

**An investigation into the Socio-economic Impact of the Shortage of
Domestic Energy Supply in Tshikunda Village of Limpopo Province,
Vhembe District**

I, MILINGONI HENRY NETSHAKHUMA student of the University of Venda hereby
declares that the dissertation for the degree of Master in Public Management at University
of Venda hereby submitted by me, has not been submitted previously for a degree at this
university or any other university, that it is my own work in design and execution, and
that all reference material contained therein has been duly acknowledged.

BY

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**A Mini Dissertation Submitted at School of Management Sciences of the
University of Venda in Partial Fulfillment of the Requirements for the
Degree of the Master of Public Management**

Supervisor: Prof M.P Khwashaba

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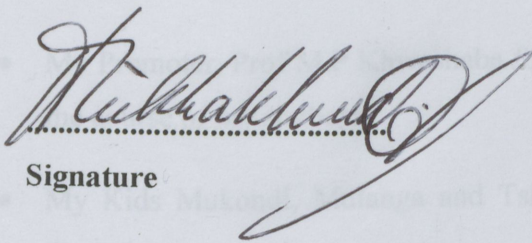
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Signature

12. 03. 2012

Date

ACKNOWLEDGMENTS

DEDICATION

My sincere gratitude is directed to the following persons who supported me during the enormous task of my studies towards the Masters degree and who made the completion of this research possible:

- The Lord Almighty, who strengthened and protected me during my years of hard work and journeys to the University of Venda;
- My Promoter, Prof M.P Khwashaba for his valuable guidance and support during the course of my studies;
- My Kids Mukondi, Mulanga and Tshifaro, thank you for your lovely support throughout my study;
- I would like to thank my wife MM Magavha-Netshakhuma, You were there for me all the way;
- Mr. K.M. Siobo & Mr. Bono Mmbengeni for assisting in the conceptualisation of this topic from the households perceptive.
- Mrs. J.R. Ramagoma for typing this dissertation accurately and professionally;

For all these people my thanks are due.

ABSTRACT

DEDICATION

On my personal note, I dedicate this project to my parents, Mr. Netshakhuma Bethuel Mphireni and Mrs Netshakhuma-Muila Mutshutshu Asnath. You were there for me all the way.

The study uses both quantitative and qualitative techniques for data collection and analysis. Qualitative techniques were mostly used in that they provide the researcher with an understanding of experiences and problems faced by communities who receive inadequate domestic energy supply. Random and purposive samplings were used for the selection of sample for the study. Both primary and secondary data were used for analysis in this study. Secondary data were obtained from government publication, research publication, and report. Primary data were obtained through personal observation, household's questionnaires.

Wood in these villages is very scarce and communities spend 5 to 6 hours per trip collecting fuel wood. Women using the load head method of carrying wood and occasionally wheelbarrows are the main source of labour used in collecting fuel wood. The paper concludes that there is a need to promote sustainable energy resources and technologies such as the use of improved wood and charcoal stoves. Furthermore, the paper recommends the promotion of solar photovoltaic (PV) systems, which have a potential of being adopted in the area. It is also argued that policies which enhance integrated rural development and promote sustainable energy utilization in rural communities need to be put in place and implemented.

The findings of the study show fuelwood use is prevalent, perhaps due to the limited ability to pay for electricity. There was a strong preference for grid electricity, but there

ABSTRACT

A study was conducted in the rural communities of Tshikunda village in Limpopo Province, with the aim of identifying types of energy resources used and the patterns of utilization of such energy sources. Surveys were conducted in village and semi-structured questionnaires were used to interview 30 randomly selected households in village. Data obtained in all surveyed villages showed that fuel wood is the main source of energy for cooking and heating while paraffin and candles are mainly used for lighting.

The study uses both quantitative and qualitative techniques for data collection and analysis. Qualitative techniques were mostly used in that they provide the researcher with an understanding of experiences and problems faced by communities who receive inadequate domestic energy supply. Random and purposive samplings were used for the selection of sample for the study. Both primary and secondary data were used for analysis in this study. Secondary data were obtained from government publication, research publication, and report. Primary data were obtained through personal observation, household's questionnaires.

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The findings of the study show fuelwood use is prevalent, perhaps due to the limited ability to pay for electricity. There was a strong preference for grid electricity, but those

who have electricity complained about frequent power cuts. Small businesses, which were not electrified used batteries (hair cutting machines or public phones), LPG (fridges, stoves, welding), wood (cooking) and candles (lights). While electrified businesses use electricity for cooking, lights, fridge and welding, they also use candles (lights), generators (fridge) and LPG (cooking) during power cuts that occur regularly in the area.

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CDS Cool Dry Season

LPG Liquid Petroleum Gas

SHS Solar Home Systems

WSSD World Summit on Sustainable Development

MDGs Millennium Development Goals

NEMA National Environmental Management Act

CHAPTER 1: INTRODUCTION AND BACKGROUND OF THE STUDY

LIST OF ABBREVIATIONS

1.1 Introduction

WHO	World Health Organization
SANEP	South Africa National Electrification Programme
WWS	Warm Wet Season
CDS	Cool Dry Season
LPG	Liquid Petroleum Gas
SHS	Solar Home Systems
WSSD	World Summit on Sustainable Development
MDGs	Millennium Development Goals
NEMA	National Environmental Management Act

CHAPTER 1: INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 Introduction

The turn of the twenty first century has seen the world's human energy consumption at its highest point. It has been argued that history reflects a relevant correlation between changes in energy use and advances in human welfare. Whether this is the case or not, it is clear that the general opinion on energy relations in our modern world sees a positive link between energy and socio-economic well being, thus, the importance of energy to the continuation of human development cannot be understated (Anderson, 2006).

The increasing human populations coupled with the enlarged energy demands of the modern lifestyle have led to what is now a challenging period in energy planning to meet sustainable development needs. Most modern methods of energy production in widespread use are known to have significant adverse effects on the environment. Global climate change, air pollution and other primary and secondary effects associated with the production of energy have raised global concern on the subject of energy production (Aubret, 2006). According to the World Health Organization as many as 160,000 people die each year from the side-effects of climate change. Side-effects range from malaria to malnutrition and diarrhea that follow in the wake of floods, droughts and warmer temperatures. In light of this, the fact that fossil fuels are providing almost 80% of the global energy demands provides cause for concern. Atmospheric releases from fossil fuels comprised 64% of global anthropogenic carbon dioxide emissions from 1850 to 1990. Environmental issues aside, declining oil reserves and the dwindling supply of other non-renewable energy sources have added further incentive to find sustainable solutions.

The challenges surrounding the supply of sustainable electricity are especially difficult for developing nations. A lack of resources, infrastructure and general poor living standards of the majority of the population make increasing the supply of, and access to, electricity problematic. In most of sub-Saharan Africa only 10–30% of rural areas have access to electricity. Even where electricity is available, the large size of many sub-Saharan countries and the expense of

electricity frequently limit its distribution to much of the rural population. Renewable small-scale energy production methods, such as solar and wind power, are deemed to be increasingly attractive alternatives to aid in the development of rural areas.

1.2 Background of the study

There is little doubt that energy is a basic need for human survival. The need for energy to cook, heat water and keep warm exists in all societies, and energy provision thus affects the material health of the population (Bartelemus, 1994). Yet access to even the most basic energy needs cannot be taken for granted amongst South Africa's poorer groups. Ian McCrae (Chief Executive Eskom 1992) stated the following "...By the turn of the century there will be approximately 35 million black people in South Africa alone. The consequences of failing to produce affordable power for the poorest element amongst these people will simply accelerate the present problem and condemn even more people to a life deprived of the benefits of electricity" At present an estimated 21 million people or 3.5 million households do not have electricity.

The situation is even worse, with less than 10% of the population having access to electricity. Further urbanisation and population growth over the next 20 years is expected to at least double the current demand for electricity. South Africa has the necessary resources to meet development needs through providing most homes with electricity. Eskom, South Africa's national electricity utility, supplies more than half the total electricity consumed on the African Continent and is one of the world's top five electricity utilities in terms of sales volume. In an article entitled "Electrifying the Nation" (Stavrou 1992) the point is highlighted that historically the immense economic and political power wielded by whites in South Africa has resulted in a markedly skewed distribution of state services on a racially discriminatory basis.

While the white urban and rural areas are well provided for and a rudimentary system of supply exists in the black residential areas, electricity services are almost totally absent in the black rural areas and shanty towns. Although Eskom monopolises the generation of electricity, there are approximately 400 Municipalities and Black Local Authorities who purchase their electricity in bulk from Eskom and then distribute it to their constituents. Most former white municipalities

have evolved distribution techniques which are reliable, safe and cost-effective and have created a network which is suited to the purpose of electricity supply to customers who utilise an average of about 700 kilowatt hours per month. In sharp contrast, the quality of electricity supply by the former Black Local Authorities to the townships is extremely poor, especially meter readings, billing and collection which has in the past caused serious problems and discontent. This has led to accounts being in arrears and often payments may never reach the bulk supplier. Due to the sometimes complex political issues involved, Eskom has in some cases agreed to take over distribution responsibility in a number of large black municipalities and through this move there has been a 95% growth in direct Eskom customers (ESKOM, 2003).

The overall aim of this study is to investigate the socio-economic impact of the shortage of Eskom's slogan for the 1990's "Electricity for All" is part of Eskom's mission statement which is "to provide the means by which customers' electricity needs are satisfied in the most cost-effective way, subject to resource constraints and the national interest. In order to satisfy the country's demand for household energy it is extremely important for policy makers to study energy usage patterns and to be aware of the factors determining energy demand, as well as possible changes in these factors. Electrification can have a major socio-economic impact, bringing about sweeping changes to the lifestyles of rural people. This study professes to investigate these changes and to identify the various factors affecting a total energy transition process.

- To investigate and identify current energy exploited in the study area.

1.3 Statement of Problem

- To determine the main uses of energy in Tshikunda Village.
- To determine the consequences of firewood shortages on rural livelihood and

The increasing consumption of fuelwood in the villages has led to a variety of environmental problems; some of the problems are caused unintentionally because the locals are not aware of the environmental conservation strategies. The collection of firewood is a physically demanding and time-consuming work especially for women and girls, who are also responsible for other household duties. The residents from the villages collect firewood from the nearby surrounding woodlands and then store them at home until they are ready for use.

There is an increasing demand for firewood at Tshikunda village. Because fuelwood is the main source of primary energy it is used with low efficiency and there are no programmes that are put in place to help minimize the consumption rate of the firewood through the use of improved wood production and utilization technology and efficient energy utilization

1.4 Research Objectives

1.4.1 General Objective

The overall aim of this study is to investigate the socio-economic impact of the shortage of domestic energy supply in Tshikunda Village

1.4.2 Specific Objectives

- To identify and examine factors affecting domestic energy distribution in the study area.
- To investigate socio-economic impacts based on the shortage of the energy in the study area.
- To investigate and identify current energy exploited in the study area.
- To determine the main uses of energy in Tshikunda Village.
- To determine the consequences of firewood shortages on rural livelihood and environment
- To develop and recommend strategies for improving energy supply in the study area.

1.5 Research Questions

- What are the factors affecting domestic energy distribution in the two study area villages?
- What are the consequences caused by firewood scarcity on rural livelihoods and environment?
- What strategies can be developed to improve domestic energy?

1.6 Research Hypothesis

- Lack of domestic energy supply impact on the productivity of women and children
- Lack of domestic energy cause socio-economic impacts
- Over exploitation of the firewood collection cause environmental degradation
- Low income generation cause poor distribution of the domestic energy

1.7 Delimitation of study

This study primarily focused on the domestic energy use in rural areas in particular Tshikunda village in Thulamela Municipality Limpopo Province. The research was to cover the period from 2009 to 2011. The study itself would not touch other villages in Thulamela Municipality except Tshikunda village, though other areas might be having other challenges of domestic energy use, but this study would focus directly to Tshikunda village in Thulamela Municipality, in Vhembe District, Limpopo province.

