regression model

The main principle behind using this model was to determine the relationship between independent and dependent variables. The model shows the best prediction of the dependent variable, defined by Y in the equation, given the independent variable X. The model is defined by the following equation:

$$\mathbf{Y=b_1x_1+b_2x_2+...+b_nx_n+c}$$

Y is the predicted value of the dependent variable.

b represent regression coefficients showing the amount the dependent variable changes when independent variables changes.

x is the value of the independent variable.

n is the number of predictors.

c represents the amount the dependent Y will be when all independent variables are 0. This is a constant number where regression line intercepts.

b. Descriptive statistics

This is the simplest type of statistical technique that only tabulates the number of times any category is used.

✧ **Microsoft Word**

This software has been important before the study can commence mainly while designing questionnaires. It also assisted in editing and working on new as well as available data throughout the research process. Included here are the data from already documented papers and data acquired from study sites to support all the chapters.

✧ **Geographical Information System** (GIS):

GIS program aided in production of maps of areas under investigation. This program has long been recognized as a useful tool in the management of natural resource development, land use planning, wildlife management, environmental planning, and

forestry planning. The use of this program can allow urban foresters to make more thorough and cost effective management decisions in urban forests (Miller, 1997).

- **Literature review**

This method plays a fundamental role in expanding the researcher's knowledge about the topic and used to support the problem statement. Moreover, materials used in gathering this information are good in identifying or having knowledge about how people abroad view things. These materials may be books, newspapers, journals and internet. Information from journals is more reliable as they have been published and any change regarding the available information can take a long time. With newspaper, it is hard to get valid evidence about what is written there. Information from internet has proved to be unreliable as research is sometimes not provided with authors and the information can be changed anytime.

In addition to the above mentioned, an open participant observation method played a major role in gathering the information. With this method an individual is able to have a better knowledge and understanding of the area under investigation. There are positive aspects of observational research approach in that observation is flexible and do not need to be structured around hypothesis. Observational research findings are considered to be strong in validity as the researcher has the ability to collect a depth of information about a particular behaviour and characteristics. Observations give additional, more accurate information on people's behaviour than interviews and questionnaires. Through this method it is easy to obtain knowledge, skill as well as important data quickly. However, ethical issues regarding confidentiality and privacy may arise. The presence of the observer may have an influence in the situation been observed.

Digital camera is one of the tools that were used to capture information and aided in taking photographs from different sites. The tool provides the reader with a clear picture of the state of the environment and also assists in giving details about the event during data analysis. A researcher can draw a valid conclusion from the picture. The information

in the picture is more reliable and cannot be changed unless if being used by another person.

3.3 Conclusion

The above methods and tools have been of importance in making it easy to obtain the required information regarding the study. Despite the success in data collection some problems have been encountered during the process. These include having difficulties in working with other community member, and being exposed to dangerous situations. All the data acquired during fieldwork has been used in compiling chapter 4 and 5.

Chapter 4

Data analysis

4.1 Introduction

This chapter focuses specifically on analysis of the data from six different study sites within Rustenburg Local Municipality. Methods in the previous chapter have been incorporated throughout the process of analysis. To simplify the process, the data was fed into Ms excel for rearrangement and prepare it for analysis in Statistical Package for Social Sciences (SPSS). Analysis included qualitative data with an addition of quantitative data. Qualitative data covered the data from observation, questionnaires, video recording and already documented data. The advantage of using qualitative data is that it offers an opportunity to gather more information about participants' perspectives. Quantitative data are better suited for the production of numerical results that are more statistically reliable and thus enabling measurement and control over variables. Through SPSS package quantitative and qualitative data were analyzed using various statistical techniques. Both quantitative and qualitative data were represented by numbers in SPSS to allow rapidly verifiable results.

Two statistical tests were utilized from range available in SPSS software package. For quantitative data a regression model was employed, while qualitative data involved the descriptive statistics. The purpose of the former technique is to ascertain the relationship between various independent variables and dependent variables. The latter approach involves the use of numerical techniques to describe the qualitative data. Through this technique, numbers of response are simply counted. Qualitative data work as a supporting system for quantitative data in which an individual can weigh results and make a conclusion about the problem related to the study area.

4.2 Qualitative analysis

Qualitative analysis was carried out to determine the relationship between the households and their local forest. Forest in this context refers to any trees within households, forest resources such as medicine; and food from local forest that is utilized to improve

livelihoods. Variables used in determining the relationship included gender (ge), have trees or forest (ht/f), access to forest (acctf), restrictions towards the use of forest (restrict), value for forest (valffore), permanent residence (pr), interaction (intac) and household extension (hhext). Findings have shown good relationship between participants and their local forest. This is indicated by their positive strong response towards how they value forest. There are three variables having more influence on the relationship between households and forest. These include value for forest, access to the forest as well as interaction. The first one accounts for less variability and thus more significant in showing the relationship.

Additionally, the variable 'value for forest' presents a stronger relationship as compared to the other variables and is best described by the highest mean value of 0.94 with a smallest standard deviation of 0.236 provided in table 4.1. The results show how close the variable is, in defining the relationship between forest and households. A large percentage of households value their local forests. The value is either based on timber production, fuelwood production, forest food and medicine, and other purposes. With a larger number of people valuing the forest and with access to the forest, most of them are likely to interact by using forest resources. Moreover, even though people do value their forest and have access to it, some of them may choose not to have trees in their yards.

Table 4.1 Summary of descriptive statistics

		**Ge	Ht/f	Intac	Acctf	Pr	Hhext	Restrict	Valffore
N	Valid	272	272	272	272	272	272	272	272
	Missing	0	0	0	0	0	0	0	0
Mean		.53	.69	.85	.93	.60	.47	.37	.94
Std. Deviation		.500	.461	.358	.249	.490	.500	.483	.236
Skewness		-.133	-.851	-1.963	-3.510	-.423	.104	.552	-3.771
Std. Error of Skewness		.148	.148	.148	.148	.148	.148	.148	.148
Minimum		0	0	0	0	0	0	0	0
Maximum		1	1	1	1	1	1	1	1
Percentiles	25	.00	.00	1.00	1.00	.00	.00	.00	1.00
	50	1.00	1.00	1.00	1.00	1.00	.00	.00	1.00
	75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

*The table summaries names of variables that have been studied, number of cases = 272 without any missing values. Skewness and standard error of skewness. Minimum and

maximum value for each variable. Mean and the standard deviation showing the dispersion of each variable based on the data set. **Refer to page vii for detailed information about the variables in **table 4.1** above.

Other variables such as gender, household extension, restriction, permanent resident are less significant in showing relationship between the household and their forest.

Frequency tables explaining qualitative data

There were differences regarding number of males and females who participated in the survey. The results shown in the table below indicate that females outnumbered male participants by 3.3%.

Table 4.2 Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	127	46.7	46.7	46.7
	1	145	53.3	53.3	100.0
	Total	272	100.0	100.0	

0= Male

1= Female

Table 4.3 summaries the percentage as well as frequency of households with natural or planted trees. Included here are also those households who own some forest. From findings it is clearly showing that most households, that is 69.5% have trees or forest.

Table 4.3 Households with trees or forest

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	83	30.5	30.5	30.5
	1	189	69.5	69.5	100.0
	Total	272	100.0	100.0	

0= No

1= Yes

From all households that were surveyed, 84.9% of them interact by utilizing forest products such as fuelwood, timber, and medicine or forest food.

Table 4.4 Degree of interaction with forest

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	41	15.1	15.1	15.1
	1	231	84.9	84.9	100.0
	Total	272	100.0	100.0	

0= No

1= Yes

The variable 'access to forest' is the most important factor determining how and to what extent the community interact or relate to the local forest. Rate of interaction can either increase or decreases depending on whether there is free access to the resources or not. Results here show that although 93.4% of the households have access to their local forest, some chose not to interact or use forest resources.

Table 4.5 Access to forest

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	18	6.6	6.6	6.6
	1	254	93.4	93.4	100.0
	Total	272	100.0	100.0	

0= No

1= Yes

About 60% of participants in the study are permanent residents. When relating this figure to the ratio of those who interact in table 4.4, an assumption can be made that the majority of participants interacting are permanent residents. This shows that positive relationship thus exist between the local community and their forests.

Table 4.6 Permanent resident

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	108	39.7	39.7	39.7
	1	164	60.3	60.3	100.0
	Total	272	100.0	100.0	

0= No

1= Yes

Table 4.7 below provides the information about number of participants intending to expand households and those that are not planning to expand. Household extension in this context refers to increasing number of individual per household. This can greatly affect the extent to which people interact as most participants are not planning to extend their households. Additionally, forest resources can be spared and sustained for the future. The population of the area can be kept at its minimal and less will be required to fulfill energy needs.

Table 4.7 Household extension

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	143	52.6	52.6	52.6
	1	129	47.4	47.4	100.0
	Total	272	100.0	100.0	

0= No

1= Yes

Results from the sites were the study was conducted indicated that restrictions regarding the use of local forest are below 40%. Even though sites are within municipal area, this shows less restriction. These could be fueled by either socio-economic reason within the area. Any municipal area is expected to have restrictions regarding the use of resources. Due to less restriction, more households have access to forest and therefore can use forest resources. About 63% of households responded negatively towards restrictions regarding the use of local trees and forest. They indicated that if there are restrictions within their area, they are not effective.

Table 4.8 Restriction regarding the use of local forest

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	172	63.2	63.2	63.2
	1	100	36.8	36.8	100.0
	Total	272	100.0	100.0	

0= No

1= Yes

Value for forest is the most important variable amongst all the above mentioned. With less variation in regards to how households value their forest, more interaction is

expected provided other factors are kept constant. This can therefore result in stronger relationship between households and their local forest. The table below shows the ratio of households that value their forest.

Table 4.9 Value for forest

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	16	5.9	5.9	5.9
	1	256	94.1	94.1	100.0
	Total	272	100.0	100.0	

0= No

1= Yes

In general, trees and forest sites are valuable in all study sites except for Boitekong area with a lower value. Less restricted sites include Kanana and Boitekong. Restriction is higher in areas like Cashan and Rustenburg as compared to Geelhout Park and Meriting. In sites where overcrowding is a problem, more participants are planning to extend their households. Most households in all sites have trees and thus interact. Gender does not play a significant role in relation to households and their trees and forest. Anyone within the household can use forest produce.

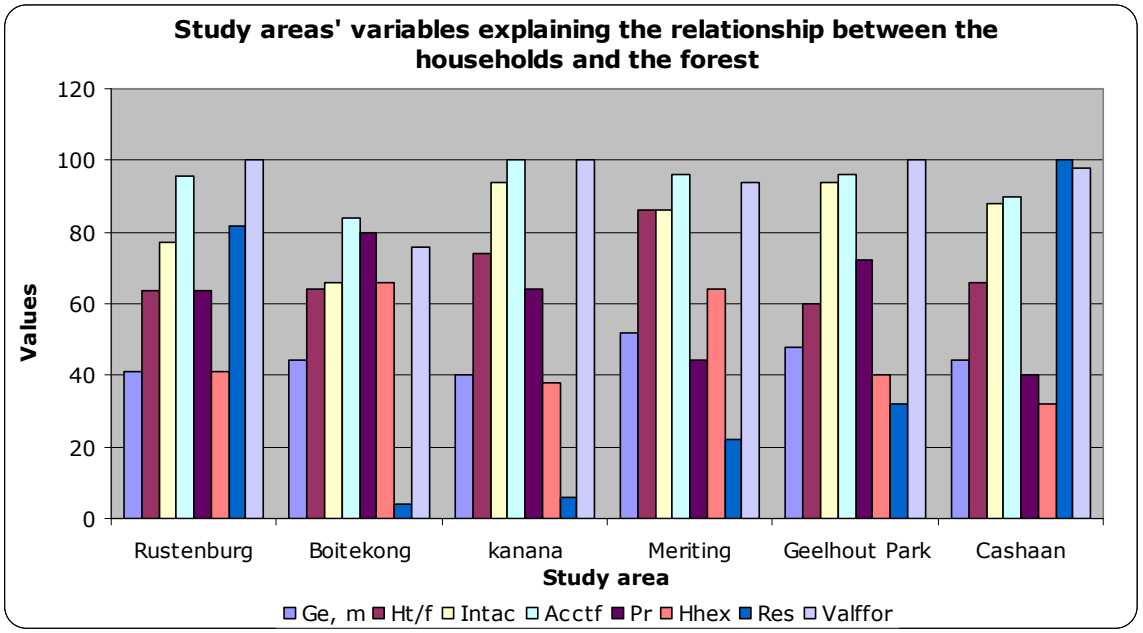


Figure 4.1: An extent to which each variable influence the relationship between households and forest for each site.

*Refer to page vii for detailed information about the legend in **figure 4.1** above.

Survey involved individuals between 10 years and over. Age range that accounts for the largest number of participants in the study area is 21 to 30 as well as 31 to 40 years. The survey covered only 5% of elders especially those above 50 years. Age distribution did not have major impact in the households' relationship towards their trees and forest as compared to other variables such as gender.

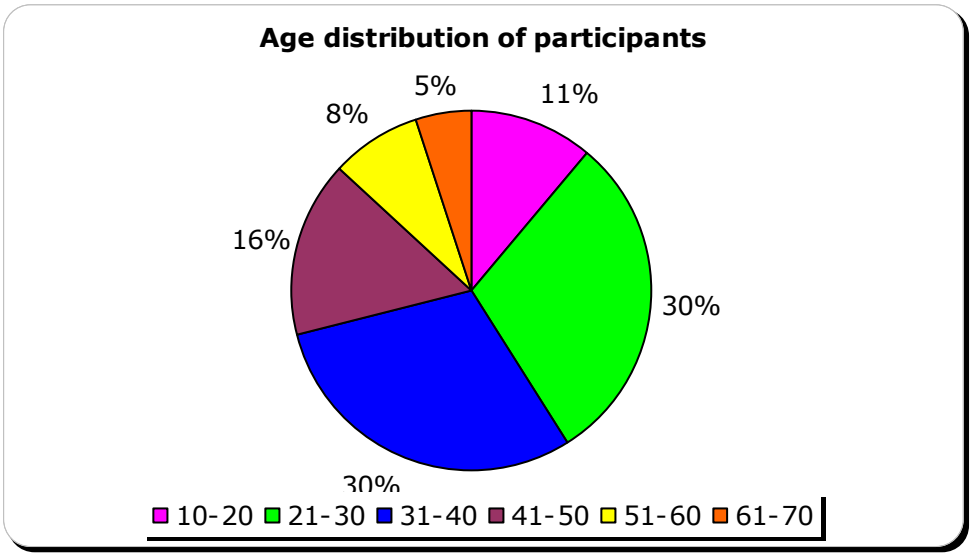


Figure 4.2: Pie chart showing the age distribution of participants.

4.3 Quantitative analysis

The main purpose of carrying out this analysis was to determine the productivity of forestlands within area under investigation. Regression model was applied as it is the best method to show how independent variables influence the dependent variables. That is how dependent variable changes with the change in or addition of different independent variables. The method can easily be understood through the equation below, and has been thoroughly discussed in chapter 3:

$$Y=b_1x_1+b_2x_2+...+b_nx_n+c$$

Four predictors used in the analysis were age distribution, employment (emp), gross annual income (gin) and household size (hh size). These variables were useful in determining fuelwood production, timber production as well as forest food production. The following results were obtained:

4.3.1 Fuelwood Production

Fuelwood production refers to the amount of wood consumed from forest as source of energy by each household per year. All the data used for estimating fuelwood, timber and forest food production, were based on the data acquired from households. The data was in grams depending how much each household utilize resource and converted to tons. There are various measures provided in tables showing whether predictors influence the production or not. The most important part of analysis is to ensure that the model is best for the data worked on.

Whether regression model is appropriate and best for analyzing the data depend on the R Square in table 4.10. R Square is a coefficient of determination, with the purpose of determining whether the model fit. This coefficient is defined as 'the proportion of variation in the dependent variables explained by different independent variables (regression model). For the model to be regarded as good for analysis, values of R Square should range from 0 to 1. Findings from analysis (table 4.10) showed that the model thus fit for all independent and dependent variables. Predictors (independent variables) in this model signify a strong relationship with the dependent variable. From the output, about 79.9% of variation in fuelwood production is explained by the relationship with the predictors (household size, age distribution, gross annual income and employment). The nature of relationship is based on the R value of 0.894, which shows strong positive relation between independent variables and the dependent variable.