1.8 Limitation of the study

There were potential threats pertaining to this study. The possibility of people affected by domestic energy use in the wrong interpretation of questions, in case of primary sources could not be ruled out, particularly with the collection of primary data through questionnaire. The use of secondary sources in this study could create a very serious problem as the credibility of these sources was highly questionable due to limited scope of the study; the researcher was likely to

make generalization and that can also create a serious problem in the process of assessment. The question of transport could possibly hinder the prompt assessment of the issues affecting domestic energy use at Tshikunda village. Inaccessible roads within Tshikunda village could also prevent thorough assessment of factors affecting domestic use.

1.9 Significance of the study

This study was critical as it intended to expose the domestic energy use experienced by the residents of Tshikunda. It was believed that the findings would propel and compel the municipality to put into place mechanisms and resources to address the problems as experienced by the women, particularly at Tshikunda. It was also hoped that the municipality would ensure that there was sustainable use of domestic energy. The outcomes of the study would further avail information and concerns of the women of Tshikunda on matters of development and domestic energy use which might be found useful for development processes.

1.10 Brief summary of Literature Review

Firewood is the dominant energy source from throughout southern Africa and the rest of the developing countries (Fluri, 2008:456). This has consequences for human well-being as well as environmental quality. In terms of the latter, large-scale use of firewood has often been implicated in deforestation and desertification. This tends to require interventions to limit perceived environmental damage, before a complete denudation occurred (Fink & Bearty, 2000:45).

In southern Africa firewood accounts for 60 to 69% of the total energy consumed having the highest proportions in the poorest countries (Flyvbjerg, 2001:23). According to Arnold and Gallopin (2003:67), about two-thirds of all non-living energy in Africa is generated from firewood or charcoal. Firewood has been considered by far the most important source of energy having an average annual per capita consumption of about 1.0 m³ (Deval, 2001:89), and it account for 58% of the total energy used in the continent (Diamond, 2005:12).

Most of the rural areas in developing parts of Southern Africa are recently faced with energy instability due to rapid depletion of firewood resources which provide the major, and in some cases the only source of fuel. The scarcity of firewood tends to manifest in the amount of time spent, especially by women and children when collecting wood.

Socio-economic context of fuelwood use

Savannas are the wooded grasslands of the tropics and subtropics that account for 46% of the South African landscape. They are second only to tropical forests in terms of their contribution to terrestrial primary production. They are the basis of the livestock industry and the wildlife in these areas is a key tourist drawcard. Socio-economically, the Limpopo Province has a resource that can improve livelihoods and bring about rural development and employment if the resource is managed in a sustainable manner (Earth Day Network, 2008:90. The unsustainable removal of these resources raises concerns in relation to the ecological impact on biodiversity.

National Electrification Programme in South Africa

The South Africa National Electrification Programme (1994-99) was a government financed initiative. The programme was implemented by Eskom and the municipalities with the key objective of raising national electrification levels to about 66 per cent by 2001 with 46% rural and 80% urban (NER, 2002a). The targets of the programme were mainly the formerly disadvantaged and rural areas, and all schools and clinics. This implied providing electricity to an additional 2.5 million households. This programme provided the basis of looking at the electrification levels and rates to the poor of South Africa.

The new connections were mostly extended by Eskom and the municipalities, but large scale farmers also connected their farm workers where necessary, but Eskom accounted for about two-thirds, while the municipalities only account for about 6% (Eskom, Republic of South Africa, 2004). However, there has been a slight drop in new connections which averaged around 450,000 households per year between 1994 and 2000 to 397,000 in 2001. The decline is due mainly to the drop in new connections by Eskom.

Provision of household infrastructure and services

Local government renders direct services that are needed for survival. This includes the provision of infrastructure such as roads, water, electricity and sanitation. Apart from the fact that basic services are a constitutional right, these services are needed to promote the wellbeing of individuals (Hattigh, 2001:80). Basic services should be provided and extended to those people who were either denied these services before, or who are still not receiving them. National government, job creation initiatives and the establishment of community based contractors to assist in service delivery can serve to expand and improve service delivery (White Paper on Local Government, 1998).

Is there a legal right to affordable electricity?

There is no doubt that access to affordable electricity for all is a desirable development objective. Given the enormous social and economic benefits derived from household electricity provision, the question can be asked, whether access to affordable electricity can even be qualified as a socio-economic right to which all citizens are entitled. This question deserves particular attention since the South African Constitution (Act 108 of 1996) recognises and spells out a number of socio-economic rights, some of which relate to basic services, such as the right to sufficient water as contained in Section 27 (1) (b) of the Constitution. Yet, the Constitution does not contain an express right to have access to electricity.

1.11 Definitions of the Study

- **Development**

The Independent Development Trust defines development as "a process by which members of a society increase their personal and institutional capacities to mobilise and manage resources that produce sustainable and justly distributed improvements in their quality of life, consistent with their own aspirations (Jevons, 1990:78)."

- **Gender**

Gender refers to the socially constructed roles of women and men rather than biologically determined variations (Harris, *et al*, 2001:69). Issues that concern gender are not new to wood energy development.

- **Rural communities**

Rural communities, by definition, are those that are without access to ordinary public services such as electricity and sanitation and are without a formal local authority (Holm *et al*, 2000:12). These communities are characterised by inferior infrastructure, low income, poor site conditions, unreliable water availability, poor access to health facilities, high population densities, lack of legal land tenure and recognition by formal government.

- **Energy**

Energy is the resources that needed for fulfilling basic human needs such as cooking, heating and lighting (Kammen, 2006:56).

1.12 Organisation of the Study

This study comprises of five chapters.

- **Chapter 1: Introduction and Background of the study**

This first chapter provides the background of the study, statement of problem, research objectives, research hypothesis, limitation of the study, significant of the study, delimitation of the study, and organisation of the study.

- **Chapter 2: Literature Review**

Chapter 2 deals with a review of the related literature of basic energy supply, Domestic energy supply in Tshikunda Village, population and the demographic situation, The energy sources and their impacts in the Developing World, Coal consumption in South Africa, Paraffin use in South

Africa, role of Local Municipalities and Structures and current basic services as well as factors affecting distribution of services supply.

- **Chapter 3: Research Design and Methodology**

Chapter 3 provides the overall research design which outlines research methodology, methods of data collection, population of the study, sampling methods ethical consideration and methods of data analysis.

- **Chapter 4: Data Presentation, Interpretation and Analysis**

Data analysis and data presentation is provided in Chapter 4.

- **Chapter 5: Findings, Conclusion and Recommendation**

Chapter 5 is a summary of conclusion and recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The aim of this chapter is to review the literature on household energy demands and consumption patterns in urban areas so that urban household energy consumption patterns can be analysed. The characteristics of urban household energy consumption in developing countries are used to develop a suitable conceptual framework. This conceptual framework enables an exploration of household fuel consumption patterns in urban areas. The first section of this chapter introduces a brief overview of various household's energy sources and their impacts in developing countries. The second section reviews sustainable development debates on household energy consumption at a global, regional and local level. The third section traces debates on household energy trends in developing countries with specific reference to multiple fuel use, fuel switching (fuel stacking) and the energy ladder model (Holiday, 2002:78). The last section of this chapter extends the energy ladder concept to develop an energy mix and offers a critique of the energy ladder and multiple fuels models.

2.2 Domestic energy supply in Tshikunda Village

Tshikunda village is situated 16 km outside Thohoyandou town of Thulamela municipality south east of Soutpansberg mountain of Limpopo province. It is located in the former homeland of Venda and it is characterized by rich cultural diversity. The study area shares its borders with three major economic engines in the area which contribute to the economic development of the region. This include Thathe Vondo plantation, Tshivhase Tea Plantation and Mukumbani Tea Plantation. The study area is situated approximately at 22°56'S and 30°20'E (Kabanda, 2004:12).

The general climate of the Soutpansberg is divided into two seasons. Warm-wet and cool-dry seasons characterize the area. The temperatures in the study area are strongly associated with seasonal conditions and topography. The warm wet season (WWS) start from December to

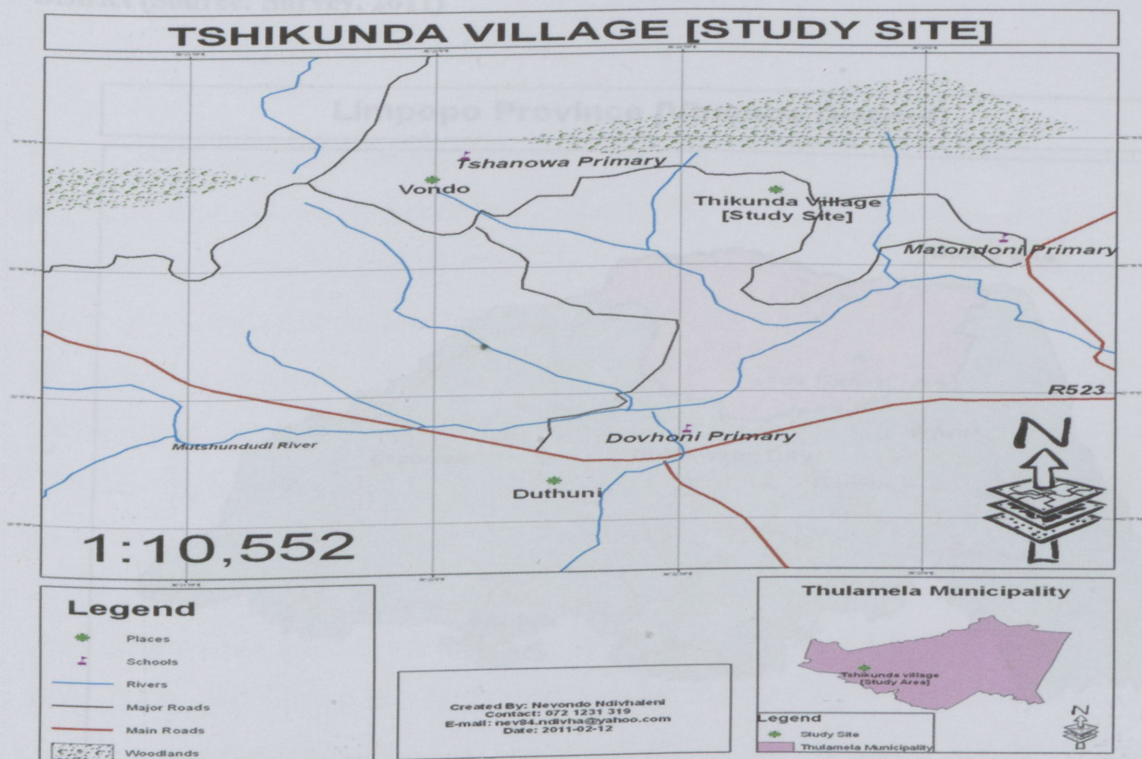
February of the following year. During summer the temperatures are relatively warmer ranging from 16 degrees centigrade to 40°C. The cool dry season (CDS) start from May-August of the same year and the temperatures ranges from 12-22 degrees centigrade (Kabanda, 2004).

The area receives one cycle of rainfall which extends from October of the previous year and ends in March of the following year (for a period of approximately 182 days). The dry season occurs from April to October of the same year. The rainfall in the area is significantly determined by the Soutpansberg where the annual rainfall reaches approximately 2000 mm south of the escarpment and rainfall peaks during January and February (Kabanda, 2004).

Cost effectively, the Limpopo province is one of the poorest provinces in South Africa supporting a large rural population that has one of the highest population growth rates in the country. As a means to support this increasing population, unaltered habitat is being destroyed at an unprecedented rate. In the past few decades large tracts of grassland and forests has been exploited for the cultivation to produce food and exotic plant species. Tshikunda village is an area which is characterized by an increasing population size of 842 peoples (Thulamela IDP document, 2007:78). This population growth has exerted an enormous pressure on the availability of natural resources particularly forest vegetation for cultivation and firewood collection purpose.

The majority of people in the area are women of the middle age and they depend on social a grant (child grant and old age pension) which is provided by the government (Thulamela IDP document, 2007:78). Women being the most dominant in the society are deeply involved in the collection of firewood as one of their domestic activities in which livelihood is sustained. According to the local statistics obtained from Tshikunda civic committee (2008:90), many people in the village are unemployed and have no other means of income to earn a living. In order for them to be able to survive and support their families, they then look up for the freely available resource such as land and fuelwood. The collected firewood is then sold to the needy people in the surrounding areas which include Phiphidi and even to Sibasa where there is no wood material available to them. The major land use changes which are taking place in the village include subsistence agriculture, residential development and concrete and gravel mining.