Table 4.10 Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.894[a]	.799	.784	.610

a. Predictors: (Constant), Household size, Age, Gross Income/hh/yr, Employment/hh/yr

b. Dependent Variable: Fuelwood production (t/hh/yr)

Analysis of variance (ANOVA).

The main principle of ANOVA is to determine whether the independent variables are important in explaining the variation in dependent variable. Significant value of F statistic is 0.00 and less than 0.005 showing that all variables are highly significant in the model.

Table 4.11 ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	76.816	4	19.204	51.675	.000[a]
	Residual	19.325	52	.372		
	Total	96.140	56			

a. Predictors: (Constant), Household size, Age, Gross income/hh/yr, Employment/hh/yr

b. Dependent Variable: Fuelwood production (t/hh/yr)

Most variables in the model are not significant except the household size as shown in table 4.12. To verify the importance of each variable, standard coefficient (Beta) is used. The coefficient describes how much the dependent variable increases with an increase in independent variables. When comparing independent variables, household size has the highest coefficient of 0.943. Furthermore, **t-test** results also show that this variable is significant with the value above 2 which is 13.028. Although the model proved to be the best for the data, most of the variables are not significant. Refer to table 4.12 on sig column showing household size as an important variable in relation to fuelwood production.

Table 4.12 Coefficients[a] of independent variables

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.010	.335		6.001	.000
	Age	.001	.006	.012	.197	.845
	Emp/hh/yr	-.147	.087	-.120	-1.680	.099
	GIn/hh/yr	.000	.002	.015	.225	.823
	Hh size	.555	.043	.943	13.028	.000

a. Dependent Variable: Fuelwood production (t/hh/yr)

Due to the results in table 4. 11 where it indicates that all variables are significant, their coefficients can be used in estimating the fuelwood production. Using these values in the regression equation, an expected production based on values of independent variables will be:

Expected Production = 2.010+Age (0.001) + Employment (-0.147) +
Gross income (0.000) +Household size (0.555)

Expected Production = 2.010+0.001-0.147+0.000+0.555

= 2.419 tons per household per year

Therefore, an expected fuelwood production is **2.419 t/hh/yr.** Changes in production is triggered by all these coefficients depending on the type of relationship they have with their dependent variable. Age distribution as indicated in table 4.12 plays no significant role in the dependent variable. Change in this factor will have no impact on production. Employment shows a strong negative relationship, any increase in number of people employed per household will lower consumption or production. More household may decide on not using the fuelwood anymore. With gross income no relationship exists with fuelwood production. Of all independent variables, household size with the highest value 0.555 showed a strong positive relationship with dependent variable (fuelwood production). This household contributes more in determining fuelwood production.

Any change in household size will bring changes to the production. For example, an increase in household size will result in more fuelwood being needed to support the growing population, this in turn will cause decline in forest areas. If the forest in the area can continue to supply the growing population, it can be regarded as productive. This is true only if other factors are kept constant, which means no tree planting projects assisting in reforesting the area.

Residuals in the table below refer to the difference between observed values of the dependent variable and predicted values of independent variables. Observed values are those that have been acquired during data collection while predicted values have been calculated in the system. The most important reason for using the residual statistic table is to ensure that the regression model is appropriate for analysis. Measures used in evaluating the significance of the model include standard error of estimate from table 4.10, standard deviation, mean, and standardized predicted and residual values.

Table 4.13: Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.91	7.31	4.54	1.171	57
Residual	-1.121	1.035	.000	.587	57
Std. Predicted Value	-1.397	2.359	.000	1.000	57
Std. Residual	-1.839	1.699	.000	.964	57

a. Dependent Variable: Fuelwood production (t/hh/yr)

*Std. is the standardized predicted or residual value.

*N = Number of households

In order to decide whether the model is good the standard error should be less than the standard deviation of the dependent variable. Furthermore, the mean of the dependent variable should be greater than standard error. The results are true for this analysis with the standard error of 0.610, mean of 4.54 and standard deviation of 1.171. The mean for the standardized predicted values is also 0 with a standard deviation of 0.587 close to 1. Coefficients for the standardized residuals is also 0 and have the standard deviation of 1. These are all good indicators of a good model.

The regression standardized residual graph below takes a form of a normal distribution curve. There is a fair distribution of fuelwood amongst the households that has been surveyed. More households still have a good relationship with these resources. Some households within the Municipality still lack services like electricity coupled with high unemployment rate; therefore they utilize fuelwood as their energy source. Despite the availability of electricity in other areas, some households still rely on these resources as life in urban areas is hectic. Fuelwood is used in order to reduce the electricity bills, for cooking and warming water as well as home. Therefore, electricity can be spared for lighting homes only.

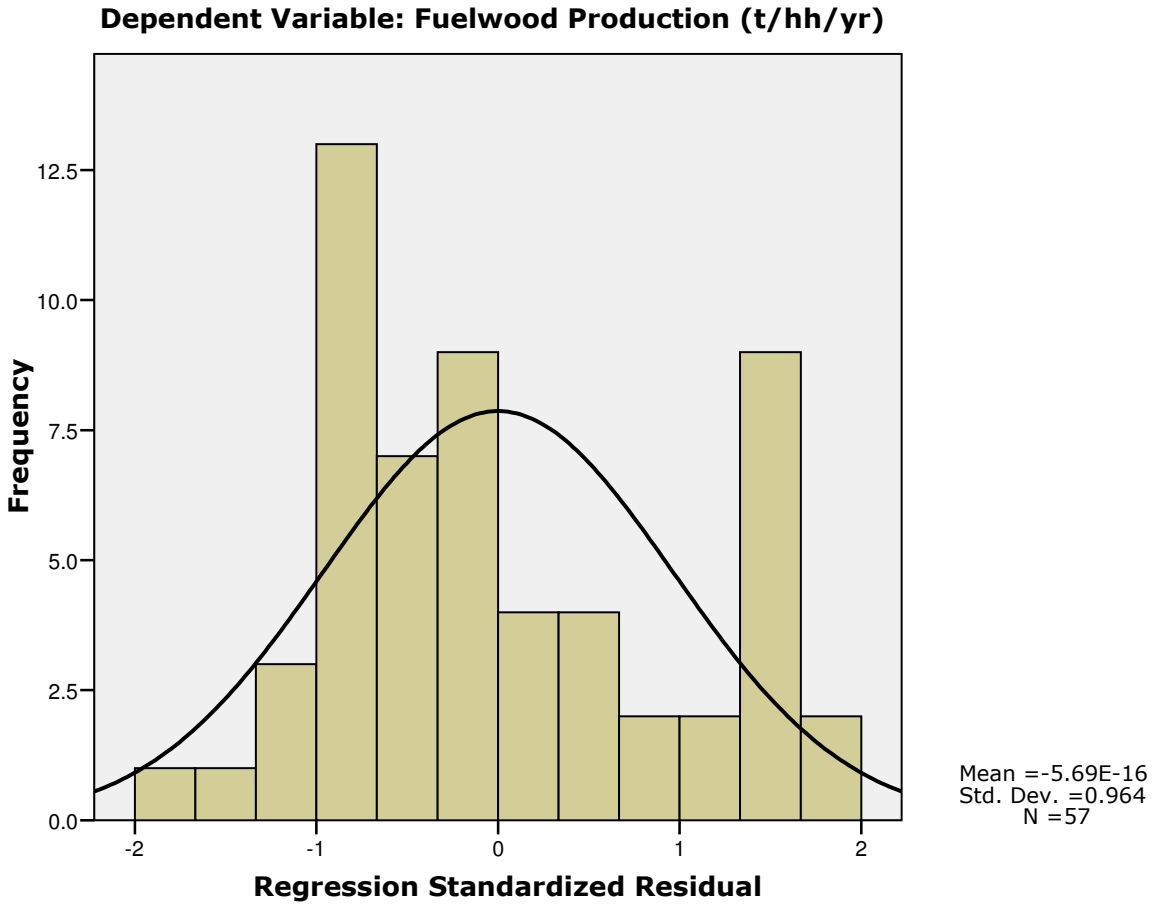


Figure 4.3: Distribution of fuelwood amongst households.

The scatterplot below clearly shows a strong positive linear correlation between household size, age distribution, employment and gross annual income towards fuelwood production. Any increase in all these variables will contribute to an increase in fuelwood production. R Square shows that about 96% of variations in fuelwood production are explained by the independent variables used in the model. Red and black lines are close to each other indicating a best fit. The lines are important in showing the extent to which all the points on a scatter plot are clustered. From this figure more points deviates towards the right than to the left but are all along fit lines.

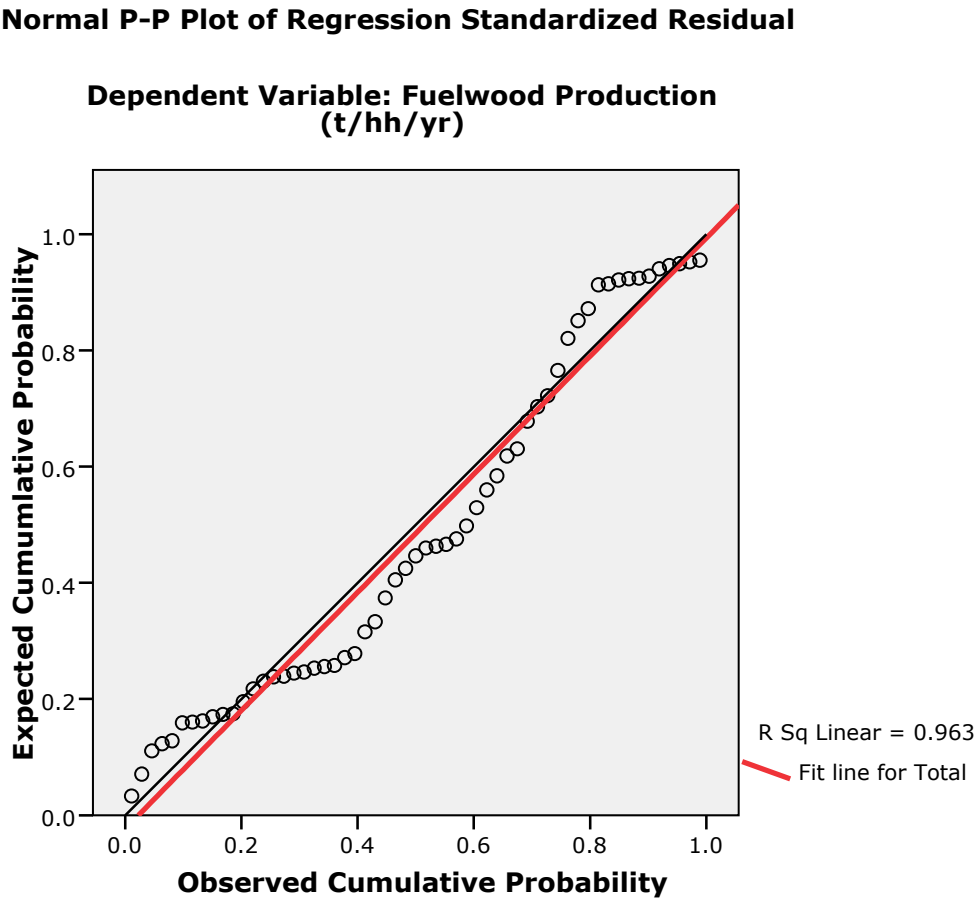


Figure 4.4: Scatterplot showing the relationship between independent variables and fuelwood production.

* R Sq is the R Square

4.3.2 Timber Production

Timber production is the amount of wood utilized for either fencing, making kraals for keeping livestock or any other purpose. The model had again proved to be relevant for the data. Table 4.14 gives detailed information about the significance of the model through R Squared and value of R, which are found close to 1.

Table 4.14 Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.828[a]	.685	.545	.934

a. Predictors: (Constant), Household size, Age, Gross income/hh/yr Employment /hh/yr

b. Dependent Variable: Timber production (t/hh/yr)

In addition, ANOVA plays a vital role in determining whether the predictors are significant in showing variation between timber productions. The result indicates that independent variables are significant; with the significance probability value of F being 0.023 and below 0.05.

Table 4.15 ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.078	4	4.269	4.895	.023[a]
	Residual	7.851	9	.872		
	Total	24.929	13			

a. Predictors: (Constant), Household size, Age, Gross income/hh/yr, emp/hh/yr

b. Dependent Variable: Timber production (t/hh/yr)

Significance of each independent variable depends mostly on the p-value (0.005). All these variables except household size with the p value of 0.006 are not significant in predicting production. The coefficient of age distribution indicates that this variable is not related to timber production, hence is not significant. Any change in an individual's age per household would have no impact in the amount of timber consumed. Employment and gross annual income shows a negative relationship with timber production. With an increase in number of people employed and income per household, less timber will be consumed. This is true as more people get employed and get better salary they may decide on using wire fencing that can last for a long time. In turn it will save both time and money, and reduce timber consumption.

Table 4.16 Coefficients[a] of independent variables

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.042	1.081		.964	.360
	Age	.036	.020	.336	1.753	.113
	Emp/hh/yr	-.033	.293	-.029	-.112	.913
	GIn/hh/yr	-.001	.012	-.015	-.066	.949
	Hh size	.468	.130	.794	3.587	.006

a. Dependent Variable: Timber production (t/hh/yr)

Household size is an important factor in predicting timber production. This variable signifies a positive relationship with the dependent variable. Any change in the household size is expected to change timber consumption or production. Therefore, an expected production will be:

Expected Production = 1.042+Age (0.036) + Employment (-0.033) + Gross income (-0.001) +Household size (0.465)

Expected Production = 1.042+0.036-0.033-0.001+0.465

= 1.509 tons per household per year

Therefore an expected timber production is **1.509 tons per household per year.** If the households depending on timber double, the consumption will also increase to **2.277 tons per household per year.**

The residual statistic table is important to ensure that the regression model is good for the data that has been analyzed. This can be determined by comparing the standard error of estimate from model summary with standard deviation and mean in the residual statistic table above. Characteristics of a good model include the standard error of estimate less than the standard deviation of dependent variable, with the mean also greater than the standard error of estimate. This is true for this model. Additionally, mean for the standardized predicted values is also 0 with a standard deviation of 0.777 close to 1. For the standardized residuals is also 0 and have the standard deviation of 0.832 also close to 1. These are all characteristics of a good model.

Table 4.17 Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.66	7.13	4.93	1.146	14
Residual	-1.989	.873	.000	.777	14
Std. Predicted Value	-1.976	1.918	.000	1.000	14
Std. Residual	-2.130	.935	.000	.832	14

a. Dependent Variable: Timber production (t/hh/yr)

The graph indicates characteristics of a Poisson probability distribution. This type of distribution results from the mean being the same as the variance. Each bar represents a proportion of timber utilized annually per household. An area of empty space is caused by the less consumption below the expected or that can be calculated in the system. From this graph, timber resources are not fairly distributed amongst households. Factors contributing these include both economic and social factor. Scarcity of wooden poles within the area, as well as shift in households needs due to a growing economy. Households turn to use wire fences that last longer than wooden poles.