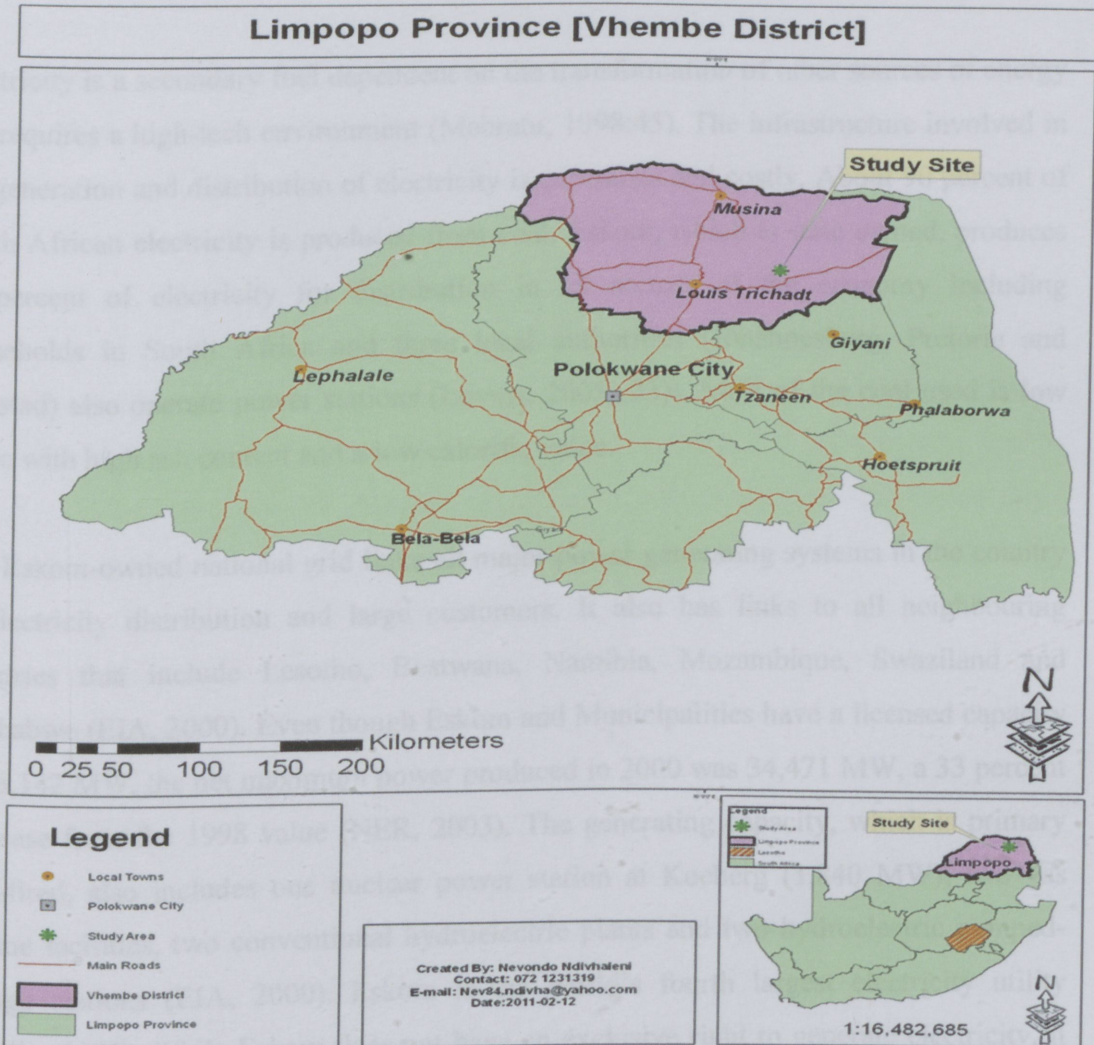
Figure 2.1: Study site map showing the location of Tshikunda village in Thulamela Municipality (Source: Survey, 2011).



2.3 The energy sources and their impacts in the Developing World

The household energy sector is divided into three sub-sectors: electricity, hydrocarbon fuels (coal, gas or paraffin) and biomass fuels (wood, dung and crop waste). In many urban communities, people use a combination of these sources to meet their energy needs. Poor urban households use biomass fuels as a combination of biomass fuels and

Figure 2.2: Limpopo Province, showing the location of the study site in Vhembe District (Source: Survey, 2011)



2.3 The energy sources and their impacts in the Developing World

The household energy sector is divided into three sub-sectors: electricity, hydrocarbon fuels (coal, gas or paraffin) and biomass fuels (wood, dung and crop waste). In many urban communities, people use a combination of these sources to meet their energy needs. Poor urban households use biomass fuels or a combination of biomass fuels and

hydrocarbon fuels in order to save electricity costs (Links, 2008:33). For the purposes of this study, these six energy sources and their related impacts are discussed below.

2.3.1 Electricity consumption in South Africa

Electricity is a secondary fuel dependent on the transformation of other sources of energy and requires a high-tech environment (Mebratu, 1998:45). The infrastructure involved in the generation and distribution of electricity is enormous and costly. About 90 percent of South African electricity is produced from coal. Eskom, which is state owned, produces 95 percent of electricity for distribution in all sectors of the economy including households in South Africa and three local authorities (Johannesburg, Pretoria and Kokstad) also operate power stations (Lovins, 2005a:23)). Most of the coal used is low grade with high ash content and a low calorific value.

The Eskom-owned national grid links all major power generating systems in the country to electricity distribution and large customers. It also has links to all neighbouring countries that include Lesotho, Botswana, Namibia, Mozambique, Swaziland and Zimbabwe (EIA, 2000). Even though Eskom and Municipalities have a licensed capacity of 43,142 MW, the net maximum power produced in 2000 was 34,471 MW, a 33 percent decrease from the 1998 value (NER, 2003). The generating capacity, which is primary coal-fired, also includes one nuclear power station at Koeberg (1,840 MW), two gas turbine facilities, two conventional hydroelectric plants and two hydroelectric pumped-storage stations (EIA, 2000). Eskom is the world's fourth largest electricity utility (Trollip, 1997). While Eskom does not have an exclusive right to generate electricity, it has a practical monopoly on bulk electricity sales to its customers.

The electricity supply industry is structured in three layers, namely generation, transmission and distribution. Most of Eskom power stations are situated in Mpumalanga Highveld. The declining availability of consolidated coalfields, increased air pollution and water scarcity are becoming serious constraints to the further development of very large coal-fired stations (Trollip, 1997). An overview of South Africa's electricity

sources is presented in Table 2.1. The electricity supply industry in South Africa deals with electricity supply and distribution. Electricity (primarily from coal based power stations) dominates urban household energy consumption in South Africa. According to Krige (2008:1) although Eskom is also heavily involved in distribution, local authorities also contribute significantly to the distribution and retailing of electricity to customers for domestic use. Local authorities primarily supply electricity to urban and peri-urban customers (Eskom, 2001).

2.3.2 Coal consumption in South Africa

South Africa is a major coal producer and exporting country. Two major local users for coal are generation of electricity and liquid fuels production. Coal provides 70 percent of primary energy supply in South Africa (Lutgens, *et al*, 2001:11). Estimates of South Africa's coal reserves are not exactly recorded. A large coal mining industry has developed over the years and South Africa should have sufficient coal for the next 100 years at least. Three fields (Waterberg, Witbank and Highveld) hold 70 percent of the total recoverable reserves. The peak demand for coal will be reached around 2070 and there will thereafter be a growing pressure on coal and a need to introduce alternative energy sources (EIA, 2000).

The coal mining industry is privately owned and controlled. However, state owned entities, or entities strongly influenced by government regulation consume the majority of the coal. Most output goes to the Eskom parastatal (56 percent) which negotiates long term contracts with private suppliers. Large amounts of coal are exported (about 23 percent), making an important contribution to South Africa's foreign exchange. In 2001, 93 percent of electricity in South Africa was generated from coal; with nuclear energy and hydropower accounting for the remaining seven percent.

Coal is mainly purchased by merchants from the mines and it is then distributed to poor urban households around South Africa. A small number of people collect coal for domestic use from the mine dumps to supplement the use of electricity. Many poor urban

households consume coal and other inefficient fuels simply because they cannot afford electricity and other clean fuels (DME, 2003). Most of the coal is high in ash (about 45 percent) but has low sulphur content (about one percent) (EIA, 2000). In lower-income households coal is usually burned in an *imbawula* (or brazier) and in cast iron stoves. This raises health concerns resulting from both particulate and carbon monoxide emissions. For example, the *imbawula* is used without a chimney and the stove is usually lit outside and moved indoors once the smoke level declines.

2.3.2 Parallel use in South Africa

Emissions from coal burning remains unacceptable in most townships and is a health hazard (DME, 2003). According to Horen *et al.* (1996) epidemiological studies done on the urban coal-using townships sampled in South Africa shows that the single most significant risk factor for the development of respiratory tract illnesses was coal. This study indicated that not only the use of coal in homes but also the extent of coal use in the wider residential areas enhances the risk of developing respiratory tract illnesses. One of the important findings of the research was that up to 50 percent of homes in urban areas, which are electrified continued to use coal for space heating in winter. In these homes, the air pollution exposures and related health risks were still significantly higher (Horen *et al.*, 1996).

2.3.3 Biomass fuel use in developing countries

Biomass fuel plays a key role in poor urban households for cooking and space heating. According to the World Bank (2003), many urban people use biomass fuels for cooking in South Africa. Biomass fuel is largely free and relatively available to most communities. Biomass fuel supply is not managed by government in South Africa but is an unregulated activity (World Bank, 2003). Communities collect biomass fuel from a variety of sources or buy biomass fuel from an unregulated local market. In urban areas however, increasing income often implies a decline in biomass fuel consumption, with an accompanying increase in the use of modern fuels (Chambwera, 2004). Wood continues to be burned in simple stoves and the *imbawula*.

The combustion of biomass fuels contributes to poor indoor and outdoor air quality. For example, burning biomass, charcoal releases smoke and other pollutants, which particularly affect those closest to the stove (i.e. women and children) (Meikle and Bannister, 2003). Biomass combustion emits products of incomplete combustion such as methane and benzene, which threaten human health and contribute towards global warming (Karekezi and Kithyoma, 2002).

2.3.4 Paraffin use in South Africa

Paraffin is widely used in poor urban households as the main source of energy. There are about five refineries supplying about 800 million litres per year of paraffin to the household sector in South Africa. The DME (2003) states that there is a fairly well established paraffin distribution network, which has been successful in promoting the use of paraffin in low-income urban households. Despite its popularity, kerosene or paraffin has a number of drawbacks, such as burns and fires, resulting from wick stoves and stove pressure malfunction. Kerosene causes many casualties resulting from exposure to fumes from burning kerosene and poisoning of children who accidentally ingest paraffin kept in cold drink bottles (DME, 2003).

2.3.5 Liquid Petroleum Gas

Liquid Petroleum Gas (LPG) is commercially available through the petroleum and gas industry (Howells *et al.*, 2003). Most of the multinational oil companies sell LPG through their subsidiaries such as Shell Easigas, BP Gas, Total Elfina and Handigas (Afrox). According to Howells *et al.* (2003) the distribution of LPG however, is mainly concentrated in urban areas. Despite its convenience, there is a great feeling of insecurity in relation to safety issues and the cylinder being stolen act as a barrier to the use of gas fuels. A fear about explosions is a concern raised by many people in relation to hazards and indoor air pollution effects (Howells *et al.*, 2003). Of course, choice is further constrained by cost as well and not only fuel costs, but also the start-up costs of connections, equipment and stoves. Some recent studies that have compared total costs of

different cooking fuels in India find that in some cases the option of purchased traditional fuels can be more expensive than LPG (Farsi, 2004).

2.3.6 Solar power in urban areas

Solar energy is among the many household technologies proposed to address climate change (Middleton, 1995). Small solar electric systems can cost-effectively supply energy to poor urban parts of developing countries while substituting for energy sources that emit carbon dioxide (CO₂). Photovoltaic (PV) solar home systems (SHS) are often the least expensive electrification option in most poor urban households (Middleton, 1995). Typically consisting of a 10 to 50 watts peak (Wp) PV module, a rechargeable lead acid battery and sometimes a charge controller, the systems generate modest amount of electricity for lights, radio, television and other small appliances. However, early experience with the technology included operational failures caused by poor maintenance and unsustainable donation programs (Middleton, 1995). Having discussed different sources of energy, the following section reviews the literature on policy reforms in South Africa and consequences thereof.

2.4 Firewood utilization and poverty in Southern Africa

Almost every feature of development - from reducing poverty to improving health care requires reliable access to modern energy services (Pezzoli, 1997:34). This development is of particular significance to Africa, where about 550 million people (75% of the population in Sub-Saharan Africa) depend on traditional biomass (wood, charcoal, cow dung, etc.) and lack access to electricity or any kind of modern energy service (Phillips, 1987:39). In rural areas, energy, which is essential for development, is used to support a range of livelihoods demands. These can be broadly classified into energy services for households, community facilities and productive sector (Naidoo, 2008:88). In industrialized countries, firewood have been largely replaced by more efficient and convenient sources of energy such as gas and electricity, but in total, rural households are

the main users of firewood energy which is used for cooking, lighting, and space heating (Diamond, 2005:134).

This is however a different case in developing regions where people are not able to afford and access these fuels. Wood therefore remains a dominant form of energy. It is clear and evident that biomass fuels dominate household energy use in rural areas. This means that the rural poor have a high dependence on collected fuelwood from common pool resources. The loss of access to these resources due to privatization or state control can therefore pose a significant problem. This loss of access would then result in the poorest being adversely and negatively affected.

Loss of access may also result in situations where there are fuelwood shortages. With fuelwood shortages, the purchased supplies are likely to increase with some household spending more time on fuelwood collection. It is also during these shortages that the poor households would use dung and straw as sources of energy while the wealthier households will shift to alternative fuels like gas and paraffin. Hall (1992) supports this view by pointing out that when biomass is in short supply as a source of energy, this usually indicates other developmental and environmental problems. This shortage of biomass as a source of energy poses a big challenge. The challenge involves the integration of social priorities, environmental issues, financial constraints, gender differences and demographic characteristics. Once these issues are addressed and put in place, the allocation of resources will efficiently improve the quality of services delivered.

Hence, it is evident that fuelwood is the most commonly used energy source of the rural poor. Even after electrification many poor households in South Africa still use fuelwood for cooking because they cannot afford the appliances and the monthly electricity bills and the use of fuelwood for cooking is clearly correlated to poverty (Omer, 2008:21). The energy sector in South Africa has both first and third world elements (Nel, 2008a:2). South Africa produces and consumes over 60% of electricity on the African continent and is the twelfth highest carbon emitter in the world, and yet over 90% (Sachs,1999:356)

of South Africa's rural households use fuelwood for energy, as do numerous urban households.

2.5 Environmental impacts associated with firewood use

Biomass energy, have certain advantages when compared to conventional source f energy (fossil fuels) but at the same time it also has some disadvantages (Stern, 2006:56). One of the major advantage that biomass energy has when being used as energy source is that, it does release carbon dioxide just like fossil fuels, however when new trees are planted, as a replacement for those trees that were removed as firewood, the new trees will take more or less the same amount of carbon dioxide. This is due to the fact that the use of biomass for energy becomes carbon dioxide neutral as compared to fossil fuels. As a result, the initiative to replace the fossil fuel energy by biomass energy can help to reduce the amount of sulphur dioxide (SO₂) emissions which may cause acid rain as well as other environmentally harmful effects (Smit, 2007:10). On the other hand, if biomass is used in an unsustainable manner, it can result to uncontrollable rate of deforestation, which in turn could result in soil erosion, desertification, floods and other negative impacts associated to environmental degradation (Stone, 2008:46).

2.5.1 Loss of ecological resources

Using biomass for energy causes depletion of the forest resources which has a negative impact on its inhabitants through the extinction of natural species due to the change in climate (Clugston and Calder, 1999:30). Since forests are habitats for a large number of species, their degradation directly affects the loss of biodiversity. This in turn, affects the local community especially women who rely on resources from environment for their daily needs (OECD, 2002; Mahat, 2004). Women are generally more vulnerable to environmental hazards than men, due to closer exposure to risks (e.g. indoor air pollution, contaminated water, long distances to collect water and fuel) (Darby, 2000:78). In addition, use of biomass from farm to fire is not only a threat to environment but also reduces the farm productivity due to the degradation of soil quality (Clayton & Radcliff,

1996:12). The degradation of soil quality is one of the major causes of food insecurity (OECD, 2002). Rural populations in poor countries pay the highest price for environmental degradation, as their livelihoods depend on the goods and services from the ecosystems (e.g. generation of water, wood and non-wood forest products, fuel, cycling of nutrients, replenishment of soil fertility, prevention of erosion, breaking down of wastes and pollutants, carbon sequestration and storage, recreation, etc) (Chambers, 1992:67). Such deprivation restricts production opportunities of rural households add to human poverty especially of women's agency to achieve the well being of the people.

2.6 Sustainable Development agenda on household energy use

This section builds more explicitly on the relationships between the international agenda and national concerns in trying to address the fuel question in the context of creating sustainable household. The world leaders discussed energy at the 2002 World Summit on Sustainable Development (WSSD), which brought new and quite intense repeated references to household energy and sustainable development (Brown, 2001:34). The 2002 WSSD document on energy goes beyond Agenda 21 by focusing more on the social dimensions of household energy and sustainable development (DEAT, 2003). In essence Agenda 21 is the global action plan for sustainable development agreed on at the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 (Davidson and Mwakasonda, 2004).

It recognised that about two billion people world wide, particularly in developing countries lack access to affordable household energy. The 2002 WSSD concentrated on the role household energy plays as a prerequisite for basic human needs, including those defined in the UN's Millennium Development Goals (MDGs). These MDGs were developed to address the problems of poverty, hunger, diseases, illiteracy, environmental degradation and discrimination against women (WHO, 2004). The aim of the MDGs is to promote a comprehensive approach and to allow many problems to be tackled simultaneously across the wide range of spectrum concerning energy. Modern household energy services are inextricably linked to many of the MDG goals as a solution to these

problems. The most significant of the WSSD 2002 references is made in Article 8 of the Plan of Implementation, which falls within the section on poverty eradication (Najam, 2003). The WSSD 2002 covered new ground, which calls for “access to reliable and affordable household energy services for sustainable development sufficient to facilitate the achievement of the millennium development goals” (Najam, 2003, 3).

For the Southern African region to achieve the MGDs agreed to at the WSSD held in Johannesburg in 2002, there needs to be a substantial increase in modern household energy service provision, especially affordable, reliable and adequate electricity (Cambell, 2002:23). Modern household energy will help in improving the current high infant mortality, low life expectancy, and high illiteracy and fertility rates of the Southern African region (World Bank, 2003). The region will require substantial electricity provision, particularly for the poor who are deprived of these services (Blumstein & Kuhn, 2006:89).

At a national and local level, household emissions remain unacceptable in many poor urban areas and have an impact on health and on the environment. People in poor urban areas should be assisted in understanding the need for efficient utilisation of energy to achieve sustainable development principles (DIMSUD, 2002). These principles are sustainability, equity, efficiency, integration and good governance. In addition, the National Environmental Management Act (NEMA) of 1998 also provides a core strategy for improving the provision and the use of household energy to contribute to sustainable development (DEAT, 1998).

This Act aims at improving environmental management while facilitating sustainable development to ensure that significant impacts on the environment are avoided and mitigated (DEAT, 1998). The Act widens access to clean, reliable and affordable modern household energy supplies in order to reduce the negative health and environmental impacts related to household energy use (Catells, 1996:11). The 1998 White Paper on Local Government concerning household energy sees environmental sustainability as an integral component of integrated development planning (USLF, 2008a). In order to assess

- Income
- Infrastructure
- Fuel availability
- Fuel prices
- Distribution network proximity
- Cultural preferences
- Demographic distribution
- Physical environment (urban or rural) (Davis, 1998).

The energy ladder studies by Leach (1992) and Smith *et al.* (1994) were based on the factors that determine the choice of fuel used and both studies concluded that the choice of fuel is determined by a particular household's personal choices and income. These studies argue that fuel switching in developing countries has been that households gradually ascend an 'energy ladder'. There is a tendency for a linear progression from relatively inefficient fuel and energy end-use equipment to a more efficient fuel, electricity and equipment, with increasing income levels and urbanization (Farsi *et al.*, 2004).

However, research into the energy consumption of households in developing countries shows that the energy ladder theory is simplistic. The results show that there are many factors other than income that determine fuel choice e.g. culture, social desirability and security of supply (Davis, 1998 and Bennett, 2000). Leach (1987) asserts that there is an energy transition process whereby households climb the ladder of fuel preferences. Recent studies conducted in South Africa have shown that as a result of the mass electrification programme the pattern of energy use has changed (Davis, 1998). Most urban households tend to switch to more extensive electricity use after being connected to the electricity grid (Davis, 1998).

In a study in South Asia, Leach (1987) found that income, relative prices, the cost of appliances and the availability of modern fuels in urban areas were the most important variables affecting this transition process. In discussing the concept of an energy transition from low to high quality fuels, Soussan (1987) found that multiple fuel use and fuel switching were common in poor urban households and were the result of a specific budgeting strategy. The nature of fuel transition is also disturbed where households are faced with insecure energy supplies (Soussan *et al.*, 1990). Under these circumstances, fuel security is the way that household energy is managed, and may prevent permanent energy transition (O'Keefe and Munslow, 1989).

Again, the state of the energy report for Cape Town 2003 states that households in Cape Town consume about 15 percent of total energy and 38 percent of total electricity (CCT and SEA, 2003). The rapid electrification since 1994 has meant that only eight percent of dwellings are currently not electrified. These are informal dwellings and backyard shacks. CCT and SEA (2003) states that low income households, whether electrified or not, are very much dependent on paraffin to meet their energy needs. Other fuels, such as wood and dung are popular amongst all households for specific activities such as braaing and brewing beer. Coal is used very little because it is expensive due to transport cost associated with it.

LPG gas is very little used amongst poor households due to poor access and perceptions that it is unsafe. However, middle to high-income households use electricity almost exclusively (CCT and SEA, 2003). This is a clear indication that households only manage to climb the ladder of fuel preferences once they can afford modern fuels. It can be argued that low-income households depend on multiple fuel use as fuel switching is difficult to achieve. Again, the nature of transition in these households is not well understood.

A growing body of literature on household energy use reveals that the energy transition does not occur as a series of simple, discrete steps but multiple fuel use is more common (Masera *et al.*, 2000). In South Africa this transition has not been clearly defined, as

diversity of energies has not declined in poor urban households (Madubansi and Shackleton, 2005).

With increasing affluence, households adopt new technologies and fuels that serve as partial rather than perfect substitutes for more traditional fuels (Masera, *et al.*, 2000; Leiwen and O'Neill, 2003). In poor urban China, for example, biomass and electricity are the most common fuel types that are paired in households (Leiwen and O'Neill, 2003). In urban areas of Guatemala, the simultaneous use of firewood and LPG for cooking is quite common (ESMAP, 2003). The situation in Brazil is different in the sense that the firewood fraction of fuel budgets falls as income rises. Woodfuel use continues even at relatively high-income levels. Only at the highest income levels do fossil fuels and electricity usually account for nearly all energy use (de Almeida and de Oliveira, 1995).