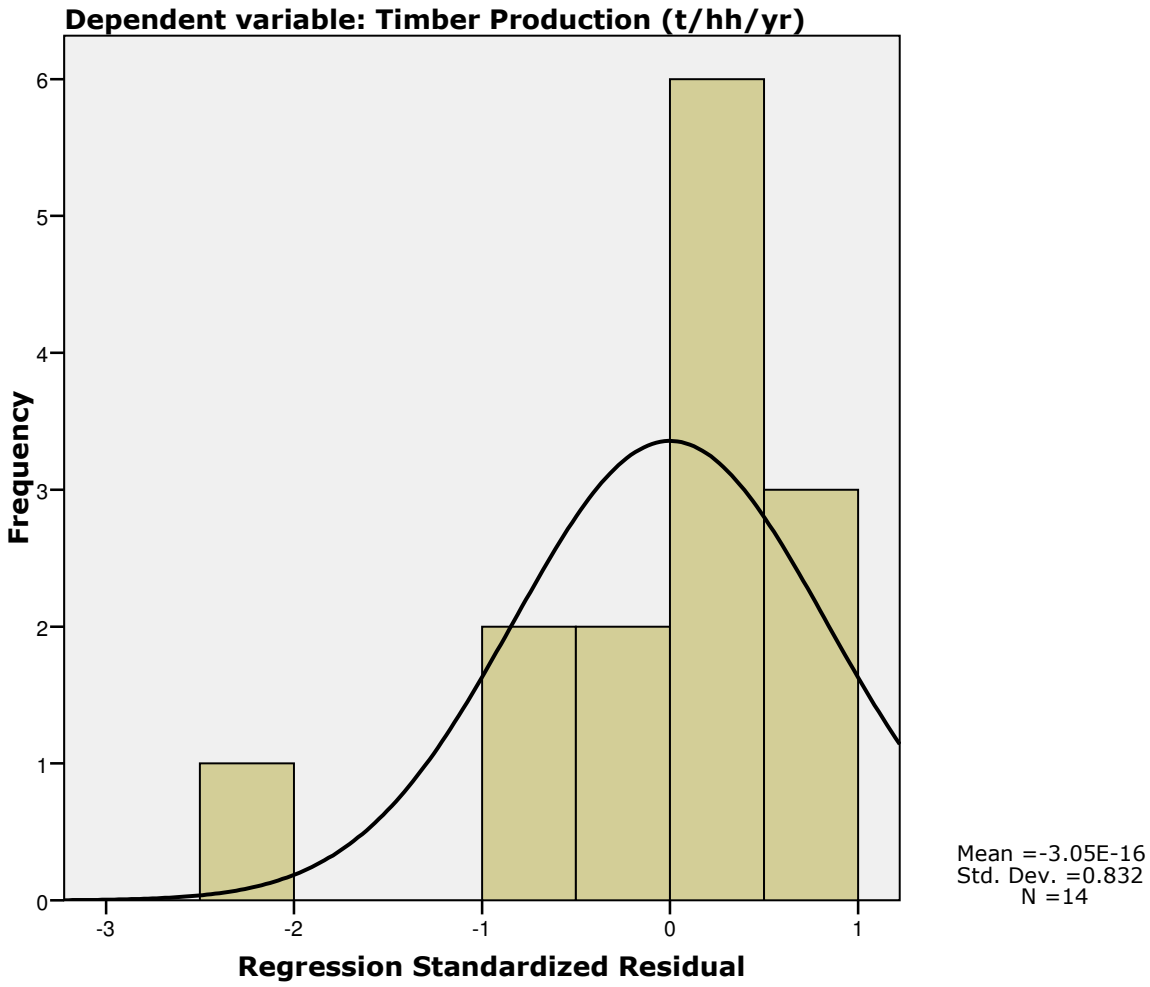


Figure 4.5: Distribution of timber amongst households.

There is a positive linear relationship between household size, age distribution, employment and gross annual income towards timber production. Any increase in all these variables will impact timber production. About 90% of variations in timber production can be explained by the independent variables used in the model. Black line shows a possible fit of points, while fit line for total signifies the exact relationship that exists between these variables (X, Y) in the model. This explains how the independent variables influence the dependent variable, the expected production. With the black line more points deviates towards the left than to the right. Red line indicates more deviation to the right, but both lines form a linear pattern.

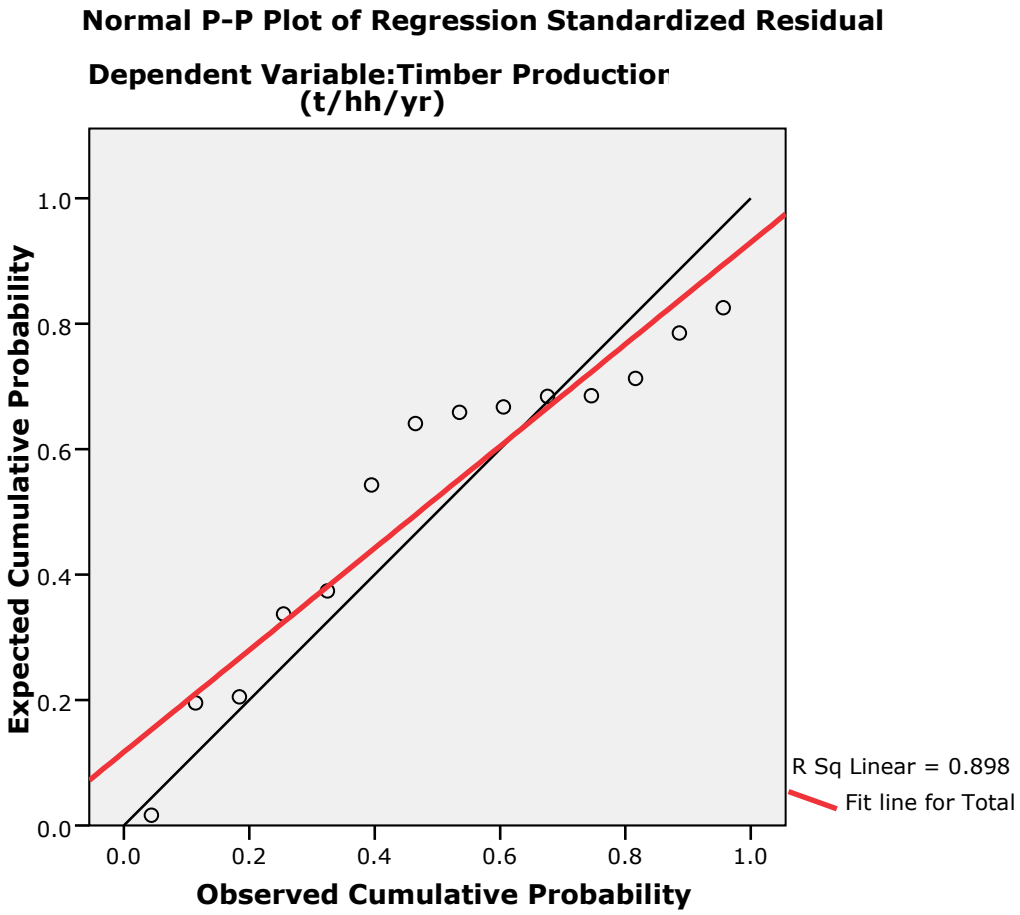


Figure 4.6: Scatterplot showing relationship between independent and timber production.

4.3.3 Forest Food Production

Forest Food Production refers to the amount of food (fruits, tubers, medicine, meat, etc) obtainable from the local forest. These also include food from planted trees or crops in urban or peri-urban areas gardens. Four independent variables (household size, age distribution, gross annual income and employment) were also used here to determine forest food production of area being studied. Analysis showed that regression model is significant for the data of the study been carried out. R and R Squared values in a model summary table, show the significance of this model. Coefficient of correlation-R indicates that there is a strong relationship between independent variable together with the dependent variable. An estimated 82% of variation in the forest food production can

clearly be explained by all the independent variables taken together. The values of these measures are found closest to 1, characteristic of a good model.

Table 4.18 Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.903[a]	.816	.807	.62534

a. Predictors: (Constant), Household size, Age, Gross income/hh/yr Employment /hh/yr

b. Dependent Variable: Forest food production (t/hh/yr)

Table 4.19 shows an overall significance of all these variables in the model. This is based on the F statistic and its significance probability having the value less than 0.005 and 0.005, which is 0.000. The results show that all variables are significant in the model.

Table 4.19 ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	143.667	4	35.917	91.848	.000[a]
	Residual	32.457	83	.391		
	Total	176.123	87			

a. Predictors: (Constant), Household size, Age, GIn/hh/yr, Employment/hh/yr

b. Dependent Variable: Forest food production (t/hh/yr)

Even though the results indicated that all variables are important, results in table 4.20 shows that some of the coefficients are not significant. Coefficients of age distribution and gross annual income show a negative relationship with forest food production and non-significant with significant probability of over 0.005. This indicates that any change in these variables will lower production. For example with an increase in annual income, people are expected to change their way of living. They may choose not to consume food from their local forest, but to buy some food from the supermarkets. Employment shows a strong negative relationship with forest food production and also not significance in determining production. With an increase in number of people employed per household, standard of living is expected to change too.

Table 4.20 Coefficients[a] of independent variables

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.356	.249		5.436	.000
	Age	-.004	.005	-.038	-.797	.427
	Emp/hh/yr	-.130	.074	-.119	-1.765	.081
	GIn/hh/yr	-.001	.001	-.040	-.844	.401
	Hh size	.596	.041	.979	14.468	.000

a. Dependent Variable: Forest food production (t/hh/yr)

The only variable showing a positive and strong relationship towards forest food production is the household size. The variable is also significant with the significant probability of 0.000 less than 0.001 and below 0.005. Household size has the highest coefficients for both B and Beta, which indicates that the variable plays a major role in predicting forest food production as compared to the others. The t-value for this variable is also above 2, which is 14.468 indicating that household size is the most important variable. The results have shown that all variables are significant at 0.005 (refer to table 4.19); therefore they can all be incorporated into the model to estimate forest food production.

Estimated Production = 1.356+ Age (-0.004) + Employment (-0.130) + Gross income (-0.001) + Household (0.596)

Estimated Production = 1.356-0.004-0.130-0.001+0.596

= 1.817 tons per household per year

In order to decide whether the model is good or not, the standard error of estimate should be less than the standard deviation of the dependent variable. Furthermore, the mean of the dependent variable should be greater than standard error. The results are true for this analysis with the standard error of 0.610, mean of 4.54 and standard deviation of 1.171. The mean for the standardized predicted values is also 0 with a standard deviation of 0.587 close to 1. For the standardized residuals is also 0 and have the standard deviation of 1. These are all good indicators of a good model.

Table 4.21 Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.0280	6.7826	3.7412	1.28505	88
Residual	-1.06450	2.61719	.00000	.61079	88
Std. Predicted Value	-1.333	2.367	.000	1.000	88
Std. Residual	-1.702	4.185	.000	.977	88

a. Dependent Variable: Forest food production (t/hh/yr)

The distribution takes a shape of normal distribution curve though in a partial way. The distribution is positively skewed amongst the households, indicating extent to which participants utilize forest food.

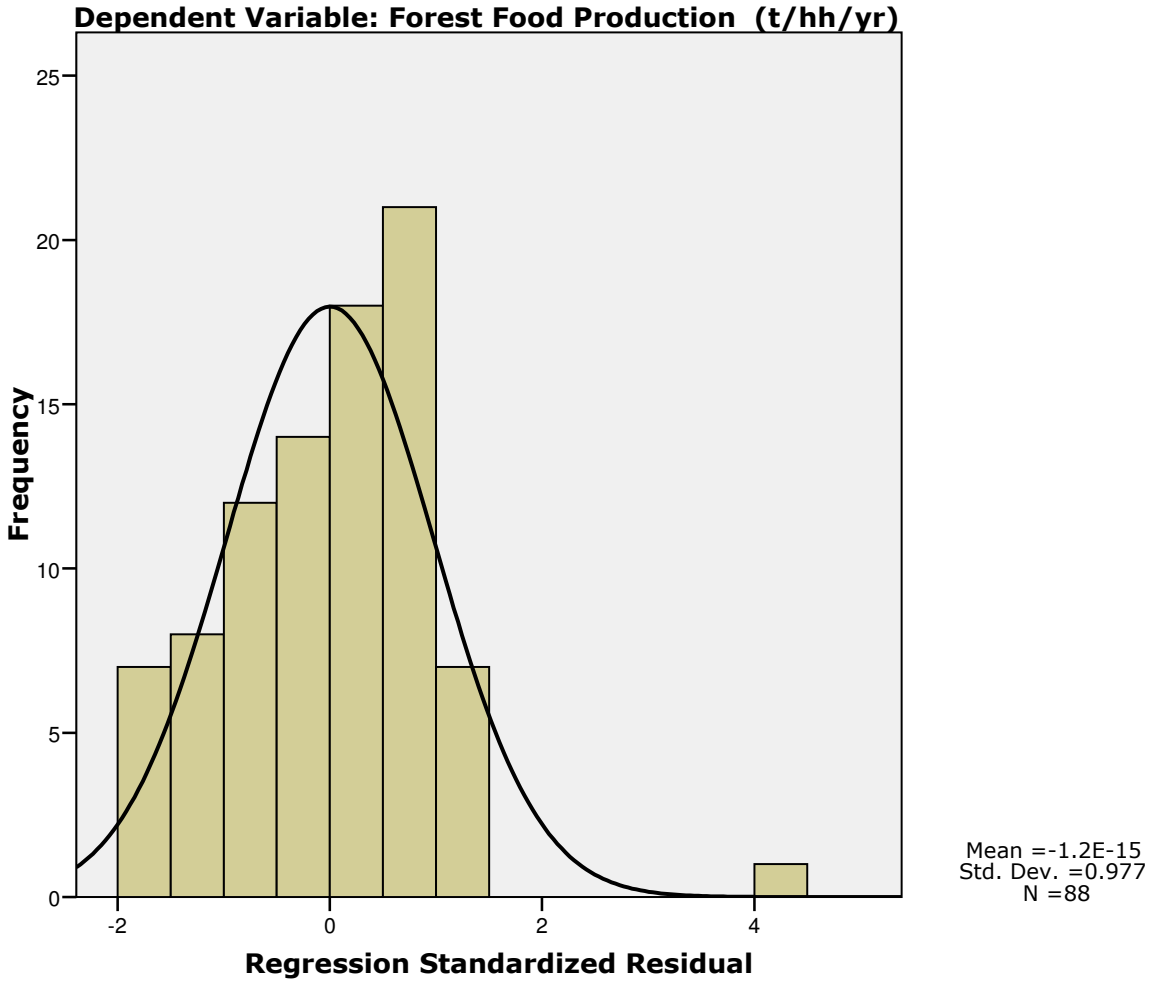


Figure 4.7: Distribution of forest food amongst households.

The results in the figure below show the type of relationship that exists between independent variables and dependent variable. There is a strong positive linear correlation

between household size, age distribution, employment and gross annual income with forest food production. R Square in this figure indicates that about 99% of variations in forest food production have been explained by the independent variables used in the model. Both fit lines (red and black) overlap indicating a perfect fit. Moreover, all points are clustered along the fit lines forming a straight line. This indicates that an increase in all dependent variables together will result in an increase in forest food production by the same unit.

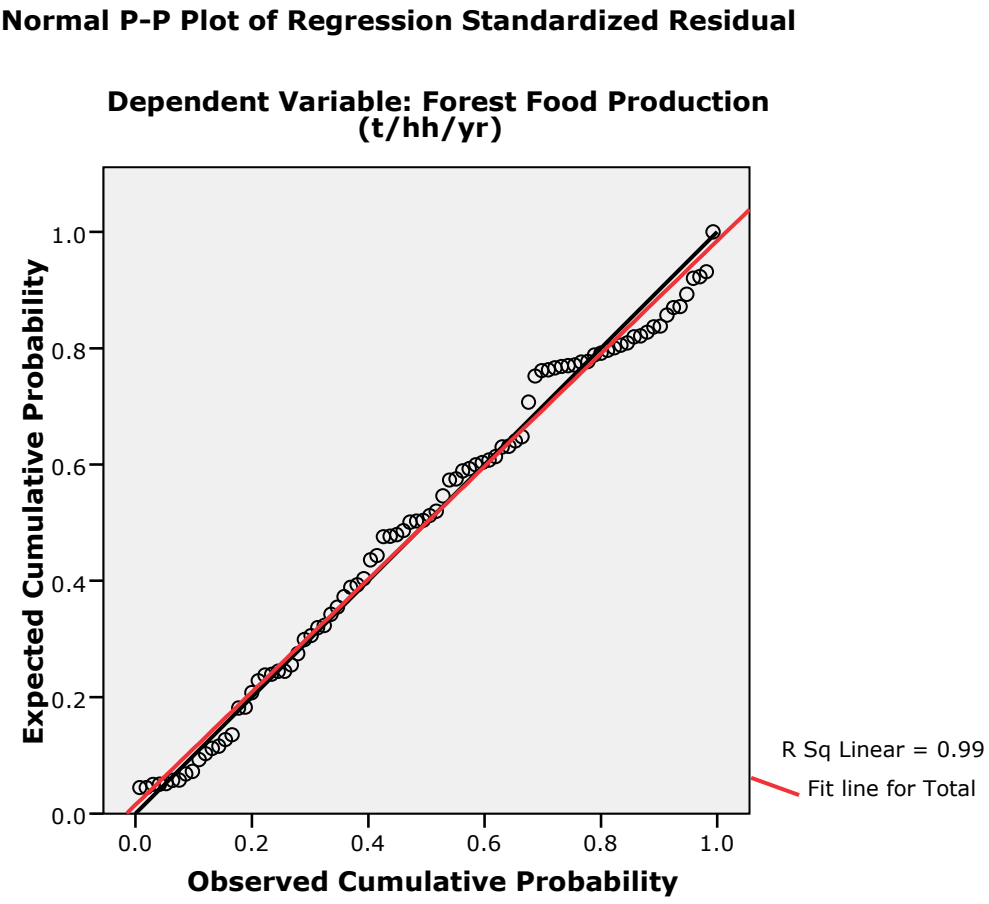


Figure 4.8: Scatterplot showing relationship between independent variable and forest food production.

4.4 Conclusion

Generally, the variable 'value for forest' has major role in determining the relationship between households and their local forests. This variable stimulates households' interaction with these resources. For quantitative analysis, household size is the only variable significant in predicting forest productivity. The highest coefficient values of this variable indicate the strong relationship, and thus contribute more to fuelwood, timber and forest food production or consumption. Any changes in this factor have a positive effect on production. The larger the household size, the more forest food, timber or fuelwood will be consumed. Moreover, forest productivity and development are expected to decline. However, the decrease in households' size will result in less forest resources being utilized and thus productivity will stabilize or increase.

There is a stronger positive linear correlation between independent variables all together with forest food production as compared to fuelwood and timber. More households within the sample tend to consume forest food as compared to the others. The results has shown that about 88 households utilize forest food, fuelwood accounts 57 while timber is utilized by only 14 households (refer to tables of residual statistics). Furthermore, 99% of variations in forest food production are explained by the independent variables, while timber is only 90% and 96% for fuelwood. This indicated that the most important forest resource utilized in the study area is forest food, and the reason can be due to the availability of the resource.

Chapter 5

Research findings and discussion

5.1 Introduction

Rustenburg area has long been established for agricultural purposes and was dominated by Bafokeng tribe. This is a nation known worldwide for its rich heritage of platinum. Rustenburg was originally a Bush-veld area and the underlying geological complex comprising mainly of an igneous complex, which give rise to occurrence of significant mineral deposits in the area. Following the discovery of platinum in 1924, the area changed and impacted upon other land uses after the commencement of mining in 1928[4]. Much later, the Rustenburg Local Municipality was formed in 2000, which now handles the planning and associated issues within the Municipality. The total area of the said municipality covers 3500 km^2 which largely comprises of tribal lands, to which must be added the responsibility for the current expansion within existing peri-urban, suburban and urban areas[5].

The Municipality as a whole experienced drastic changes fueled by global growing demand for platinum in the world markets. The results are residential developments encroaching into reserved areas and agricultural lands. Mining is the primary cause of influx and overcrowding of people as well as the establishment of informal settlement in and within proximity of RLM. Population growth and expansion of the area have negative impact on our valuable resources, particularly on the current vegetation cover as well as providing a poor visual enhancement.

Income in the RLM is heavily dependent upon minerals and these are expected to last at least for 35 to 40 years to come. Mining injects an estimated R180 million rand into the local economy annually. Some of this bounty is used to assist students and some on community development Projects[6]. However, the RLM has seriously depleted its natural resources and to ensure sustainable economy in the area, the community intends on

[4] http://www.royalbafokeng.com/economy.html
[5] Rustenburg Local Municipality, State of Environment 2007
[6] http://www.royalbafokeng.com/economy.html

establishing new business opportunities. Currently, the establishment of tourism sites is the only future plan made by the RLM, and it is therefore up to the community to broaden the scope of alternatives that will be necessary in the future.

5.2 Land use types per study site

✧ Kanana

This is one of the tribal lands under the authority of Royal Bafokeng Administration, and is located between 27°30'689" E Longitude and 25°56'979" S Latitude. Land is utilized for mining, agriculture and residential purposes. This is a typical, underdeveloped rural area with poor roads, where most households still practice agriculture for their survival. People grow different crops including fruits, maize and vegetables in their home gardens. The area is under tribal authority but most activities are undertaken by Local Municipality in partnership with the chief and councillors. This includes developments in the area which are currently in their initial stage. Kanana is a former shrub land and due to the continuous mining activities and need for residential areas; part of it has been converted to grassland. The area is dominated by Setswana speaking people under jurisdiction of Chief Leruo Molotlegi[7].

Figure 5.1: Types of land use within Kanana area.

✧ Boitekong

Boitekong has been established during 1990s and is located between 27°32'420" E Longitude and 25°62'139" S Latitude. This is a peri-urban area which is used for

[7] http://www.royalbafokeng.com/whoweare.html.

agriculture (cattle, goats, chicken) and residential purposes. Types of houses built are low cost housing (RDP) and shacks. Rate of unemployment, establishment of illegal settlements and crime is high. The area is currently undergoing major developments of mining shaft for Anglo Platinum, and construction of a prison. Other developments include housing and roads construction. Even though the area is under authority of the municipality, there are no restrictions regarding the use of forest, if any restrictions exist the community doesn't comply with that. The area is characterized by the mixture of grassland and shrub land sites.

Figure 5.2: Boitekong area

✧ **Meriting**

This is an area established in 1997 and located between 27°25'648" E Longitude and 25°59'641" S Latitude. The establishment of Meriting was to meet housing demand for mine workers within Rustenburg. The area was developed for medium cost housing in former agricultural lands, specifically sunflower fields. Types of land use include residential and underground mining activities. The dynamite used in mining causes most of the houses to crack and lose their value. This is a poorly developing area; with mixture of shacks, illegal settlements "Sondela"[8], low cost and medium cost houses. Meriting is a site of attraction for thousands of citizens as they prefer being close to workplace. The results are reduction in vegetation cover, and overcrowding exacerbates the problem as it stimulates land use changes. Even though the area is few kilometers away from town,

[8] Zulu word meaning come closer.

some households farm pigs, chickens, goats and sheep. Most households lack services such as running water, good roads and toilets.

- **Geelhout Park**

Geelhout Park is one of the suburbs in Rustenburg Local Municipality named after the plant species that was dominating the area. The area is located between 27°21'666" E Longitude and 25°66'810" S Latitude. "Geelbossie" is a tree that bears yellow flowers and was the most important tree making part of the site. The area occupied by the species is decreasing and the situation is expected to worsen due to the pressures on the environment. This is a former white area; currently developing well as compared to peri-urban areas. Types of developments include schools, shopping complex, industrial and residential sites. Most people here are government employees and mine workers of all races. Geelhout Park is a woodland area with rich indigenous forest site where developments have not yet taken place.

- **Cashan**

To the far south of Rustenburg is Cashan area mostly dominated by Whites. The area is located between 27°23'539" E Longitude and 25°68'852" S Latitude, and has been established on the vicinity of Kgaswane Mountain Reserve. The area is within hilly slopes and used for residential, business (shopping complex) as well as conservation site. Most people residing in the area are mine workers, hence these are mining houses. Cashan is the richest site amongst those that have been studied in terms of indigenous forest. The area is still developing and extends into the forest areas, and will ultimately impact these resources. These are most significant resources valued by the residents of Cashan. The suburb has characteristics of urban areas with everything within reach.

- **Rustenburg town**

This is a multi-functional unit of land mainly used for industrial purposes. Also included here are residential sites and other activities carried out in any town or city. Rustenburg,

meaning "Town of Rest"[9] is situated between 27°25'151" E Longitude and 25°59'641" S Latitude. The area is expanding with current developments like roads and business sites. Most participants have different perspectives relative to the importance of trees and forest in the surroundings. A large number of the sampled population value plantations than indigenous trees especially fruit trees. The area comprises mostly of plantations which have been stimulated by continuous land use changes in town. All the information regarding land use and forest areas for all six sites are provided on pages 85, 86 and 87.

5.3 Trees and forests in Rustenburg Local Municipality

RLM experiences both dry and wet seasons that influence the distribution of vegetation in the area. In addition, geology and landscape varies from site to site with maximum temperatures at extremes during summer seasons. Water is a limiting factor for growth and development of plant species in the area. RLM forms part of South Africa's Bushveld areas with patches of grassland areas. Distribution of other vegetation ranges from mountain, riversides as well as wetlands areas.

The definition of forest and trees in this study has been adopted from Knuth (2005), who included elements such as community gardens, vacant and productive land. In addition, all vegetation, soil, animals, water are included in urban forest. Species richness differs from site to site, and their distribution has been influenced by either socio or environmental factors in the area. Findings have shown that all the suburbs are rich in forest species, as they are well managed and protected sites within the Municipality. Included here are parks, open spaces and reserves such as Kgaswane Mountain Reserve situated next to Cashan. The reserve comprises of the largest variety of plant species. Peri-urban areas comprises mainly of patches of *Acacia* species, *Rhus lancea* and *Ziziphus mucronata.*

[9] http:www.pamgolding.co.za/areas/rustenburg/rustenburg.asp

Figure 5.3: Some trees and forest species found in the peri-urban and suburbs of the study area.

Acacia species especially *A. karroo and A. tortilis* spread throughout peri-urban, suburbs and into urban areas. Trees and forest are sparsely distributed in peri-urban areas while clustered in suburbs. These species are mostly dominant in the rural area that has been studied. Factors such as changes in land use have had major influence in the type and distribution of flora within the study sites. For example, former agricultural areas (sunflower fields) are have been transformed into grassland area as depicted on the figure below. These species are well established in most open spaces in the Municipality.

Figure 5.4: Dominant grass species in peri-urban areas of Rustenburg Local Municipality

5.4 Forest Productivity

Forest in this regard refers to, in terms of South Africa's National Forest Act (Act No. 84 of 1998), "all natural forests, woodland and plantation, forest produce and the ecosystem which it makes up". Furthermore, natural forests are defined as groups of indigenous trees which have been declared by the Minister to be natural forests. The definition

applies to all the indigenous trees whether they have crowns that are largely contiguous or not. Forest productivity for any site depends on an ecosystem's natural capacity to capture energy, sustain life and produce forest resources. The ratio of flora and fauna within the local forest and whether the forest is able to meet the community 's demand for food, timber, fuelwood and other environmental benefits like clean air are essential in determining productivity of forest.

State of forests in RLM explicitly differs in all sites where the study has been conducted. The difference is intensified by factors such as overpopulation and poor standard of living in most of these sites. Most forest sites particularly in Cashan and Geelhout Park, have been planted with indigenous trees and are in good conditions. Areas of forest within the rural, peri-urban and on periphery is declining due to poor management and planning. All of these forests fall under Municipal Authority with less attention being given to the community in low cost housing. These areas do not only experience decline in forest area, but also have issues such as poor waste management and services. All these factors contribute to environmental instability and the local community is at risk of developing contagious diseases. Vegetation in these areas is exposed to severe wildfires as burning is not controlled. This affect species richness and composition of the site as some animals and plant cannot adapt to these types of environment.

Figure 5.5: Conditions of vegetation and forest within Cashan and Boitekong area.

5.4.1 Forest produce and services provided by trees and forests of the Municipality

The local forest provides various goods and services to the community. Households obtain food, medicines, fuelwood, timber and other services from the forest.

5.4.1.1 Forest food consumption

There is a wide range of food obtainable from trees and the forest of Rustenburg. Included in the category of forest food are all wild fruits and all fruits from home gardens, tubers, leafy vegetables, meat from wild animals, insects and also birds. A large number of households have shown a positive relationship towards forest food production during the study. All types of food available and consumed within the local forest are listed in appendices section, and are available in different seasons.

There are two leafy vegetables identified during field study; *Amaranthus dubius* and *Manihot esculenta* that are widely spread in streets of Boitekong and Meriting. *A. dubius* is a species common in South Africa. Most participants treat the species as a weed while others value it for its nutritional contents. The vegetable is rich in vitamin C, vitamin A, vitamin B6, riboflavin and folate. *A. dubius* is also valued for its essential mineral supplement[10]. These include calcium, zinc, copper, iron, manganese, phosphorus and potassium.

Findings from the study have shown that the importance of this species is not recognized by most households. Consumption of the vegetable in RLM is low due to poor environmental conditions. The plant is collected and prepared by women in the morning. The leaves of the plant are used to prepare relish and can also be mixed with other vegetables. The species is highly recommended for people with low blood circulation. Some studies have shown that the vegetable can also improve health of those suffering from hypertension and cardiovascular diseases[11]. The vegetable is not sold, and no problems have been encountered through the use of it. Most households require moderate quantity everyday and there is sufficient supply.

[10] http://en.wikipedia.org/wiki/Amaranth
[11] Daniells, 2005.

Figure 5.6: Some of vegetables consumed in the study sites.

Manihot esculenta (cassava) is a hardy plant and also regarded as a weed by most tribes in South Africa, except for the Shangaan within Rustenburg. This is a significant part of diet especially in poor African countries where malnutrition is common. The plant is toxic and tubers cannot be consumed raw. Tubers need to be soaked into the water for 3 days. There are differences regarding the way cassava is used, some people use leaves while others only use tubers. Leaves are used to prepare relish and seeds may be eaten while still green. Leaves are good in treating hypertension and headache. Tubers of this species resemble the sweet potatoes and are rich in carbohydrates, calcium, phosphorus and vitamins. They can be used for making chips, dumplings, soup as well as relish.

Tubers of *M. esculenta* can be used to combat diarrhea, malaria and stomach ache. The period the tubers take to mature is equivalent to potatoes but can be left underground for a long time. The vegetable is available throughout the season, and collected by both adults and children when needed especially in the morning while still fresh. No income is generated from *M. esculenta* in RLM as it is not common, and most households are not familiar with it. Small quantities are required everyday as the plant has high concentration of starch. Food from this plant is consumed as soon as possible after preparation, as it spoils very quickly even when inside the refrigerator.

✧ **Medicinal plants**

Rustenburg Local Municipality is a home for many people with varying cultures and religions. The area is dominated by Africans who are still bind to their tradition. Due to high level of unemployment in most sites of the study area, most households still rely on traditional medicines for treating many diseases. Other households especially in rural and peri-urban areas cannot afford to pay for private doctors. They have to spare little that they earn for other needs such as food and clothing. In addition, these medicines are easily accessible and cheap as compared to the one from the pharmacy. Currently, no legislation exists within RLM dealing with management and protection of these resources[12].

Number of traditional healers is growing, and most of them depend on their local forest for their medicine. Men and women are included here, whether poor or rich, from rural to urban areas. An individual's educational status has no influence over use of traditional medicine. The use of African traditional medicine ranges from bathing, drinking, sniffing, applying to the body, and as a sign of protection to newborn babies. Parts of plants used include the bark, leaves whether dry or fresh, roots, tubers, wood and the sap. Medicine is either available as a powder, in liquid form stored in bottles, piece of wood or slice of tuber.

Figure 5.7: Medicine sold in the streets of Rustenburg town.

There are differences regarding the use of medicinal plants depending on the type of sickness and the situation. Generally, both men and women are responsible for collection

[12] Rustenburg Local Municipality, State of Environment 2007

of the medicine when needed. Collection is done in the morning while plants are still fresh. Sometimes collection is done late in the afternoon, and in respect of culture. Most household have not experienced problems following the use of the medicine as they follow the right prescribed dose. Demand for African traditional medicine is growing leading to extinction of other plant species. This is a problem faced by all unprotected forest areas within Rustenburg Local Municipality. As the area of these resources is decreasing, other households have started home gardens for planting traditional medicines. Planting of these species will ensure that they are sustainable for the future. This is common in Kanana area where households aimed at keeping pace with the demand for traditional medicines. Some plants are planted as flowers for decorating homes as well as medicinal purposes. Therefore, these medicines can easily be accessed and preserved.