Multiple fuel use has also been termed 'fuel stacking' (Masera *et al.*, 2000). Although poor households often use several fuels simultaneously, they generally shift towards the adoption of cleaner, more efficient energy sources as income rises. Multiple fuel use arises for several reasons. First, households often have significant capital invested in 'traditional' technologies (e.g., wood-burning stoves) and may not have the spare capital to purchase new energy-consuming appliances immediately upon gaining access to new energy sources (Saghir, 2004). Second, modern energy sources are usually expensive and thus are applied carefully for unique services such as radios and television for entertainment (Thom, 2000). Thus, when new fuels arrive, traditional fuels and technologies tend to exit more slowly. Thus, modern transistor radios exist alongside primitive cooking stoves. Finally, multiple fuels can provide a sense of energy security. Complete dependence on commercially traded fuels leaves households vulnerable to variable prices and often unreliable service. Households in Hyderabad, India, for example, experience an average of two or three power outages each day (ESMAP, 1999).

The energy ladder and multiple fuels metaphor differ in the conception of precisely how energy sources are adopted. Both recognise that hierarchies in household energy services are quite common. According to Victor (2002) cooking and heating are the first functions

fulfilled, followed by lighting and later entertainment. For the poorest people in developing countries, cooking (and space heating in particularly cold times) can account for upwards of 90 percent of the total volume of energy consumed. Lighting accounts for the majority of the remaining share (Howells *et al.*, 2003).

Appliances such as electric irons, refrigerators and water heaters arrive in household energy budgets only after core heating, cooking and lighting services are satisfied (Victor, 2002). Thus, the first kilowatts of electricity acquired by households are commonly used for lighting, entertainment and communication services, while many households continue to cook and heat the home with traditional fuels long after modern energy enters the household (EIA, 2002; WEC/FAO, 1999).

Taste preferences and familiarity of cooking with traditional fuels and technologies contribute to the tendency of cooking to be the last energy service supplied by modern fuels. In India, for example, many wealthy households retain a biomass fuel stove for baking traditional breads (Malhotra *et al.*, 2000). While in certain regions of Mexico even high-income households cook tortillas over an open wood fire rather than using an LPG stove because they prefer the taste and texture provided by wood cooking (Masera *et al.*, 2000; Saatkamp *et al.*, 2000).

Hosier and Dowd (1987) conducted a similar study in urban Zimbabwe using a multinomial logit model to test the energy ladder hypothesis for household fuel choice. The multinomial logit model refers to a model, which shows that although economic factors do affect fuel choices, a large number of other factors such as culture, social desirability and security of supply are also important in determining household fuel choice (Hosier and Dowd, 1987). Furthermore, fuel switching is often not complete and is a gradual process with many households often using multiple fuels.

There are a number of reasons for multiple fuel use and sometimes they are not dependent on economic factors alone. In some households, people choose to use more than one energy source because people want to increase the security of supply. In other

cases, the choice might be dependent on cultural, social or taste preferences (Hosier and Dowd, 1987). The community can also influence the fuel choice. Living amongst people using coal can prompt others to use it despite economic advantage (Hosier and Dowd, 1987). An investigation of household energy choices for a sample of households residing in the city of Bangalore uses a binomial logit model (Reddy, 1995). A binomial logit is defined as a model, which determines the choice between each pair of energy sources.

This model according to Reddy (1995) helps to explain the shift in the energy pattern of consumption of different fuels used for cooking and water heating. The findings confirm that urban households ascend an energy ladder and the choice is determined by income. However, other factors worth noting that play a significant role in fuel switching amongst households is family size and occupation of head of the household (Reddy, 1995). A similar study in India also employed a multinomial logit framework to represent household fuel choice (World Bank, 2003). However in the World Bank model a household's decisions concerning the choice of both cooking and lighting fuels are dealt with together. The World Bank took a closer look at a choice set that consists of all the key alternatives to different energy sources combinations used by a household. The objective of this model was to study the effectiveness of the existing price subsidies in facilitating a shift to cleaner and more efficient fuels like kerosene and LPG. The results showed that subsidies are unsustainable in meeting social policy objectives and disproportionately favours the rich (World Bank, 2003).

2.8 Gender and rural energy

Gender refers to the socially constructed roles of women and men rather than biologically determined variations (Clancy *et al.*, 2004). Issues that concern gender are not new to wood energy development. For many years they have played a crucial role in community forestry and household energy activities (FAO-RWEDP, 1995). It is however of no doubt that women are heavily involved in projects involving firewood collection. In most countries from around the globe, particularly in rural areas, it is primarily women who are

actively involved with the collection of firewood or crop residues for family fuel use, and automatically do the cooking in the household (Skutsch, 1995).

Populations living in colder climates tend to consume more energy than those in warmer climates. Because women are the ones who are actively involved in the fuelwood business, in most cases one often finds that the majority of firewood energy planners are men, but when problems that are related to firewood usage happen, the whole matter is thrown into the hand of women as if they are the ones responsible for everything related to firewood energy. It is therefore very important that issues of gender differences are taken into consideration during the implementation phase of firewood activities.

2.9.2 Resource endowment as a predictor of energy consumption

The women's engagement is not limited to the collection of firewood but also very important in the efficient utilization of such fuelwood (Oosterveen, 1995). Women are also deeply concerned about the growing and the management of multipurpose tree planting in order to meet the domestic requirement, while men are more involved in the decision making roles concerning the growing and management of those multipurpose trees. At certain times conflict of priorities arises between men and women that stem from the use of various forest goods. This existing difference between men and women justifies the need for specifically including women in social forestry activities, not only for reasons of equity, but also because of their collection, use and distribution of firewood, their role in the management of fuelwood resources and their income gathering activities (Borg, 1989).

2.9 Non-income variables affecting energy consumption

This is especially true at lower income levels, where energy is often used to supply heating services; only at high income levels do households purchase fans and air conditioners that fulfil the demand for cooling (ESMAP, 1999). Families living in close proximity to forests see a larger fraction of their energy mix comprised of woodfuel than do those located further from forested areas. A study conducted in urban India by Bowonder *et al.* (1985) found this pattern to hold true even for high-income households.

2.9.1 Climate variation and energy demand

Populations living in colder climates tend to consume more energy than those in warmer regions (Eberhard and Van Horen, 1995). This is especially true at lower income levels, where energy is often used to supply heating services; only at high income levels do households purchase fans and air conditioners that fulfil the demand for cooling (ESMAP, 1999). In rural China, for example, energy use is, on average, greater in the cooler regions of the north than in the warmer regions of the south (Leiwen and O'Neill, 2003).

2.9.2 Resource endowment as a predictor of energy consumption

The relative shares of different fuels in a country's overall energy mix are determined to a large part by the nation's endowment of natural resources and agricultural activity, especially at low income levels where non-active, imported fuels are beyond the economic reach of most (Dunkerley and Gottlieb, 1987; Kaul and Liu, 1992). Where forest is a sizeable section of a country's total land area, such as in Laos and Cambodia, fuel wood is likely to account for a large fraction of total energy supply (Victor and Victor, 2002). Families living in close proximity to forests see a larger fraction of their energy mix comprised of woodfuel than do those located further from forested areas. A study conducted in urban India by Bowonder *et al.* (1985) found this pattern to hold true even for high-income households. Other countries lack large fuelwood supplies but boast an abundance of other primary energy sources. In South Africa, coal dominates domestic energy supply in the coal-rich part of the nation (e.g. Johannesburg).

2.9.3 Distance to markets and energy use

Rural towns and villages are particularly prone to a lack of modern energy services because of the high cost of connecting to energy infrastructures (e.g., electricity grid) and service networks (e.g., kerosene and LPG supply chains). Even when remote regions are supplied with modern fuels, services to sustain energy infrastructure are often in short supply, making the availability of energy unreliable (ESMAP, 2002; Chaurey *et al.*,

2004). Even high-income households in remote areas are frequently forced to rely largely on biomass because the low density of demand for modern energy services makes the supply networks prohibitively costly (WEC/FAO, 1999).

The trend of continued reliance on biomass fuels can be seen in India, where the top expenditure decile in rural areas uses almost seven times as much of biomass energy as the top expenditure decile in urban areas (Pachuari, 2004). Though the energy ladder model has been used to understand the energy use dynamics of urban households in developing countries, the model provides a limited view of reality in actual households. It is specifically limited in its ability to estimate the actual quantities of different fuels consumed by households.

2.10 Fuel switching and the energy ladder

On a theoretical level, an exploration of complex and diverse understanding of the energy ladder, which is crafted by income and lifestyle, clearly affects the energy transition in the developing world. In order to assess these realities, the final part of this chapter uses a theoretical framework as an analytical tool to accommodate the diverse energy demand in urban household of developing countries. The concept of a fuel switch or an energy transition is central to any understanding of the peri-urban and urban sector.

As urbanization proceeds, there is a tendency for household energy use to increase, diversify and switch from wood and charcoal to modern fuels. The key issue in this sector is the relative price and availability of different fuels and technologies. Where sustainable fuelwood supplies can be provided, they should be encouraged. However, there is little confidence in the potential of wood and charcoal as major long-term fuels. Energy transitions are not unidirectional; fuel shortages can encourage hoarding (i.e., stocking) or switching “downwards”, from commercial fuel back to a tradition fuel (Chambwera, 2004).

Bensel and Remeda (1993) state that, generally speaking, the extents to which modern fuels have replaced woodfuels in a particular urban area have been determined by the size of the city and the level of economic development of the country involved. Household fuel switching may be a seasonal or short-term response to changes in supply, or a long-term measure. Bensel and Remeda (1993) also state that it is quite common for households with access to electricity to rely on coal or wood for cooking because of inadequate supplies, power cut or high electricity prices. The concept of an energy ladder, where people change to high-quality fuels and technologies based on growing income elasticity, is complicated in urban townships areas as energy-technology security is a key issue, not income elasticity to purchase commercial fuels (Chambwera, 2004).

In poor urban areas, wood are likely to be a market commodity and people are generally aware of the cost (in monetary terms) of their fuel (Chambwera, 2004). It is in such cases that fuel-efficient stoves are more likely to have an impact and fuel switching is likely to be higher priority, as well as more feasible. Keterere (1990) indicates that there are two essential criteria for fuel-switching to occur. Firstly, people must have sufficient income to be able to afford the asking price (both for the fuel and for the necessary equipment); secondly, the fuel supply must be maintained. Two issues are apparent, income and infrastructure. As individuals become wealthier, (assuming the infrastructure can maintain alternative fuel supply), fuel switching will occur.

There are a number of factors that work against a fuel switch. Paraffin is often seen as unsafe and a fire hazard; it is also seen as a “dirty” fuel which leaves prepared food with bad taste (Bensel and Remeda, 1993). If a household has had the experience of kerosene at an earlier stage, it can often prompt the same household to switch to another, higher on the energy ladder. However, the mitigating factor with kerosene is the ability to purchase it in small quantities, which is the major factor in explaining why people do use kerosene (Bensel and Remeda, 1993). Furthermore, it is suitable for two specific end-uses, namely lighting and boiling water for drinking.

In some parts of residential urban areas, the energy transition from wood to coal through kerosene, LPG and electricity has been seen in many different countries. This transition may be a slow or a rapid process. This transition will be patchy as different sectors of the residential urban zone use modern fuels, traditional fuels and a mix of fuels, depending on income and availability (Chambwera, 2004).

2.11 Multiple fuel use in urban areas

The gaps prevalent in the energy ladder hypothesis provide a basis for building on alternative models that describe household energy consumption. In this study, a conceptual framework is developed on which empirical household energy demand will be based. Such a framework should lend itself to understanding household energy consumption patterns. The literature confirms the fact that households use multiple fuels (Foster *et al.*, 2000; Masera *et al.*, 2000; Kebede *et al.*, 2002; Campbell *et al.*, 2003).

The estimation of the demand for one fuel (electricity in this case) should therefore be carried out within the context of other fuels consumed by households. The formulation of an analysis framework should capture this reality, and also capture the fact that the use of different fuels is associated with several indicators of socio-economic status such as income and household size. In the case of income, the wealthier the household, the more likely the household will use more of modern fuels than traditional fuels.

Masera *et al.* (2000) propose an alternative “multiple fuels or fuel mix” approach that takes into account economics of fuel and stove type and access conditions to fuels, technical characteristics of cooking practices, cultural preferences and health impacts. Using data from three Mexican states, they show that households do not switch fuels, but rather follow a general multiple fuel or fuel stacking strategy (Masera *et al.*, 2000). The specific combination and the relative consumption of each fuel are governed by the characteristics of fuels and end-use devices, fuel availability and local cultural and social contexts (Chambwera, 2004).