Figure 5.8: Some of planted medicinal species available on the study sites.

Moreover, scarcity of other medicinal plants in the Municipality has lead to establishment of "Muthi"[13] shops where people can sell and buy traditional medicines. This makes it possible for residents to access them if they are not available in the local forests. Both street traders and those who own 'Muthi' shops generate an income from traditional medicines. These people work from early morning hours at around 6 until late in the evening at around 7 everyday. Medicinal plants utilized by households have been listed in the appendices.

[13] Zulu word referring to African traditional medicine.

5.4.1.2 Fuelwood consumption

Fuelwood still plays a significant role in most households within Rustenburg Local Municipality. Despite the availability of electricity and other source of energy; the resource is utilized for cooking, heating homes and warming water for bathing. For example in rural and peri-urban areas, wood is the basic source of energy. These are sites of high unemployment rate and thus most people can't afford to use electricity or paraffin to meet their energy demand. It is within these areas that communities experience shortage of fuelwood as there is huge demand during winter. DWAF (2006) pointed out that fuelwood contributes about 26% for fuel needs and 31% of heating requirements. Included here are both urban and rural areas of the North West Province where Rustenburg forms part of the area.

Consumption of the resource is high and differs from one area to the other. An overall consumption is a stack (about 3 to 7 kg) per day depending on the living standard. Peri-urban areas experience high shortage as large portion of the forest area has been destructed, through continuous establishment of informal settlements and mining activities. These are populated areas as compared to suburbs and rural areas. Tree species utilized are those accessible and carried on head or donkey carts.

Figure 5.9: Wood collection by donkey carts and humans' head.

Due to shortage of wood in the area, these resources are utilized whether they are wet or dry. Residents gather them, keep them within their yards where they dry out and can be used. Both women and men are involved in collection of fuelwood usually in the morning and in the afternoon. About 57 households in the sample rely on fuelwood. This includes

areas such as Boitekong and Meriting which are also overcrowded. Consumption in these areas is high as compared to urban and suburbs. Other people collect wood from the landfill site within Meriting, which are cuttings from suburbs or sites that have been cleared for developments. The wood is used regardless of the type of species.

The use of wood is far different in all the areas where the study was conducted. Some urbanites and residents in suburbs utilize wood for "braai"[14] while others use it for charcoal production to warm their homes. Species utilized include *Rhus lancea, Ziziphus mucronata, Acacia karoo and Combretum apiculatum.* In most cases, wood is required when people want to cook their meat. Wood is obtainable from street traders along the road. For most rural and peri-urban residents, wood is an important multi-purpose resource.

5.4.1.3 Timber consumption

Few households have shown a positive relationship with timber. Timber is gathered from the local forest and can also be obtained from the mines. The use of timber ranges from building, fencing poles, and for making fire in rural and peri-urban areas as there is a shortage of fuelwood to meet the current demand. In the mines, men use timber from different companies like Mondi as there is no local timber supply. In areas like Meriting, many households use old timber from the mine for building shacks, fencing and fire making. Demand for timber increases during winter with insufficient supply as more people turn to the resource for heating their homes. Some unemployed women in the area use it to prepare African beer, which is sold to support the family. Timber is collected by both men and women using trucks and motor vehicle at least twice a week.

5.4.2 Other importance of trees and forest in the Municipality

Trees play an extensive and significant role in both man and the environment. These are major parts of the ecosystem channeling any life that exist within it. Evaporation rate in Rustenburg area exceeds humidity; therefore vegetation cover reduces loss of moisture on the surface. Part of the sample from RLM Community perceives trees and forests for

[14] The way of preparing meat by placing it on the stand with fire underneath it.

their ability to provide shade while the remaining sees the resources as source of crime. Rate of crime is high and associated with poverty.

Within suburbs and urban sites of Rustenburg area, the trees and forests serve different purposes. For example, in Geelhout Park some indigenous trees have been reserved as part of the park. These trees are in good conditions and are mostly *Acacia* species. Even though the park is in good conditions, people within the area fear to make use it due to rate of crime in the area as they are targeted by criminals while relaxing there. Most households have been supplied with seedling from the Municipality to plant in their yard. Trees common in the area include cotton producing species which are a problem during windy weather. Another site of good forest view includes Cashan area located next to Kgaswane Mountain Reserve. It is a hilly area largely covered by indigenous trees forming part of a beautiful landscape. The area is currently developing but most houses have been built within these trees.

Figure 5.10: Significance of trees in the improving natural landscape and value of houses**.**

✧ **Kgaswane Mountain Reserve**

Kgaswane Mountain Reserve is a well known reserve within the Municipality, situated on the border of Cashan area. The reserve is under Municipality management and is managed by the North West Parks and Tourism Board. Kgaswane Mountain Reserve is a home for a variety of faunal and floral species and covers an area of about 4777 hectares[15]. Faunal species within the reserve include small wild animals that are not

[15]Custers, 2003

harmful to the community. Additionally, most households within and outside Cashan utilize the reserve as a site of relaxation, camping, rock climbing as well as site for educating scholars about animals and their environment. This is one of the reserves that are important in preserving our biodiversity as most endangered species are within the area. Plant species available at Kgaswane Mountain Reserve are listed in appendix 6.

In general, a large number of households in the study consume forest food and medicines as compared to other resources. The main reason contributing to these is the accessibility of these resources in the area. Other households have fruits and gardens for medicinal plants available at different seasons to keep with the demand. Apart from gardens, forest food is available and sold on the streets and supermarkets in town. Consumption of fuelwood is high in rural and peri-urban areas as compared to suburbs and urban areas. These are areas where unemployment rate is high in spite of a growing mining industry.

About 21% of households sampled utilize these resources for their energy demand. Only 6% have shown a positive relationship with timber. Shift in the use of resource can be due to changes within the area, availability of timber or for economic reasons. Wooden poles for fencing do not last for a long time as compared to wire fencing; therefore households may prefer to use wire fencing because they are durable. About 18% of the sample benefit from reserve sites of the Municipality. These include green open spaces such as parks and game reserves. Most households involved are from suburbs and urban areas of Rustenburg. They have access to the reserves and can afford to go there most of time.

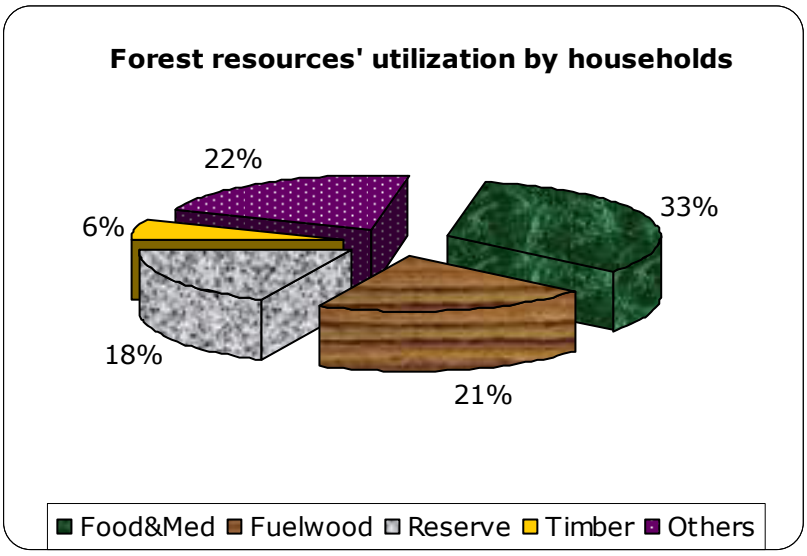


Figure 5.11: Resource utilization within the study area.

Others in the above figure refer to all the benefits that households get from trees and forest with an exception of those mentioned in the above figure. These include shading from trees during hot weather, flowers to improve and beautify the environment, protection from windy conditions. Mining and production processes from industries as well as developments in Rustenburg Local Municipality are associated with air pollution. These cause major impacts on the environment, animals and human beings. Trees and forests aid in modifying the environment by improving air quality within the area.

5.5 Factors causing environmental degradation

Rustenburg Local Municipality is the fastest growing Municipality in the North West Province. Growth is associated with many opportunities such as employment; investments by companies from other countries as well as improved infrastructure. The results are environmental instability from factors such as mining activities, enormous developments taking place, and continuous flow of people in the area which is hard to control. Developments take into account all areas within the Municipality including suburbs, peri-urban, urban and rural areas. RLM is becoming more urbanized and associated with activities posing a major threat to the local environment.

✧ **Mining sector**

Mining in Rustenburg Local Municipality contributes more to the destruction of natural resources especially water, air, vegetation and habitats. Due to increasing demand for platinum in the world market, the industry is expected to continue growing throughout decades[16]. Currently there are more sites identified for future mining activities which contribute to new human settlements in the area. Regardless of opportunities that arise from this sector, there are also problems associated with mining. Establishment of mining site (shaft) results in formation of illegal settlements and the need for large quantity of water. Mining exploit more resources, for example water than any other sector in the Municipality. Mining utilize both water from rivers and groundwater.

Figure 5.12: New Anglo-Platinum shaft located at Boitekong and impact of mining on vegetation cover.

✧ **Housing development**

Due to the current overcrowding in most areas of Rustenburg Local Municipality, there is a need for housing and more facilities to support the growing population. Most housing developments are carried out within mining sites as large number of people resides there. This type of development is now growing at an alarming rate as there is a need for more houses to provide for the growing population. Types of houses that have mostly been built are RDP houses, as a solution to deal with problems of informal settlements. Natural resources (forest and grassland areas) compensate for establishment of these houses, resulting in loss of important irreplaceable species. Some of these houses are on

[16] Bembani Sustainability Training, 2005

dangerous sites, for example Meriting extension 1 (Sondela) has been established close to a land fill site and Jabula mine. Sondela is the former informal settlement that evolved while developing medium cost houses within the area. Residents here are likely to develop respiratory infections from mining wastes. The land fill site becomes more problematic during rainy season and windy conditions as residents are exposed to bad smell from wastes.

Figure 5.13: Residential area located within a close distance from mine and land fill site.

✦ **Overcrowding**

Households mainly comprise of an average of 5 people leading to over-utilization of other resources such as water, electricity and other services. Even though houses have been built, due to an uncontrolled influx of people in the Municipality, it is impossible to keep pace with the growing demand. For example, Boitekong is amongst areas where there is a huge demand for housing as compared to any area in the Municipality. An estimated number of houses needed for each area in RLM is shown in the table below with more houses needed in Boitekong area. This is an area associated with rapid establishment of illegal settlements by people from within and outside South Africa.

Table 5.1: Estimated Rustenburg Local Municipality Housing Need by 2015. *Source:* Thomas, 2005.

Spatial Development Framework Settlement Clusters	Estimated Housing Need (2004-2015)
Rustenburg	20173
Boitekong	**38725**
Phokeng	5736
Hartbeesfontein	7042
Thekwane	13022
Luka	2406
Robega	5003
Tlaseng	2873
Wonderkoppies	4042
Monnakato	940
Bethanie	686
Phatsima	1960
Marikana	444
Modikwe	451
Maumong	212
Tantanana	253
Makolokwe	144
Berseba	119
Rankelenyane	103
Mamorotse	165
Tlapa	97
Mathopestat	222
Maile	65
Kopman	69
Mabitse	20
Olifantsnek	40
Rustenburg rural *	7180
Rustenburg mines	2301
Total Municipality Housing Need 2015	**114493**

*Refers to all reserved areas within the Municipality where there have never been any developments.

Number of houses required every year in the Municipality is estimated as 3000, (Clusters, 2003). The situation is aggravated by continues influx of people in the mining areas. Most households of mine-workers are filled beyond the capacity and thus enforce the need for housing construction in the area. They consist of more than two tenants who are also in need of their own place. The situation is worse in areas like Boitekong, Meriting and Kanana closely situated next to mining shafts.

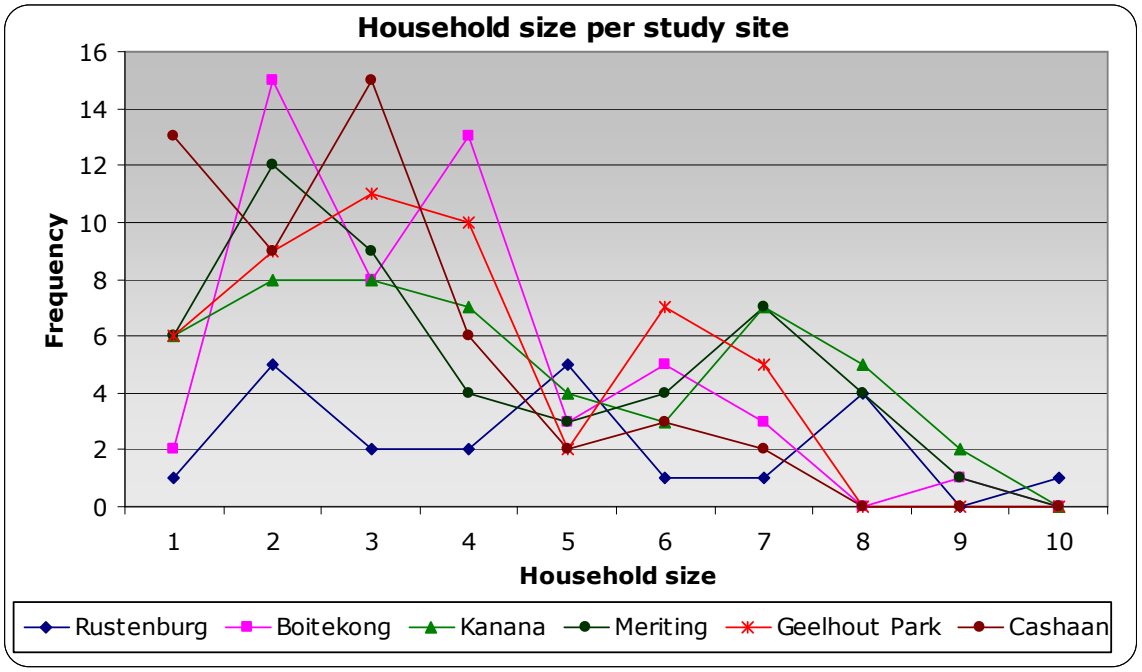


Figure 5.14: Household size per study site.

✧ **Informal settlements**

In most cases overcrowding and urban expansion in RLM resulted in poor planning as well as illegal settlements. This type of settlements makes it impossible for the town planners to make wise decisions regarding the use of the site without harshly affecting the environment. Some of these settlements have been established in fragile areas not good for residential purposes. For example, Meriting is within the mining area. Initially, the site was for medium cost houses but overcrowding lead to establishment of Sondela. This is an informal settlement dominated by Xhosa speaking people from Eastern Cape. These people not only impact the local vegetation, but also the value of the houses on the site. People here started building their shacks there until the Municipality decided on developing the area for low cost houses.

Sondela is still expanding but there are conflicts arising between the Municipality and residents as they are trying to control the situation. In February 2007, the Municipality destroyed part of the area, mostly shacks, and people lost their properties. Most of their shacks were burnt and destroyed using heavy machineries, with the environment being left in bad conditions of wastes everywhere. As soon as these people are moved from the

site, they find another place to settle which means continuous removal of vegetation cover. All the informal settlements in the area share the same problems: uncontrolled destruction of vegetation cover, uneven distribution of resources such as water which results in people using the wheel-barrow in the peri-urban areas.

Figure 5.15: Destroyed informal settlement and the problem of water supply in the area.

The community within Yizo-yizo is not only faced with poor water supply, but also the serious problem of waste management. Waste in this regard includes human waste, the situation in which people have no pit latrines or sewage system at all. These people have no alternative but to utilize the forest sites to help themselves. Community is susceptible to chronic diseases especially when it is raining. These are the signs of poverty fueled by overcrowding, poor planning and unemployment. Poor waste management generates problems such as illegal dumping sites that threaten both human and plant species. These are municipal areas but the situation which people are leaving in, is unacceptable.

Figure 5.16: Areas are associated with poor services and high crime rate

Overcrowding and poverty stimulate other problems such as crime in the area. This is the current problem within the study sites and is growing at an alarming rate. Forest in peri-urban areas is not valuable like in other areas since there are sites where criminals hide. Crime is reported everyday in most of peri-urban areas as compared to tribal, suburban as well as urban areas. Due to the escalating crime rate, a new prison is currently under development within Boitekong and will soon be finished in early 2008. The development of this prison created more opportunities for local unemployed community members.

Other aspects having a significant role in forest development include Value, Access, Interaction and Restriction (VAIR) to forest. The more communities value their forest, the more they can have a good relationship with the forest. This includes the ability to make wise decisions regarding all components of the forest. Moreover, when the community has access to the forest which includes being exposed to forestry activities such as planting trees, the forest can be productive and sustain other animal species. However, if there is less restriction concerning the use of forest, these resources can be overexploited resulting in less productive forest areas. In addition, if the community involvement in forestry is restricted, productivity is expected to stabilize provided the community does not make use of resources. The forest can also become less productive if it is utilized without any planting to ensure sustainability. Factors such as gender, household extension, forest ownership and permanent residence do not have major impact in forest development as shown in figure below.

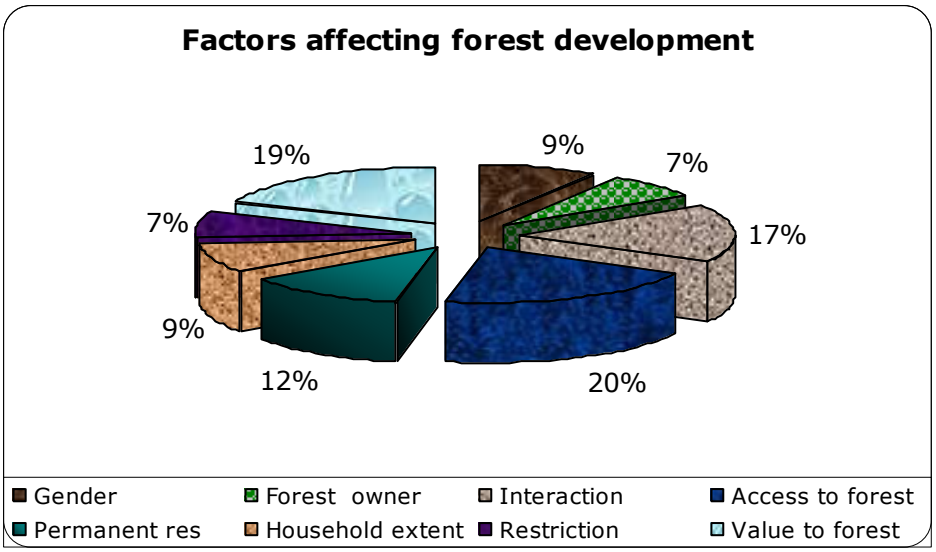


Figure 5.17: Factors affecting forest development or productivity.

5.6 Management strategies and policies involved

There are various parties working together to ensure sustainability of natural resources in Rustenburg Local Municipality (RLM). Included here are South Africa's National Department of Water Affairs and Forestry (DWAF), Department of Environmental Affairs and Tourism (DEAT), Department of Agriculture (DEA) as well as the Municipality itself. These bodies have different strategies as well as legislations to guarantee their success.

5.6.1 Existing strategies within the Department of Water Affairs and Forestry

DWAF focus mainly of issues related to water and forest resources in the country. Within RLM, the Department has implemented many strategies to deal with environmental problems including destruction of forests in the area. The Department has an outstanding relationship with RLM's Environmental Unit. The unit is a temporary storage for their seedlings from Mafikeng Nursery, situated about 201 km away from Rustenburg. Over 5000 seedlings are delivered every year for use during Arbor Day and throughout seasons within the area, except in winter when plants are dormant. DWAF within RLM has been established in 2006; therefore number of seedlings planted is expected to go up with the growth in the Department. Planting of these seedlings is part of Greening in the area and

distributed mainly to institutions such as schools, prisons, police stations, churches and new built-up areas[17].

The Greening Programme has been initiated in the area by the Department in conjunction with Food and Trees For Africa (FTFA) and EDuplant towards the end of 2006. The programme is part of Community Forestry outlined in section 32(1) (b) and (c) of the National Forest Act (Act no.84 of 1998). In terms of this Act trees can be planted by any person or organ of State for aesthetic reasons or improving quality of life. Moreover, Community Forestry promotes sustainable use of natural forest and woodlands by communities in rural and urban areas either in or outside State forest. FTFA also introduced the concept of Community Based Educator (CBE), which involves training community members who assist in planting of seedlings.

The community not only acquires planting skills but learns more about the importance of the environment. Workshops are organized by DWAF officials to educate and stress the significance of Environmental Awareness in the community within the Municipality. Currently, DWAF supply the community mostly with indigenous trees only which can adapt to the environment and climate of Rustenburg. This is a Bush veld area characterized by variation of rainfall throughout the year.

[17] Department of Water Affairs and Forestry, Rustenburg.

Table 5.2: Temperature variations within Rustenburg Local Municipality. *Source:* Rustenburg Local Municipality, State of Environment 2007.

Month	Maximum	Minimum	Mean temperatures
January	30.3	17.2	23.8
February	29.4	16.8	23.1
March	28.3	15.0	21.7
April	25.5	11.2	18.3
May	23.3	6.5	14.9
June	20.4	3.2	11.8
July	20.9	2.8	11.8
August	23.7	5.1	14.4
September	27.3	9.6	18.5
October	28.7	12.9	20.8
November	29.4	14.9	22.1
December	30.1	16.1	23.1
Yearly	**26.4**	**10.9**	**18.7**

Most planted trees *include Ziziphus mucronata, Rhus lancea, Olea africana, Celtis Africana, Schinus molle* and *Rhus pyroides*[18]. Other trees distributed by the department are listed in appendix 5.

✧ **Climatic requirements and values for each species**

a. *Ziziphus mucronata*

The species is also known as Buffalo Thorn and well adapted to any soil. The plant is drought and frost resistant, and regarded as the fastest growing tree in South Africa. The species is valued for various reasons. For example fruits (reddish when ripe) can be eaten by both man and wild animals like black rhino, warthog, baboon, monkey, nyala as well as impala. Fruits can also be utilized for brewing beer, and to treat stomach ulcers and chest pains. Most importantly, fruits can be used during drought periods to prepare flour and porridge. Leaves are browsed by other animals mentioned above with an exception of

[18] DWAF, Rustenburg

baboons and monkeys. Additionally, branches of this tree are laid down on graves of Zulus chiefs and royalties to honour them[19]. Roots are utilized for treating sores as well as boils. Wood is important for fencing poles.

b. *Rhus lancea*

The tree is native in South Africa and known as African Sumac Tree. *R. lancea* can adapt to different sites in the country with well drained soils. This is an evergreen, fast growing species that is drought, frost and wind resistant. The tree requires full sun to grow well. Fruits are black with a papery coat and can be utilized for brewing beer by some tribes. The flowers produce pollen that can be harmful to people allergic during windy conditions.

c. *Olea africana*

O. africana can survive long periods of drought and requires a little water after establishment. The species can stand severe frost as well as strong winds and is well suited and widespread over different habitats. These include forest, riverside bush and open grassland areas. *O. africana* can be utilized for treating sore throat, backache, kidneys and eye infections. Some studies have shown that leaf extracts of the plant have been used against HIV-1 virus. Fruits are dark purple when ripe and can be used as a drug. The importance of its wood is not known yet.

d. *Celtis africana*

This tree is commonly known as White Stinkwood and is amongst the fast growing species in the country. It is well established in hardy to moderate frost and drought. The disadvantage of the tree is that it does not tolerate shading, and thus needs full sunlight. The tree has a strong root system which can be a problem when roots extend under building. This can cause the house to crack. Values range from providing good food sources for birds like Barbets ad Bulbuls, shade and mostly for its good shape.

[19] http://home.intekom.com/ecotravel/plant-kingdom/trees/ziziphus-mucronata-buffalo-thorn.htm.

e. *Rhus pyroides.*

R. pyroides is known as Fire-thorn karee and can adapt to any environment in South Africa. The tree has been chosen as one of 2007 Tree of the year (392)[20]. Even though the tree has been selected as the National Tree of the year, it is not amongst the protected species by the country's National Forest Act (Act no. 84 of 1998). Protected tree species has been identified and declared as protected by the National Department of Water Affairs and Forestry in 2004. The species is resistant to any fungal infection, frost and drought. Preferable habitats include riverside, open bush, forest verges, hills, valleys and open grassland areas. Fruits of this tree are red when ripe and eaten by both humans and birds.

f. Schinus molle

This is an evergreen tree well known as "pepper tree" and native in African countries including South Africa. The tree can adapt well in bush land in dry or moist well drained soils. *S. molle* is draught tolerant but requires full sun to grow well. The tree bears pinkish-red fruits, in which oil can be extracted for use as a spice. Moreover, leaves and fruits can be used to cure digestive problems as well adding peppery taste to food.

Figures 5.18: Seedlings on newly developed sites within Municipality-Boitekong area

5.6.2 The role of Department of Environmental Affairs and Tourism

Department of Environmental Affairs and Tourism (DEAT) is responsible for ensuring that everyone complies with environmental legislation. This is made feasible through

[20] DWAF: Arbor Week 2007.

National Environmental Management Act (NEMA) (Act no.107 of 1998). The main principle of the Act is to ensure that everyone has the right to an environment that is not harmful to his or her health or well-being. Section 2 (2) of this Act emphasize the need for environmental management in considering people and their needs first; so as to ensure that their physical, psychological, developmental, cultural and social interests are not violated and thus equitable. Furthermore, any development should be environmental, social and economically sustainable. The Act also urge everyone to be responsible for the environment they are living in, section 2 (4) (a-r).

DEAT in RLM has its own strategy in preventing loss of biodiversity. This includes the use of Basic Assessment Report (BAR) and Environmental Impact Assessment (EIA) depending on the type of activity proposed. These assessments have been outlined in section 23, 26 and 32 of NEMA. For any small development taking place the Department uses BAR, while for big development they use EIA. BAR includes the detailed description of the proposed activity, property on which the activity is to be undertaken, the location where the activity is to take place and the description of the environment that may be affected. There are other legislations that are used to guide for decision making, whether to allow applicant to continue with that activity or not. The public within the area are allowed to comment on these issues. Applications may take only 30 days as compared to EIA that takes minimum of 9 months. EIA is more detailed than BAR as it deals with major activities. Involved here is scoping assessments and public participation. Major impacts of a proposed activity, whether short or long term are considered by involving Interested and Affected Parties.

Besides the use of some legislation in managing natural resources, the management of Kgaswane Mountain Reserve has proposed strategy and policies to the area. Future plans include expansion of the reserve to sustain the fauna and flora within the Municipality. In addition, enormous developments are carried out without complete removal of vegetation on the site. Most houses are built within indigenous trees and forest to ensure the continuous existence of the species. However, South Africa's National Environmental Management: Protected Areas Act (Act no 57 of 2003) support the system through

declaration and management of protected areas. The Act guarantees the sustainability of these resources and ascertains that all activities carried out within these areas are environmentally friendly. By integrating policies with management strategies within the protected areas, the future of these resources can be guaranteed.

5.7 Conclusion

Forests are the most significant assets of the environment in terms of investments and preserving flora and fauna. The future of these resources is at stake especially in developing world from pressures of urban expansion and overcrowding therein. These necessitate intensive management strategies by different parties to deal with environmental crisis and to ensure sustainability of our resources. Due to the prevailing vast developments and rapid population increase in Rustenburg Local Municipality, it is required that relevant decisions are made and strategies are developed to deal with problems that persist.

Map 3: Land use within Meriting- Kanana- Boitekong

SIZE: A3

Map 4: Land use within Cashan- Geelhout- Rustenburg town

Map 5: Conservation/ forest areas

Chapter 6

Conclusion and recommendations

Every growing town or city in developing nations is faced with environmental problems. Factors such as urban expansion and population growth are responsible for any change in each other. More opportunities are fueled by developments as well as employment and thus generate influx of people in these areas. An increase in population growth stimulates factors such as overcrowding and the need for more resources to support the population. These include food, land for building houses, water, and health facilities to provide for the community. An enhanced economic growth of Rustenburg Local Municipality stimulates developments within various industries, and establishment of informal settlements. In spite of its sustainable economic growth, the Municipality is heading for severe social and environmental disasters. A large area of the RLM is experiencing drastic changes mainly stimulated by growing population. Due to a growing population and enormous developments within housing and mining sector, the state of natural resources and the environment has been altered. This includes loss of large areas of valuable plant and animal species.

In order to solve the problem of housing shortage in the area most grassland, agricultural and forest sites have to be cleared. Some of these species in these areas are not replaceable and these harsh conditions may lead to their extinction. In addition, by continuously changing agricultural areas into other land use the area will add up problems of food insecurity in the country. RLM was known for its agricultural activities, but mining is rapidly changing the areas in an unsustainable manner. Agricultural lands have been reduced due to prevailing developments and activities taking place. Most farmers lose their lands, resulting in low food supply, with high demand associated with growing population. In most cases, shortages of supply coupled with high demands result in increased food prices. Currently, this is a problem faced by South African citizens and is expected to worsen in the future due to reduction and limited agricultural sites. Not only business people want to invest in urban areas, but also rural dwellers are leaving to urban

areas leading to overcrowding. The situation needs to be dealt with in order to be able to overcome the future environmental crises.

The expansion of the Municipality especially in urban and peri-urban areas is in general, poorly managed. The situation is worsened by regular movement of rural people, who are driven by poverty into the area. The results are increase in unemployment rate, inadequate housing and infrastructure. In addition, poverty levels within the Municipality also rise. Development in many instances involves growing of industries, building infrastructure and houses for communities. This involves use of heavy machineries in construction of roads, houses and also mining that cause soil compaction and erosion arises. Erosion inhibits growth of some vegetation and establishment of habitats for some animals. With the continuous urban and peri-urban expansion, the area of these plants and animals is reduced and thus forest becomes less productive. Soil compaction reduces chances of forest development as most plant species fail to grow under this condition.

The impacts of expansion are visible on peri-urban as compared to urban areas. These are areas of high poverty level where the communities are not provided with all basic services such as toilets and electricity. Urban and suburban areas comprise of well managed and rich forest that covers a large area. Municipality still lacks that capacity to deal with housing crises as well as management strategies. In addition, despite the establishment of DWAF within the Municipality not much work has been done regarding forest protection and development. Many projects focus on planting of trees during Arbor Day and all the households provided with seedlings are not taking good responsibility for their trees. Some of the seedlings dry out and die.

Growth is important when all aspects of sustainability; social, economic and environmental are integrated in planning, implementing and decision making to ensure developments serve the present and future generations. Rustenburg Local Municipality is currently experiencing economic growth expected to last for some decade due to mining. Growth is good for every nation; but our natural resources should not be compromised for that. However, there is no guarantee that mining will continue maintaining the

economy of the area. There is a decline of 1.1%[21] for 2007 as compared to the economic growth of 6%[22] recorded between 1996 and 2002. Minerals are non renewable resources that take a long time to build up within the area. Exploiting them will not only lead to loss of the minerals, but also severe damage to the environment. Sustainability of the resources is the responsibility of the current community in Rustenburg Local Municipality, with the future generation facing environmental, economic and social disaster.

Mining is not environmental friendly as it poses threat to all natural resources as well as human being. All activities taking place within the sector cause major destruction in the environment through wastes, smoke, and heavy machineries. Removal of vegetation for mining activities and any developments in the area reduce the capacity of these resources to maintain balance in the ecosystem. Therefore, they become less productive and affect other elements of the ecosystem such as availability of water, air circulation, soil fertility and change in the landscape. People moving into Municipality are mainly for mining sector, they tend to settle close to the work place. These include peri-urban associated with poor environmental conditions. Community within these areas is likely to develop respiratory infections as they are exposed to smoke from industries. Heavy smoke is built up on the atmosphere and is visible in the afternoon than during the day. In addition, the smoke makes visibility impossible and can result in more accidents occurring in the area.