Since urban households purchase most of their energy, the consumption of different sources of energy within a household can be considered in terms of the financial allocations made for each fuel for its purchase (Chambwera, 2004). Economic theory postulates that consumers allocate their disposable income amongst different goods to maximize utility (Chambwera, 2004). In utility theory, the combination of goods with different prices enables the consumer to attain a specific level of satisfaction. The objective of the consumer is to attain the highest possible level of utility subject to constraints. The main constraint is that the total outlay to all commodities must not exceed the available income. Given the above realities of the consumption patterns by households using different sources of energy, economic theory can be employed to analyse the behaviour of the consumer i.e. how the consumer allocates expenditure to different sources of energy.

Using the empirical findings of earlier studies that indicate the use of multiple fuels by households, and economic theory concerning the allocation of income to several goods to maximize utility, a conceptual framework presents itself in terms of urban household energy consumption (Chambwera, 2004). To meet their energy requirements limited income households decide how much of their total income or expenditure to allocate to their energy. According to Kebede *et al.* (2004) in any particular period, households are assumed to choose a set of energy types that they use for household tasks to meet their total energy requirements. For example, a household chooses to use electricity for cooking special dishes.

Alternatively, electricity may be used for cooking evening meals while firewood is used for preparing day meals. A household may also decide to use different energy types on specified days of the week or month, for example firewood during the weekend. These decisions differ from one household to the other, and they are influenced by several factors that have to do with the socio-economic status and cultural background of households. The total cost of this set of energy for any particular period does not exceed total energy outlay. The ultimate decisions that all households make are on how much of its total energy expenditure to allocate to each fuel to achieve maximum satisfaction.

Households therefore work out their fuel mixes for specified periods based on these and other factors. This approach is used for example for studying the demand for commodities like food types (Chambwera, 2004; Forster, *et al.*, 2000; Masera *et al.*, 2000).

When the circumstances concerning a particular fuel change, the household is expected to change its fuel mix. For example, when a household moves to a house without electricity, it changes its fuel mix; when kerosene becomes unavailable, it changes to another combination (Chambwera, 2004). When the price or cost of using any one of the fuels used by a household change, the combination is also changed to accommodate the price change while maintaining the same level of utility. Different sources of energy are adopted or dropped, increased or reduced in any period when factors pertaining to the household or the fuels themselves change (Chambwera, 2004).

The key features are the types of energy and their levels of consumption in any fuel mix. For any household with defined characteristics such as income and household size, it is possible to analyse its mix of energy sources and determine how much of each fuel it consumes based on its expenditure on it. The formulation provides a way to determine the quantity of fuelwood that a particular household consumes.

2.12 Conclusion

The literature review section shows different types of energy used in most developing countries. Many countries in the developing world are characterised by a variety of traditional and modern energy sources. In the urban areas of South Africa, with a particular reference to townships, the household energy sector is subdivided into electricity, hydrocarbon fuels and biomass fuels. The household emissions from these fuels, particularly hydrocarbon and biomass fuels, remain unacceptable in many urban areas.

The recent literature shows that most household energy debates draw from the concept of an energy ladder, where solid fuels occupy the lowest rung and modern fuels like electricity, LPG sits on the higher rungs. The energy ladder is based on the premise that the choice of fuels is determined by a particular household based on income and choices people make. Some researchers criticise the energy ladder hypothesis, saying that multiple fuel use is most common in poor urban households. Both multiple fuel use and the energy ladder model recognise that hierarchies in household energy services are quite common. In some urban areas, households might not climb the energy ladder even if supplies of clean energy fuels are lacking.

It is important to note that household energy use in the urban areas of developing countries is poorly understood because of the complexity of the fuel switching process. This section has presented a critical discussion of the energy ladder model and has concluded that the energy ladder has been rendered insufficient to represent actual energy consumption dynamics in many poor urban areas. The last section provides conceptual frameworks on two aspects: the energy ladder and multiple fuel use.

information for this study.

Research methodologies refer to the rationale and the philosophical assumptions that underlie a particular study (Leedy, 2004). This is, therefore, influenced by both quantitative and qualitative approaches. Philosophically, its arguments are underpinned by inequalities of electricity supply.

According to Leedy (2004), quantitative approach is based on positivism, in which scientific explanation is adopted. Quantitative data collection methods are based on measurements using verification instruments in order to objectively phenomena under study. Measuring instruments involves the assignment of numbers, in terms of fixed rules, to reflect differences between them in some of their characteristics.

Quantitative research focuses on measuring objective facts and variables and uses statistical analysis to express numbers (Neuman, 2006). Because of the power the

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The aim of this chapter is to illustrate an overall methodology together with the methods used to achieve the objectives of this research as stated in chapter one. It also describes the overall methodology adopted, population identification, sampling procedures and unit of analysis, the means to study site methods for data collection and analysis

3.2 Research Methodology

The collection of primary data for this study involved field surveys which comprised of semi-structured interviews through the use of a questionnaire. The use of survey design is the main element for data collection procedure in scientific research (Bless & Higson-Smith, 2000). In conducting the survey, participatory approaches were used to collect information for this study.

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statistical evidence providers to research methods; it was used in this study to statistically support how the community thinks about the energy they used.

Leedy (2001) further defines qualitative study as an inquiry process of understanding a social or human problem based on building a complex, holistic picture formed with word, reporting detailed view of informants and conducted in a natural setting. From the participant's point of view, constructivist or post positivist approach. In this study qualitative research is also suitable since it provides the researcher with the understanding of experiences and problems faced by the communities that receive inadequate water. Quantitative research was used to obtain data about the domestic energy and electricity supply system in the study area.

3.3 Methods of Data Collection

3.3 Population of the study

Both primary and secondary data was used for this study. Secondary data was obtained Donald and Pamela (2003:78), defined population as the group upon which the researcher is interested in making inferences. Population is defined as a set of entities in which all the measurements of interests to the practitioner or researcher are presented. (Powers, Meenaghan and Toomey 1985:235)The target group will be selected in order to represent the entire population of Thulamela municipality. The population was comprised of municipality officials (Community Services Section), households, stakeholders and Eskom Officials. The population was comprised of one racial group, two nationalities with mixed gender and different age groups.

3.4 Sampling technique

Tshikunda village in the Thulamela municipality area was purposely selected for this study. Tshikunda was selected because it has been subjected to a variety of domestic energy shortage impacts in the past few years. In the study area there are about 150 households in total, a sample size of 30 households were randomly selected for the purpose of the study. A simple random sampling technique was chosen for this study because it does not consume lot of time and is less demanding in terms of manpower.

During the operation of the study the researcher sampled about 30 participants which constitute 30% of the households in the area. This technique was chosen because each member of the population was given an equal opportunity to participate in the study.

The researcher together with his assistants has conducted a door to door initiative to distribute a set of stickers' containing a unique number ranging from (1-150), in order for the researcher to randomly select 30 households who participated in the study. The researcher prepared a set of numbers which correspond with the number given to a specific household in the village and then apply the lottery method when choosing 45 households which formed part of the respondents.

3.5 Methods of Data Collection

Both primary and secondary data was used for this study. Secondary data was obtained from government publications, research publications and reports. Secondary data was collected through literature reviews aimed at identifying attributes and adequate energy supply, energy used and energy demand by households. Primary data was obtained through field observation of infrastructure and household questionnaires.

3.5.1 Questionnaire Survey

A list of structured questionnaires was administered to 30 households that were randomly selected, the researcher embarked on a door to door activity whereby only 30 households that were selected were given questionnaires to answer on their own. In cases where the respondent could not read and write the researcher assisted the respondent by reading out and then explaining to them in the language that they understand. The first set of questionnaires was asking questions related to the social demography of the target population. This information helped the researcher to know the social response of people in the household and energy demand.

The questionnaire was specifically developed for collecting data from the people who are actively involved in energy use and cooking though other members of the household contributed in answering the questionnaire. Apart from energy use in the rural areas and cooking habits, questionnaires also include characteristics such as attitude and perceptions of local people in the village on community woodlots, afforestation, type energy demand. The approach also helped in overcoming misunderstanding or misinterpretation of words and questions. In this case the researcher ensured that the respondent understands the question correctly (Babbie, 2004). This approach also ensured that all items in the questionnaire were considered and no question was omitted. The respondents were asked for explanation and clarity on certain unclear answers.

3.5.2 Field survey

An observation was also undertaken to assess the infrastructure used for supplying energy and whether or not members of the community protect and take good care of the supplying system around the community and in their houses. An observation on whether the community can afford energy was also done. Several site visits were undertaken to observe and collect relevant data. During the visit data related to scarcity of energy, deforestation and many other environmental problems such as soil erosion and soil trampling were also observed. Images that were taken also include an overview of the natural environment in its current state, and they include photographs of the most harvested tree species which are used for firewood purpose

3.6 Data processing and analysis

Questionnaires were distributed randomly to selected households in the village. The data was collected and then captured into Microsoft Excel after which it was analyzed statistically using statistica 7.1 and it was presented in the form of graphs and tables in a percentage format. During data analysis quantitative approach was used to get logic of the primary data. The questionnaires were coded and analyzed according to the procedures as described by Robson (2002) and De Vaus (2002). The questionnaires were

processed and analyzed in order to obtain the findings for the research objectives and research questions research of the study. All questionnaires were then analyzed using Microsoft Excel spread sheet where graphs, charts and tables were then used to present data in a graphical format, graphs charts and tables were used to compare variations in response from different respondents.

3.7 The means of access to study

This research study was conducted in the Tshivhase tribal authority, Headmen and Thulamela municipality. A letter from the Headman facilitated gaining entry to administer a household questionnaire survey. Permission was also asked on individuals that were interviewed. For clear representatives of the energy supply systems and quality, pictures were deemed necessary, so permission for shooting the pictures was asked from the households and members who are harvesting and participating in energy and management issues. In promoting anonymity the pictures were taken in wide-shot and questionnaires didn't request for names.

3.8 Ethical Issues and Consideration

For Neuman (2006:131) "ethical research requires balancing the value of advancing knowledge against the value of non-interference in the lives of others". Lives will always be interrupted when people are included in research, even if it is stopping a person on the street to ask a few questions. Huysamen (1998:178) identified three stages in a research project where ethical consideration comes into play. Firstly when participants are recruited at the outset of the investigation, their written permission must be obtained. Secondly the measurement procedures should not be harmful in anyway, i.e. physically or mentally, and thirdly when the results are released, the researcher must be sensitive not to released results that might link any individual to the research.

The researcher remains accountable for the quality of the research and should take care when conducting the research in all three stages (Henning, 2004:73-74). Ethical considerations commenced long before the participants were recruited. Firstly the researcher has to first obtain permission from the relevant institution to conduct the research. Rubin and Rubin (2005:104) explain how institutions, such as universities, are required to have a review board that evaluates the research proposals of students and staff members. This is done ensure that the research is ethically sound before the researchers are permitted to commence research. After permission is obtained a researcher starts recruiting participants.

Permission was obtained from the headman to work in his village. Thereafter, participants who agreed to be included in the research signed a letter of informed consent, which was drawn up on the basis of the guidelines provided by authors such as Huysamen (1998:179), Henning (2004:73) and Rubin and Rubin (2005:104). The informed consent letter explained the nature of the study and the rights of the participants, such as opportunity to think about the research before agreeing to participate and the freedom to ask questions about the investigation. Potential participants were also assured that they were under no obligation to participate in the study and issues of confidentiality, privacy and freedom from harm for the participants were explained. It was made clear that the participants could withdraw from the study whenever they wished to. Finally, participants were informed about how the research results would used.

The informed consent letter as well as the satisfaction survey and the activity of the focus groups were translated into Tshivenda (the local language in the study area) to enable people to read the letter and the questionnaires in their home language. During interview, the letter was read out a load to all participants and they were given an opportunity to confirm whether they understood the contents by singing or drawing a cross at the end of the letter.