In most cases, population growth is associated with problems such as poverty and overcrowding. Poverty stimulates issues including high crime rate, and environmental degradation. This not only impact on the local economy but on the country as a whole. Furthermore, overcrowding results in poor planning as decision makers are forced to change their plans due to existing housing demands. Developments in Rustenburg Local Municipality are partially carried out in an unsatisfactory manner. Therefore, there is a need for incorporated developments which can include shifting focus to developing other sectors such as forestry and agriculture within the sites that have been studied.

[21] Rustenburg Local Municipality, State of Environment 2007
[22] Bembani Sustainability Training, 2005

Recommendations

- Complete removal of vegetation should be avoided at any stage of developments.
- Where the area is cleared, planting either grass, small and large trees should follow right away. This will prevent soil erosion as well as degradation of nutrient within the soil.
- Planting should not be responsibility of greening organizations or departments only. Communities should be educated about the significant role of trees and forest in their everyday living. In addition, communities should establish home gardens to improve their lives and environment. For example vegetables and herbs garden can reduce level of poverty and unemployment in their area.
- All construction companies need to have their own strategies or planting programmes before commencing with the proposed activities.
- Mining sector, developers and Municipality need not to focus more on investments, rather on implementing principles of "Batho Pele"[23].
- Impacts from any industry should be kept at minimal, if not possible be dealt with immediate effect.
- As the area is expected to continue growing, major changes need to done by Department of Water Affairs and Forestry, Municipality and Department of Environmental Affairs and Tourism to ensure sustainable growth. This can be done by securing more forest sites, ensuring that all construction companies adhere to all policies regarding environmental management and forest management.
- Municipality should provide households with all services including electricity to reduce pressures on the forests. For households that cannot afford to pay for electricity, community woodlots should be established.
- Environmental awareness programmes should be an everyday part of the community development. More security is needed which involve police working in partnership with the community to reduce crime in the area. This will not only change people's perspectives towards trees and forests, but households will treat forests as valuable assets therein. Positive relationship towards trees and forests will also grow more than before.

[23] Putting people's needs first by ensuring that the environment they live in is suitable for their well being.

- Municipal information need to be efficient to keep with changes within the area.
- Decisions need to be collaborated between all stakeholders to ensure sustainability.
- The Government, private sectors and individuals planning to start business should start investing in other parts of the Municipality including rural areas. This will aid in reducing pressures on the urban and peri-urban areas.
- Investors should extend focus on other resources for alternative economic growth, for example getting more land for agricultural purpose. Land can be utilized for improving and producing sufficient food for South Africa that may be sold to foreign countries. Food production can be part of rural areas and can create many jobs for rural South Africans. Not only food crisis resulting from high prices can be controlled, but also rural communities can find a cheaper way of supporting their families.
- Findings from the study have shown that the importance of *Amaranthus dubius* is not recognized by most households. Consumption of the vegetable in RLM is low due to poor environmental conditions stimulated by both human and industrial wastes.
- Waste management issues should also be responsibility of community.
- As the Department of Water Affairs is in the process of eradicating 'bucket system'[24], households should establish their pit latrine to reduce chances of a harmful environment. Included here are peri-urban areas where projects take a long time to be implements.
- Where there are severe problems regarding waste disposal, big temporary bins should be provided at least 4 per area to reduce pollution and for feasible collection by the Municipality. Until Rustenburg Local Municipality find a way of integrating aspects of sustainability and not only focusing on economic welfare, loss of natural resources will continue. What will be left in the area will be quarries from mining activities to bury the community, and building in bare areas with buildings while investors are gone with their money. Therefore, it is important to ensure that what is available now is sustained for the future including local vegetation which serves major role of modifying our environments. With the current demand for housing and mining sector in the Municipality, environmental instability is expected to continue in the future.

[24] The system used by households as an alternative where there are no pit latrines as well as sewerage for human waste.

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APPENDICES

Appendix 1

Questionnaire Facesheet

Date…… Location ……..…Duration…….....

Demographic information

1. **Gender**

Male ☐ Female ☐

2. **Age distribution**

10-20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ 60 + ☐

3. **Current place of residence**

Urban ☐ Suburban ☐ Peri-urban ☐ Rural ☐

4. **Land use type in your residence**

Farming ☐ Industrial ☐ Agriculture ☐ Mining ☐ Others ☐

5. **Education**

PHD ☐ Masters ☐ Honours ☐ Bachelors degree ☐ Matric ☐ Primary ☐

Below primary ☐

6. **Employment status**

Unemployed ☐ Farmer ☐ Mine-worker ☐ Student ☐ Others ☐

(Please specify_____)

7. **Date of establishment**

yyyy	mm	D d

8. Area (ha)……

9. Dominant ethnic group

Whites ☐ Coloureds ☐ Africans ☐ Others ☐

(specify_____)

10. Citizenship

South African ☐ Foreigner ☐

(Specify_____)

11. Are you a permanent resident?

Yes ☐ No ☐

If no, please attend question 12, 13 and 14.

12. How long have you been staying here?

Few months ☐ A year ☐ Two years ☐ More ☐

(Please specify_____)

13. Where was your previous residence?

(Please specify_____)

14. Reasons for staying there?

Land tenure system ☐ Employment ☐ Family ☐ Studies ☐ Others ☐

(Explain_____)

15. Do you plan to move out of the place and why?

Yes ☐ No ☐

(Explain_____)

16. Household size

2-4 ☐ 4-6 ☐ 6-8 ☐ 8 + ☐

17. Number of employed people in household

0-2 ☐ 2-4 ☐ 4 + ☐

18. Do you plan to extend your household and how?

Yes ☐ No ☐

19. Gross monthly income

R100-R499 ☐ R500-R999 ☐ R1000-R1499 ☐ R1500-R1999 ☐

R2000-R2499 ☐ R2500-R2999 ☐ R3000 + ☐

20. Sources of income

Salary ☐ Hawker ☐ Services ☐ Others ☐

(Please specify_____)

General Questions (Answer N/A if it is not available)

1. **Do you own any forest or trees?** (if no, question 2 won't be answered)

Yes ☐ No ☐

2. If yes, how big is your area?

3. Forest ownership

Municipality ☐ Tribal authority ☐

4. Do you have any access to forest?

Yes ☐ No ☐

5. Types of land cover

Woodlands ☐ Shrubland ☐ Grassland ☐ Afforestation area ☐

6. Land use pattern

Cultivated ☐ Pasture ☐ Forest ☐ Others ☐

(Elaborate_____)

7. State of forests

Managed ☐ Over-exploited ☐ Neglected ☐ Others ☐

8. Any changes regarding state of forests since you stay here?

Remain the same ☐ Changed ☐ Don't know ☐

9. If there is any, are you concerned about changes about the local forests?

Very concerned ☐ A little ☐ Not at all ☐

10. Have you taken actions to show your concern?

Yes ☐ No ☐

(Elaborate_____)

11. Forest area (ha/type)_____

12. Forest distribution

Dense ☐ Sparse ☐ Mixed ☐

13. Any interaction with the forests?

Yes ☐ No ☐

14. Who often interacts with forests in your household?

Children ☐ Youth ☐ Woman ☐ Men ☐

15. How often do you interact with forests?

Never ☐ sometimes ☐ Always ☐

16. Any restrictions regarding the use of the forests?

Yes ☐ No ☐

(Elaborate_____)

17. Do you value your forests?

Yes ☐ No ☐

18. Which forest species are more valuable in your area and why?

Natural ☐ Plantation ☐

19. Any problems related to the use of species of your choice?

Yes ☐ No ☐

(Elaborate_____)

20. What goods and services do you get from your local forest?

Reserves ☐ Timber ☐ Fuelwood ☐ Medicine ☐ Food ☐ Others ☐

If the answer is reserve, attend questions below 20.1; if the answer is timber, go to questions below 20.2; if the answer is fuelwood, attend questions below 20.3; if the answer is medicine, attend questions below 20.4 and if food attend questions below 20.5.

20.1 Reserve

20.1.1 What kind of reserve is that one?

Nature reserve ☐ Recreation ☐ Development ☐

(Explain_____)

20.1.2 Who owns the reserve?

Municipality ☐ Privately owned ☐ Community ☐

20.1.3 Do you benefit from this reserve?

Yes ☐ No ☐

(Elaborate_____)

20.1.4 What is your opinion about the reserve?

Very bad ☐ Bad ☐ Neutral ☐ Good ☐ Very good ☐

20.2Timber

20.2.1 What is this timber used for?

Building ☐ Fodder ☐ Mining timber ☐ Others ☐

20.2.2 What forest species are used for above selection and why?

_____

_____

20.2.3 Who is responsible for timber collection?

Women ☐ Men ☐ Youth ☐ Both ☐ Others ☐

20.2.4 When do you collect timber?

Morning ☐ During the day ☐ Afternoon ☐ Others ☐

20.2.5 How do you transport your timber?

Truck ☐ Donkey cart ☐ Bicycle ☐ Others ☐

(Specify_____)

20.2.6 Any income generated from timber and how?

Yes ☐ No ☐

(Elaborate_____)

20.2.7 How is timber demand?

High ☐ Moderate ☐ Less ☐

20.2.8 How many tons are required per day?

1-9 ☐ 10-19 ☐ 20-29 ☐ 30 + ☐

(Elaborate_____)

20.2.9 How is the supply of timber?

High ☐ sufficient ☐ Insufficient ☐

20.3Fuelwood

20.3.1 Which forest species are utilized for fuelwood and why?

_____

_____

20.3.2 What is fuelwood used for?

Cooking ☐ Charcoal ☐ Others ☐

(Elaborate_____)

20.3.3 Who is responsible for fuelwood collection?

Women ☐ Men ☐ Children ☐ Both ☐

20.3.4 How often do you collect them and why?

Everyday ☐ Once a week ☐ When needed ☐ Other ☐

(Elaborate_____)

20.3.5 When do you collect fuelwood?

Morning ☐ During the day ☐ Afternoon ☐ Others ☐

20.3.6 How do you transport your fuelwood and why?

Truck ☐ Donkey cart ☐ Bicycle ☐ Others ☐

20.3.7 Any income generated from fuelwood and how?

Yes ☐ No ☐

(Elaborate_____)

20.3.8 How is the demand of fuelwood?

High ☐ Moderate ☐ Less ☐

(Elaborate_____)

20.3.9 How many tons of wood is consumed per day?

1-9 ☐ 10-19 ☐ 20-29 ☐ 30 + ☐

20.3.10 How is the supply of fuelwood?

High ☐ Sufficient ☐ Insufficient ☐ Others ☐

(Elaborate_____)

20.4 Medicine

20.4.1 Which forest species are utilised for medical purposes and why?

_____

_____

20.4.2 Any differences regarding the use of these species?

Yes ☐ No ☐

20.4.3 Availability of the species and nature of these species

Scarce ☐ Moderate ☐ Sufficient ☐

20.4.4 Which ethnic group is more into using these types of plants?

Whites ☐ Africans ☐ Others ☐

(Elaborate_____)

20.4.5 Who is responsible for collection of the plants?

Women ☐ Men ☐ Children ☐ Both ☐

20.4.6 How often do you collect them?

Everyday ☐ Once a week ☐ When needed ☐ Other ☐

20.4.7 When do you collect them and why?

Morning ☐ During the day ☐ Afternoon ☐ Others ☐

20.4.8 Any income generated from these plants?

Yes ☐ No ☐

(Elaborate_____)

20.4.9 Any problem associated with the use of these plants?

Yes ☐ No ☐

(Please explain_____)

20.5 Food

20.5.1 What kind of food is available in your forests?

_____

_____

20.5.2 Reason why these plants are used as a source of food?

(Explain_____)

20.5.3 When are they available and why?

Summer ☐ Winter ☐ Spring ☐ Autumn ☐

20.5.4 Who is responsible for collection of the plants?

Women ☐ Men ☐ Children ☐ Both ☐

20.5.5 How often do you collect them?

Everyday ☐ Once a week ☐ When needed ☐ Other ☐

20.5.6 When do you collect them and why?

Morning ☐ During the day ☐ Afternoon ☐ Others ☐

20.5.7 Any income generated from these plants and how?

Yes ☐ No ☐

(Elaborate_____)

20.5.8 Do you encounter any problems through the use of these plants?

Yes ☐ No ☐

20.5.9 What is the quantity required everyday?

High ☐ Moderate ☐ Less ☐

20.5.10 How is the supply of these plants?

High ☐ sufficient ☐ Insufficient ☐

20.5.11 Any differences regarding the use of plants and why?

Yes ☐ No ☐

(Elaborate_____)

21. State of your current place of residence

Developed ☐ Developing ☐ Underdeveloped ☐ Poorly developed ☐ Others ☐

(Specify_____)

If the answer is developed, attend questions below 18.1; if the answer is developing, go to questions below 18.2; if the answer is underdeveloped, attend questions below 18.3; and if the answer is poorly developed, attend questions below 18.4

21.1Developed

21.1.1 How do manage your forests?

21.1.2 Do you expect any changes in your forests in the future and why?

Yes ☐ No ☐

21.2 Developing

21.2.1 What kinds of developments are in your area?

21.2.2 How do you think these are going to affect your forests?

Not at all ☐ A little ☐ Severely ☐

21.2.3 Any rules regarding your forests?

Yes ☐ No ☐

(Elaborate_____)

21.3 Underdeveloped

21.3.1 What do you think contributed to your area being underdeveloped

Lack of finance ☐ Neglected ☐ Poor management ☐ others ☐

(Elaborate_____)

21.3.2 How do you think the situation is going to impact your forests?

Not at all ☐ A little ☐ Severely ☐

21.4 Poor development

21.4.1 What are indicators of poor development

Shacks ☐ Low class houses ☐ Mixed ☐ Others ☐

21.4.2 What do you think contributed to the situation

Poor planning ☐ Lack of information ☐ Lack of facilities ☐ others ☐

(Elaborate_____)

21.4.3 How is the situation affecting your forests

Not at all ☐ A little ☐ Severely ☐

22. Any future plans regarding management of forests?

yes ☐ No ☐

_____

_____

_____

♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣ ***Thank you*** ♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣♣

Appendix 2

Trees available and utilized as source of energy by households in Rustenburg Local Municipality					
Local name	**Language**	**Scientific name**	**Common usage**	**Demand**	**Availability**
Mookana	Tswana	*Acacia karroo*	Cooking/charcoal	High	Sufficient*
Molutu/modutu	Sotho/tswana	*Celtis Africana*	Cooking	Moderate	Moderate
Moshabele	Tswana	*Rhus lancea*	Cooking	High	Sufficient
Mosu	Tswana	*Acacia tortilis*	Cooking	High	Sufficient
Mokgalo	Tswana	*Ziziphus mucronata*	Cooking/charcoal	High	Sufficient
Moselesele	Tswana	*Oxal dissitiflara*	Cooking	High	Moderate
Mulberry	English	*Morus alba*	Cooking/fruit	Moderate	Sufficient
Mnga	Xhosa	Not known	Cooking	Moderate	Moderate
Mthole	Xhosa	Not known	Cooking	Moderate	Moderate
Morutlhware	Tswana	*Acacia caffra*	Cooking/charcoal	High	Insufficient
Mongana	Tswana	*Acacia mellifera*	Charcoal production	High	Moderate
Motshana	Tswana	*Acacia nilotica*	Cooking/heating homes	High	Moderate
Peperboom	Afrikaans	*Warburgia salutaris*	Cooking/heating homes	Moderate	Moderate
Geelbossie	Afrikaans	*Lopholaena coriifolia*	Cooking/charcoal	Moderate	Insufficient
Jacaranda	English	*Jacaranda mimosifolia*	Charcoal production	Moderate	Moderate
Mosetlha	Tswana	*Peltophorum africanum*	Charcoal production	High	Insufficient
Mofeye	Tswana	*Ficus burkei*	Cooking	Moderate	Insufficient
Mofudiri	Tswana	*Combretum apiculatum*	Charcoal production	Moderate	Insufficient