3.9 Conclusion

This chapter has covered all issues concerning overall research methodology adopted, population identification, sampling procedures and units of analysis, the means of access to study sites and methods for data collection and analysis. The issue of how data were collected and analysed were dealt with in this chapter. The Tshikunda village is actively involved in the consumption and poor management of natural resources. Most of the respondents are women in both study areas which proves that women are always at the front position when it comes to energy matters. Irrespective of whether the village is a deep rural or semi-rural, fuelwood remain the source of energy. The next chapter deals with the interpretation and analysis of the collected data.

community.

4.2 Biographical characteristics

Table 4.1: Indicate the gender distribution

Gender	N=30	
	Count	Percentage
Male	10	33.33%
Female	20	66.67%

The average number of respondents was seven with a minimum of three households that were interviewed. The data were analysed using SPSS software. The sampled households were

CHAPTER 4: DATA PRESENTATION, INTERPRETATION AND ANALYSIS

	Frequency	percentage
15-25	10	33
26-35	8	27
26-45	6	20
46-55	4	13
Total	30	100

4.1 Introduction

This chapter presents the findings of the study including information the use of energy by the rural community. The amount of time spent and distance traveled and its impacts on rural livelihoods associated with the scarcity of firewood. Another aspect is the society's perception on who should manage the wood lands as a common property resource in their community.

Table 4.3 Level of education

	Frequency	Percentage
None	6	20

Table 4.1: Indicate households response from a social demographic profile

Gender	Married		Single		Divorced		Widowed	
	N=30	%	N=30	%	N=30	%	N=30	%
Male	07	23.3	0	0	0	0	0	0
Female	16	53.3	4	13.3	2	6.6	1	3.3

The average number of people per household who were interviewed in the village was seven with a minimum of two and a maximum of twelve individuals. From 30 households that were randomly selected 77% of the respondents were females of which 6.6% were divorced only 3.3% are widowed (Table 4.1). The male respondents from the 53.3% were married and only 13.3% of those women were single mothers, and about sampled households account for only 23% of the respondents in the village.

Table 4.2 Frequency distribution of subjects by age groups

	Frequency	percentage
15-25	12	40
26-35	8	27
26-45	6	20
46 and above	4	13
Total	30	100

Most educators in the study sample fell within 15-25 years age range. They make 40% of the sample. Only 27 percent of the sample was between 26-35 years of age. Respondents of various age were well distributed in the final study sample.

Table 4.3 Level of education

	Frequency	Percentage
None	6	20
Primary	12	40
Secondary	8	27
Tertiary	4	13
Total	30	100

Table 4.3 shows that the education level of the respondents is very low; more than 60% of the participants did not go beyond matric level (grade 12). Only 13 percent have Diplomas and Degrees. Finally 60% of the interviewed population has primary level of education and 27% received secondary education.

Table 4.4: Respondents income generation

	frequency	Percentage distribution (%)
R100-R1000	15	50
R1000-R2000	10	33
R2000-R5000	2	7
R5000-R10 000	2	7
R10 000 Plus	1	3
Total	30	100

Table 4.4 shows that the participant's income varies with income source. A significant part of participants with the lowest income (50%) depend on social grants whilst 7% of this income category depends on remittances and 33% depends on piece jobs. Most of the high income participants depend on monthly salaries (Educators). Their studies found out that the majority of participants have an income in the range of R100-R2000 (Table 4.4). This shows a high degree of income inequity where very few people have high incomes while many are poor. Of those who are formally employed, the highest incomes are for those who work in the public sectors representing only 17% of the total population.

Table 4.5: Language used by the respondents

	Frequency	Percentage
English	0	0
Tshivenda	30	100
Tsonga	0	0
Total	30	100%

The 100% of the respondents spoke Tshivenda as their mother tongue and used the same language as medium of communication in meetings, and 2% of the respondents did not indicate their home language (See table 4.5).

4.3 Energy used and challenges in Tshikunda Village

Table 4.6: People use paraffin for cooking.

	Frequency	Percentage
Strongly Agree	20	66
Agree	2	7
Unsure	0	0
Disagree	5	17
Strongly disagree	3	10
Total	30	100

Table 4.6 show that 66% use paraffin for cooking, while 17 % of the participants disagree with the idea .10% strongly disagree while 7 % of the respondents agree with the statement, and this indicates that the majority of the respondents have problem of electricity.

Table 4.7: People use firewood for cooking.

	Frequency	Percentage
Strongly Agree	19	63
Agree	2	7
Unsure	2	7
Disagree	4	13
Strongly disagree	3	10
Total	30	100

Table 4.7 reveals that 63% of the respondents strongly agree that people use firewood for cooking while 13 %disagree whereas 10%strongly disagree. 7% of the respondents are unsure meanwhile 7% of people agree that they use firewood. The 10%of the respondents who strongly disagree could be those who have electricity.

Table 4.8: Electricity supply is a problem in the village.

	Frequency	Percentage
Strongly Agree	21	70
Agree	2	7
Unsure	1	3
Disagree	1	3
Strongly disagree	5	17
Total	30	100

According to table 4.8 the majority of the respondents strongly agree that electricity supply is a problem in the village and this suggests that the majority of the respondents do not have electricity. 17% of the respondents strongly disagree that there is a problem of the electricity supply in the village and this could be the fact that they have electricity at home so there is no problem with the supply of electricity to their homes. 7% of the respondents agree that there is indeed a problem in the electricity supply while 3% of the respondents disagree and moreover 3% are unsure and this could be the problem of lack of information around those respondents.

Table 4.9: Firewood is another source of energy.

	Frequency	Percentage
Strongly Agree	22	73
Agree	2	7
Unsure	3	10
Disagree	1	3
Strongly disagree	2	7
Total	30	100

Table 4.9 indicates that 73% of the respondents strongly agree that firewood is another source of energy. The fact that 7% of the respondents strongly disagree could be an indication those respondents have electricity and have nothing to do with firewood, The table further illustrate that 7% of the respondents agree that fire wood is another source of energy while 3% disagree .The fact that 10% of the respondents are unsure could be a clear indication that some people are ignorant of what is taking place in the area

Table 4.10: Deforestation is another problem.

	Frequency	Percentage
Strongly Agree	20	66
Agree	2	7
Unsure	2	7
Disagree	3	10
Strongly disagree	3	10
Total	30	100

Table 4.10 shows that 66% of the respondents strongly agree that deforestation is another problem against 10% of the respondents who disagree and strongly disagree, This could be the fact that 10% of the respondents have electricity are against the 66% of the respondents who experience problems of getting firewood on a daily basis. The 2 % of the respondents who are unsure could be having a problem of lack of information.

Table 4.11: Other people do have electricity while others don't.

	Frequency	Percentage
Strongly Agree	21	70
Agree	4	13
Unsure	3	10
Disagree	2	7
Strongly disagree	0	0
Total	30	100

Table 4.11 reveals that 70 % of the respondents other people do have electricity while others don't have while 7% of the respondents disagree this is a clear indication the majority of the people do not have electricity the 10 percent of the respondents are unsure could be based on ignorance 7% of the respondents disagree while 13 % agree and in view of this percentage one could conclude that the majority of the respondents do not have electricity

Table 4 .12.Electricity is an issue in this village.

	Frequency	Percentage
Strongly Agree	22	73
Agree	2	7
Unsure	1	3
Disagree	3	10
Strongly disagree	2	7
Total		

Table 4.12 indicates that electricity is an issue in this village as revealed by 73% of the respondents' who strongly agree that electricity is a very serious issue here. In view of the opinion of the respondents it is clear that electricity could be the real issue. The fact that 10% disagree and 7% strongly disagree could be the fact that very few people have

electricity in this village. The 3% of the respondents who are unsure reveals the ignorance of the people in the community.

Table 4.13: Solar energy is another source of energy.

	Frequency	Percentage
Strongly Agree	21	70
Agree	4	13
Unsure	1	3
Disagree	2	7
Strongly disagree	2	7
Total	30	100

Table 4.13 shows that 70% of the respondents use solar as a source of energy. The fact that 7% disagree and strongly disagree could be the fact that certain people are indeed ignorant in the community. The agreement by 13% of respondents corroborates with the idea that indeed solar is source energy.

Table 4.14: Financial constrain is another serious problem to those who have electricity.

	Frequency	Percentage
Strongly Agree	20	66
Agree	3	10
Unsure	3	10
Disagree	2	7
Strongly disagree	2	7
Total	30	100

Table 4.14 reveals that 66% of the respondents agree that financial constrain is a serious problem to those who have electricity. This could be possible due to poverty which

affects the majority of the people in the area. The fact that 7% of the respondents disagree and strongly disagree reveals that the minority of the people have electricity. The agreement by 10% reveals that indeed financial constrain is a serious issue and it corroborates well in this passage while 10 % os the respondents who are unsure confirms the ignorant of another section of the people in the community.

Table 4.15: Poor maintenance of electricity supply system causes shortage of electricity.

	Frequency	Percentage
Strongly Agree	19	63
Agree	2	7
Unsure	2	7
Disagree	4	13
Strongly disagree	3	10
Total	30	100

Table.4.15 shows that 63% of the respondents strongly agree that poor maintenance of electricity supply system causes shortage of electricity. Although 7% of the respondents are unsure of the prevailing developments in the area, the issue of poor maintenance is also corroborated by 7% of the respondents who agree that indeed poor maintenance of electricity supply system causes shortage of electricity. 13% Of the respondents who strongly disagree and 10% who disagree could be the fact that those respondents do not have any problem of electricity at all.

Table 4.16: Wood collection is another form of saving electricity.

	Frequency	Percentage
Strongly Agree	19	63
Agree	3	10
Unsure	2	7
Disagree	3	10
Strongly disagree	3	10
Total	30	100

Table 4.16 reveals that 63% of the respondents strongly agree that wood collection is another form of saving electricity and this is also corroborated by 10% of the respondents who also agree that indeed wood collection is an alternative of saving electricity. The 10% of the respondents who strongly disagree and at the very same time disagree shows that a certain section of the community has access to electricity and they have no problem whatsoever to pay electricity bills.

Table 4.17: Women and children are responsible for fire wood collection.

	Frequency	Percentage
Strongly Agree	23	76
Agree	2	7
Unsure	2	7
Disagree	1	3
Strongly disagree	2	7
Total		

Table 4.17 shows that 76% of the respondents strongly agree that women and children are responsible for fire wood collection, while 7 of the respondents strongly disagree. The difference in one way or another shows that women and children carry the responsibility of collecting firewood, the process which is mostly applicable where a society is

characterized by male dominance. The fact that 7% of the respondents are unsure reveals the ignorance surrounding certain section of the community.

Table 4.18: Sustainability of trees for wood is mostly affected by deforestation.

	Frequency	Percentage
Strongly Agree	20	67
Agree	1	3
Unsure	4	13
Disagree	2	7
Strongly disagree	3	10
Total	30	100

Table 4.18 shows 67% of the respondents strongly agree that sustainability of environment is affected by deforestation and could be the lack of knowledge and poverty affecting those people. The fact that 10% of the respondents strongly disagree and 7% disagree confirms lack of knowledge of the respondents who can afford to pay electricity.

Table 4.19: Poverty causes people not to buy electricity.

	Frequency	Percentage
Strongly Agree	18	60
Agree	4	13
Unsure	3	10
Disagree	3	10
Strongly disagree	2	7
Total	30	100

Table 4.19 reveals that 60% of the respondents strongly agree that poverty causes people not to buy electricity and that is the reason why in other tables people preferred firewood as a source of energy. The fact that 7% of the respondents strongly disagree and 10%

disagree could be the fact that those who can afford knew very little about the plight of poverty affecting people.

Table 4.20: A high cost of electricity units prevents people to buy electricity.

	Frequency	Percentage
Strongly Agree	22	73
Agree	3	10
Unsure	1	3
Disagree	2	7
Strongly disagree	2	7
Total	30	100

Table 4.20 indicates that 73% of the respondents strongly agree and 10% agree that a high cost of electricity units prevents people to buy electricity. This could be the poverty affecting people in this study area. The 7 % of the respondents who strongly disagree and disagree clearly demonstrates the fact that those who afford know little about the poor and the 3% of the respondents who are unsure reveals the acute ignorance affecting certain people in the study area.