*****The most common and utilized species in the area due to availability of the tree.

Appendix 3

Forest food available and consumed by community within study sites					
Local name	**Language**	***Scientific name***	**Demand**	**Availability**	**Part used**
Moretologa	Tswana	*Ximenia americana*	Less	Sufficient	Fruits
Moretlwa	Tswana	*Grewia flava*	Less	Sufficient	Fruits
Mmupudu	Tswana	*Mimusops zevheri*	Less	Sufficient	Fruits
Morula	Tswana	*Sclerocarya birrea*	Less	Sufficient	Fruits/ wood/bark
Mokgalo	Tswana	*Ziziphus mucronata*	Less	Sufficient	Fruits/ wood
Motlhatsa	Tswana	*Englerophytum magalismontanum*	Less	Sufficient	Fruits
Mmilo	Tswana	*Vangueria infausta*	Moderate	Moderate	Fruits
Mandandi/Cassava	Shangaan/English	*Manihot esculenta*	Less	Insufficient	Leaves/tubers
Thepe	Tswana	*Amaranthus dubius*	Less	Sufficient	Leaves
Mofeye	Tswana	*Ficus burkei*	High	Insufficient	Fruits
Rapa	Xhosa	Not known	Moderate	Sufficient	Leaves
Spaile	Xhosa	Not known	Moderate	Sufficient	Leaves
Leleme la konyana	Tswana	Not known	High	Sufficient	Tubers
Mpunzi/lephutse	Pumpkin	*Cucurbita maxima*	Moderate	Sufficient	Leaves/seeds
Garenate	Tswana	*Punica granatum*	Moderate	Sufficient	Seeds
Mophane	Tswana	*Colophospermum mopane*	Moderate	Moderate	Worms
Mulberry	English	*Morus alba*	Moderate	Sufficient	Fruits/ wood
Mango	English	*Mangifera indica*	High	Insufficient	Fruits
Peach	English	*Prunus persica*	High	Insufficient	Fruits
Orange	English	*Citrus sinensis*	High	Insufficient	Fruits
Apple	English	*Malus pumila*	High	Moderate	Fruits

Lemon	English	*Citrus limonium*	Moderate	Moderate	Fruits
Grapes	English	*Vitis vinifera*	High	Insufficient	Fruits
Guava	English	*Psidium guajara*	Moderate	Sufficient	Fruits
Sunflower	English	*Helianthus annuus*	Moderate	Sufficient	Seeds
Avocado	English	*Persea americana*	Moderate	Insufficient	Fruits

Appendix 4

African traditional medicines utilized by participants					
Local name	**Language**	**Scientific**	**Common usage**	**Availability**	**Race**
Phate ya ngaka	Tswana	Not known	For diarrhea & blood circulation	Moderate	Africans
Tshikhopha	Venda	Not known	Heals many illness such as stomach ache.	Sufficient	Africans
Muberegisi	Venda	Not known	Heals stomach ach.	Sufficient	Africans
Sekaname	Tswana	Not known	For 'futha'	Scarce	Africans
Mthobothi	Xhosa	Not known	To cure skin rash	moderate	Africans
Nkomnophondo/ mathubadifala	Xhosa/tswana	Not known	For widows to clean blood after loss of the husband.	Sufficient	Africans
Sindabaloi/moragabaloi	Shangaan/tswana	*Osyris lanceolata*	For protection against evil deeds	Sufficient	Africans
Sekatsane	Shangaan	Not known	For healing Sexually Transmitted Diseases & rash	Sufficient	Africans
Santamari	Shangaan	Not known	Help restless kids during the night	Sufficient	Africans
Lengana (wild mint)	Tswana/English	Not known	For making tea as well as for cold	Sufficient	Africans
Tholwana	Tswana	*Solanum aculeastrum*	For sore-feet, witch craft and healing diarrhea.	Moderate	Africans
Tshuku ya poo/ African potato	Tswana	Not known	For cleaning blood, for kidney & bathing	Scarce	Africans
Mathubadifala	Tswana	Not known	Rash, stomach & waist ache	Sufficient	Africans
Serokolo	Tswana	*Carrisa bispinosa*	To be active all the time (gatega) & also drink for headache	Sufficient	Africans
Tlhoya	Tswana	Not known	All used for rash inside & to ensure that the baby grows well; flu & cough in kids	Sufficient	Africans
Ditantanyane	Tswana	Not known	All used for rash inside & to ensure that the baby grows well	Sufficient	Africans
Nko ya thipa	Tswana	Not known	For treating kidneys and cramps,	Scarce	Africans

Sebebetswane	Tswana	Not known	For cleaning bowl and skin rash.	Scarce	Africans

Tshetlho	Tswana	Not known	Treating rash	Scarce	Africans
Bloekom	Afrikaans	Not known	For flu and tonsils	Sufficient	Both
Chips	English	Not known	For healing tonsils & toothache/ or treatingsoar throat & ear..	Sufficient	Both
Kgophane	Tswana	*Aloe greatheadii*	Used to prevent anything from happening to the baby	Sufficient	Both
Mokgopha	Tswana	*Aloe marlothii*	For healing chickens, cleaning blood & treating wounds	Sufficient	Both
Legalanaa	Tswana	Not known	Used to detox	Scarce	Africans
Modikasope	Tswana	Not known	To prepare cough mixture	Scarce	Africans
Lengana	Tswana	Not known	Healing cough, flu & womb.	Scarce	Africans
Benreit	Afrikaans	Not known	Cough	Scarce	Africans
Tlhaba	Tswana	Not known	For tooth ache	Scarce	Africans
Peperboom	Afrikaans	*Warburgia salutaris*	Flu	Sufficient	Africans
Mogaga	Tswana	Not known	Used during funeral & for bathing to prevent evil deeds	Scarce	Africans
Garenate	Tswana	Not known	Roots are crashed & boiled to drink for healing flu	Scarce	Africans
Moshabele	Tswana	*Rhus lancea*	Bark is boiled to drink for flu, for treatment of belly.	Scarce	Africans
Seswagadi	Tswana	Not known	Taken by widows	Scarce	Africans
Mosiama	Tswana	Not known	Used for bathing to remove bad luck	Sufficient	Africans
Intelezi/telezi	Zulu/xhosa	Not known	Flower, muthi for cleaning up the bowl & protection against evil deeds.	Scarce	Both
Nyongo	Xhosa	Not known	Rash & perform rituals in Zulu.	Sufficient	Africans

Makgabenyana	Tswana	Not known	For treating kidney problems.	Scarce	Africans
Setlhatsana	Tswana	Not known	Used by women for treating womb to prepare for pregnancy	Scarce	Africans
Leshe	Tswana	Not known	For bathing & for drinking after boiling.	Scarce	Africans
Syringa	Shangaan	*Melia azedarach*	For healing stomach ache.	Scarce	Africans
Mathunga	Xhosa	Not known	For pain	Scarce	Africans
Mhlabelo	Xhosa	Not known	For curing broken leg	Scarce	Africans
Nzinziniba	Xhosa	Not known	Cough & flu	Scarce	Africans

Sengaparile	Tswana	*Harpagophytum procumbens*	Stomach ache	Scarce	Africans
Phate tse ntsho	Tswana	Not known	For widow.	Scarce	Africans
Motlhakola	Tswana	*Euclea divinorum*	Used after lightning had killed livestock or damaged crops.	Sufficient	Africans
Mositsana	Tswana	*Markhamla acuminata*	For bathing	Sufficient	Africans
Mosetlha	Tswana	*Peltophorum africanum*	Used by Africans to heal widows	Scarce	Africans

Appendix 5

List of trees distributed by Department of Water Affairs and Forestry	
Scientific name	**Common name**
Indigenous plants	
Acacia erioloba	Camel thorn
Acacia galpinni	Monkey thorn
Acacia sieberana	Paper bark thorn
Acacia tortilis	Umbrella thorn
Brachychiton populneus	Kurra jong
Callistemon viminalis	Weeping Bottlebrush
Celtis australis	Chinese Nettle tree
Ceratonia siliqua	Carob tree
Celtis africana	White Stinkwood
Dodonaea viscose (angustifolia)	Sand olive
Dovyalis caffra	Kei apple
Cupressus glabra	Smooth-Barked Arizona cypress
Combretum erythrophyllum	River Bush Willow
Olea africana	Wild Olive
Parkinsonia aculeata	Jerusalem thorn
Rhus lancea	Karee
Rhus pendulina (viminalis)	White karee
Schinus molle	Pepper tree
Thuja orientalis	Thuja
Phoenix redinata	Wild date palm
Phoenix	Water palm
Ziziphus mucronata	Buffalo thorn
Tipuana tipu	Rosewood
Proposed fruit trees	
Dovyalis zeyheri	Applekos
Citrus aurantium	Orange
Vitis vinifera	Grape
Prunus persica	Peach
Ficus carica	Fig
Citrus limon	Lemon

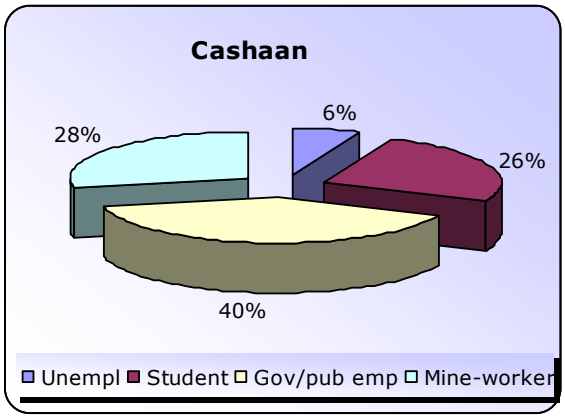
Appendix 6

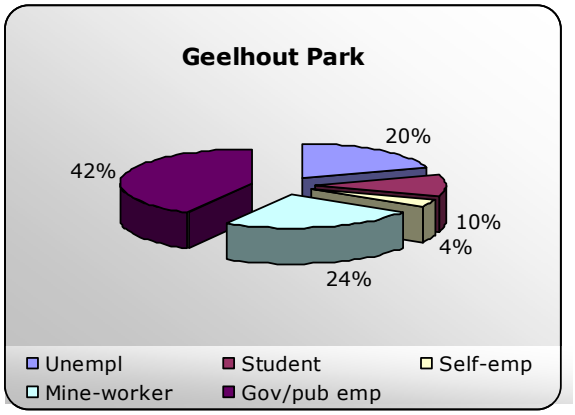
Plant species within Kgaswane Mountain Reserve		
Acacia ataxacantha	*Dombeya rotundifola*	*Olea capensis*
Acacia caffra	*Dovyaliszeyheri*	*Olea europaea*
Acacia karoo	*Ehretia rigida*	*Olinia emarginata*
Acacia nilotica	*Englerophytum magalismontanum*	*Olinia rochetiana*
Acacia robusta	*Euclea crispa*	*Osyris lanceolata*
Acacia tortilis	*Euclea natalensis*	*Ozoroa paniculosa*
Acalypha glabrata	*Euclea undulata*	*Pappea capensis*
Acokanthera oppositifolia	*Erythrina lysistemon*	*Pavetta gardeniifolia*
Aloe marlothii	*Euphobia cooperi*	*Pavetta zeyheri*
Apodytes dimidiata	*Faurea saligna*	*Peltophorum africanum*
Berchemia zeyheri	*Ficus abutilifolia*	*Phylica paniculata*
Brachylaena rotundata	*Ficus burkei*	*Pitttosporum viridiflorum*
Bridelia mollis	*Ficus ingens*	*Pouzolzia mixta*
Buddleja saligna	*Ficus natalensis*	*Pterocelastrus echinatus*
Buddleja salviifolia	*Ficus salicifolia*	*Protea caffra*
Burkea africana	*Flacourtia indica*	*Protea gaguedi*
Calodendrun capense	*Flueggea virosa*	*Protea welwitschii*
Canthium gilfillanii	*Grewia flava*	*Psydrax livida*
Canthium mundianum	*Grewia monticola*	*Rhamnus prinoides*
Canthium suberosum	*Grewia occidentalis*	*Rhus lancea*
Cassinpsis ilicifolia	*Gymnosporia buxifolia*	*Rhus pyroides*
Celtis africana	*Halleria lucida*	*Rothmannia capensis*
Chionanthus foveolatus	*Ilex mitis*	*Salix mucronata*
Clerodendrum glabrum	*Lannea discolor*	*Sclerocarya birrea*
Combretum apiculatum	*Maerua caffra*	*Scolopia zeyheri*
Combretum erythrophyllum	*Maytenus undata*	*Solanum giganteum*
Combretum molle	*Mimusops zeyheri*	*Strychnos pungens*
Combretum zeyheri	*Morella pilulifera*	*Strychnos usambarensis*
Croton gratissimus var.	*Morella serrate*	*Tarchnanthus camphoratus*
Cussonia paniculata	*Mundulea sericea*	*Trema orientalis*
Cussonia spicata	*Mystroxylon aethopicum*	*Tricalysia lanceolata*
Cyathea dregei	*Mystroxylon burkeanum*	*Vangueria infausta*
Dichrostachy cinerea	*Nixia congesta*	*Vangueria parvifolia*
Diospyros lycioides	*Nixia glomerulata*	*Zanthoxylum capense*
Diospyros guerkei	*obetia tenax*	*Ziziphuz mucronata*
Diospyros whyteana	*Ochna holsti*	*Ximenia Americana*
Dodonaea viscosa	*Ochna pulchra*	*Ximenia caffra*

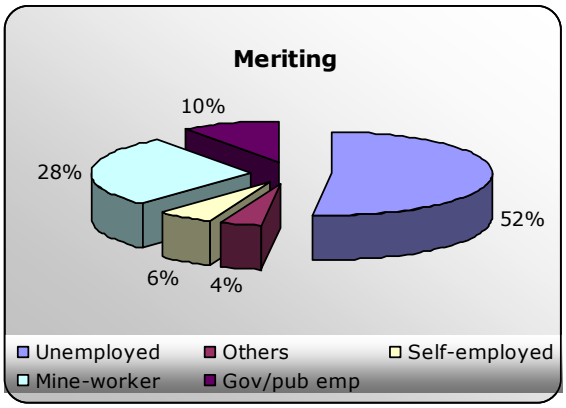
Appendix 7

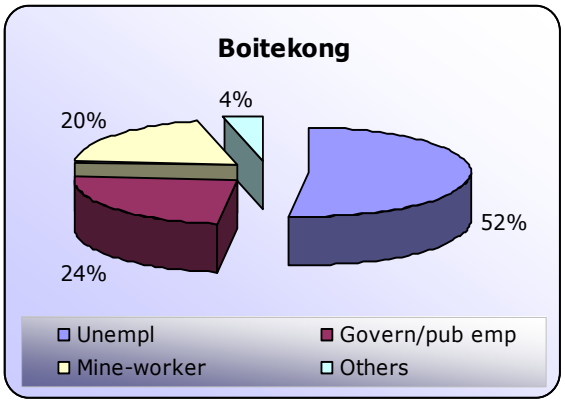
Demographics

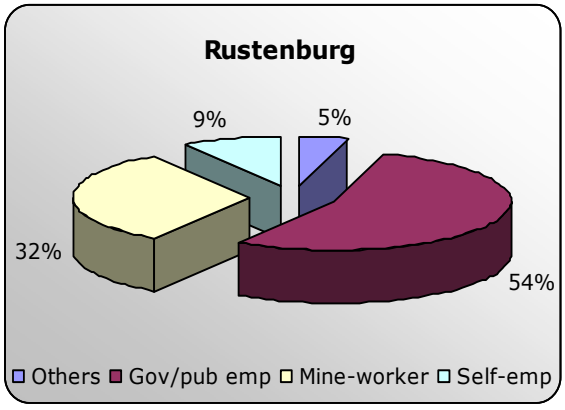
Comparison of employment rate within study sites

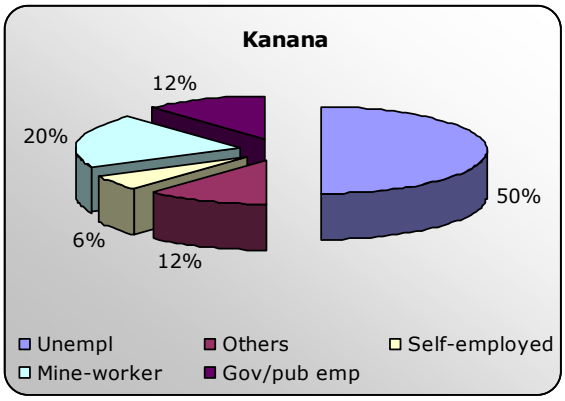












Dominant ethnic groups