Table 4.21: Lack of energy impacts on the socio-economic development of the people.

	Frequency	Percentage
Strongly Agree	21	70
Agree	4	13
Unsure	2	7
Disagree	2	7
Strongly disagree	1	3
Total	30	100

Table 4, 21 shows that 70% of the respondents strongly agree and 13% agree that lack of energy impacts negatively on the socio- economic development of the people in this

study area. The fact that 3% strongly disagree and 7% disagree could be the manifestation of the lack of compassion on the side of those who can afford to buy electricity on a day to day basis.

Table 4.22: Illegal connection of electricity causes shortage of electricity.

	Frequency	Percentage
Strongly Agree	19	73
Agree	3	10
Unsure	3	5
Disagree	2	7
Strongly disagree	3	5
Total	30	100

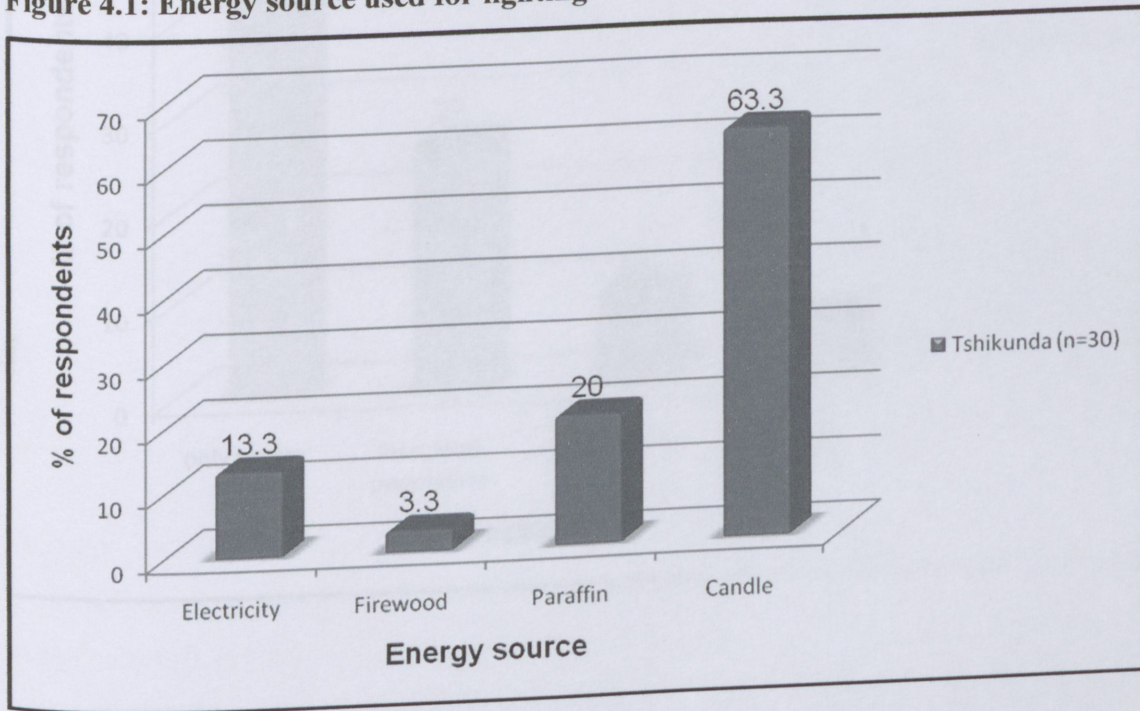
Table 4.22 shows that 73% of the respondents strongly agree and 10% agree that illegal connection of electricity causes shortage of electricity. This could be the fact that people in this study area are poor and they can hardly afford to buy electricity very often. The 5% of the respondents who strongly disagree and 7% of the respondents who disagree demonstrates the ignorance of those in die poverty of those who can afford to buy electricity. In this study area 5% of the respondents are neutral which clearly demonstrates ignorance of certain people in this study area.

4.4 Type of energy used for lighting

The majority of the respondents indicated that they either make use firewood as the primary energy sources in association with the secondary energy sources. About 63.3% of the respondents showed that they use Candles as their first choice, secondary energy source for lighting (in association with for example; firewood and paraffin respectively). Up to 20% of the respondents showed that they use paraffin for lighting as an alternative energy source, only 3.3 % of the respondents indicate that they use firewood for lighting (Figure 4.2 below). From the results it is clearly indicated that to transform this

community as candles are the most dominant energy source used for lighting, and these candles in themselves have some negative impacts to human lives. The increasing cost of Paraffin has a massive contribution in the manner in which the society chooses their energy source since they cannot afford to buy in on a daily basis.

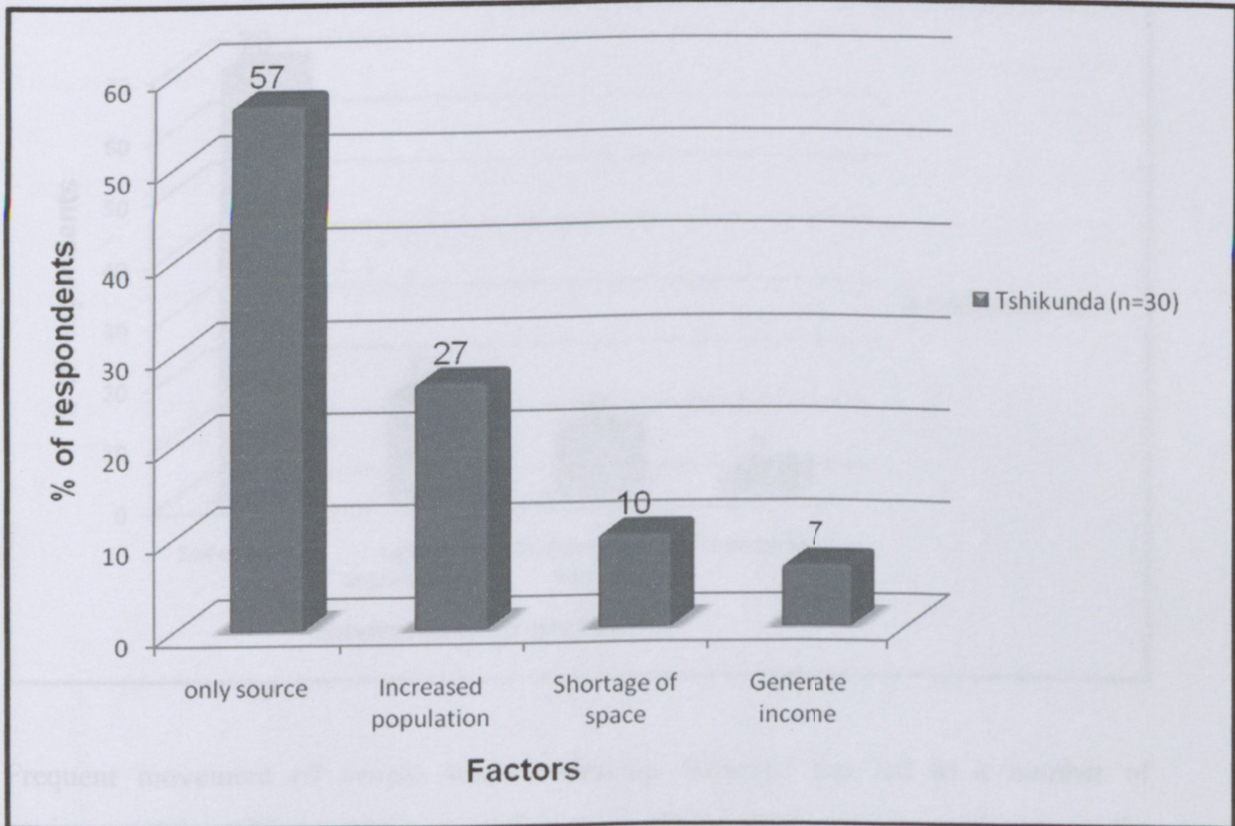
Figure 4.1: Energy source used for lighting



4.5 Factors affecting the scarcity of firewood

Firewood as the main primary energy source at Tshikunda village has become a scarce resource and the rural livelihood of the people have been negatively impacted. From the study it was indicated that firewood was used as the only energy source as freely available to people in the village and it account for 57% of the respondents. The rapid population growth only account for almost 27% on scarcity of firewood (Figure 4.10). On the other hand shortage of agricultural and residential space has contributed by about 10% on the scarcity of firewood in the village and only 7% of the respondents indicate that the use of firewood as a means to generate income is also contributing towards the scarcity of firewood.

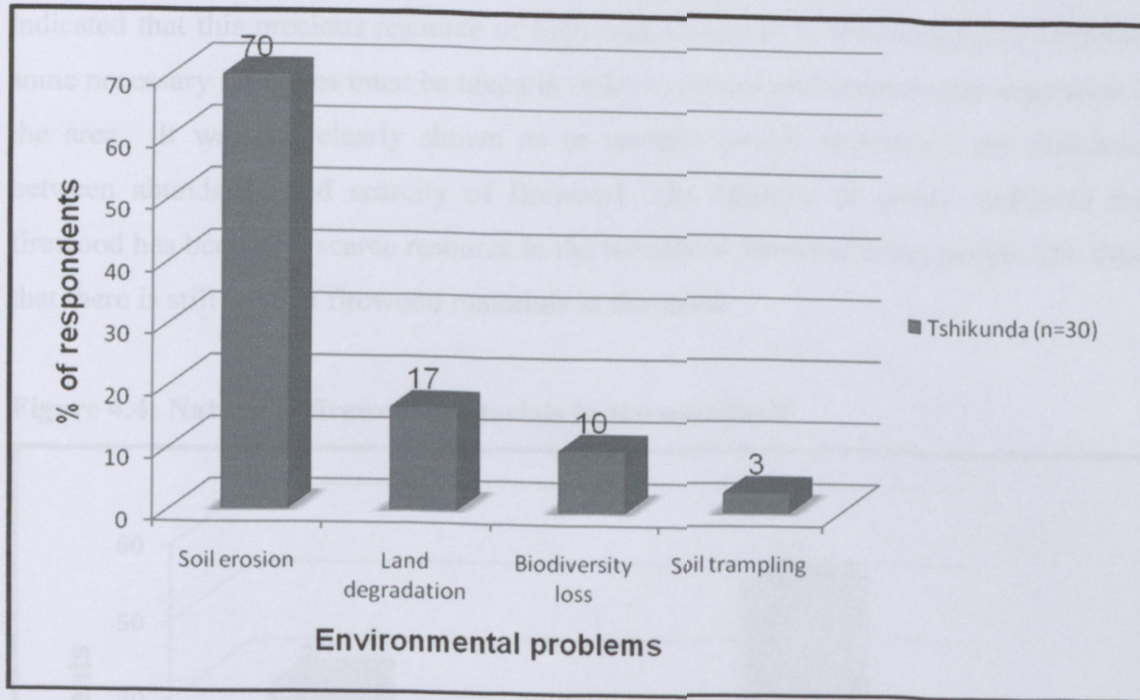
Figure 4.2: Driving factors affecting the scarcity of firewood



4.6 Common environmental problems occurring in the area

The problem of soil erosion was recorded as the most common environmental challenge experienced in the area and account for 70% of the respondents and then followed by land degradation which only account for about 17% of the households respondents in the village. Small percentage of the households' respondents was recorded on loss of biodiversity and account for only 10% of the respondents in the village (Figure 4.12). The respondents showed a limited awareness of soil trampling as one of the environmental problems happening in the area and account for only 3% of the overall respondents.

Figure 4.3: The nature of land degradation happening in the area



Frequent movement of people when collecting firewood has led to a number of environmental problems which include among others sheet erosion as shown on the image above. It is evident that as people move up and down as they collect firewood they take less precautionary measures of the environmental impacts that may arise in the process. If no action is taken to mitigate the impacts caused as a result of firewood gathering, and if they continue harvesting firewood in the manner in which they do very little of the vegetation cover would be left living the soil expose to different forms of erosion. The findings also showed that very little is known about soil trampling as one of the environmental problems which lead to soil erosion.

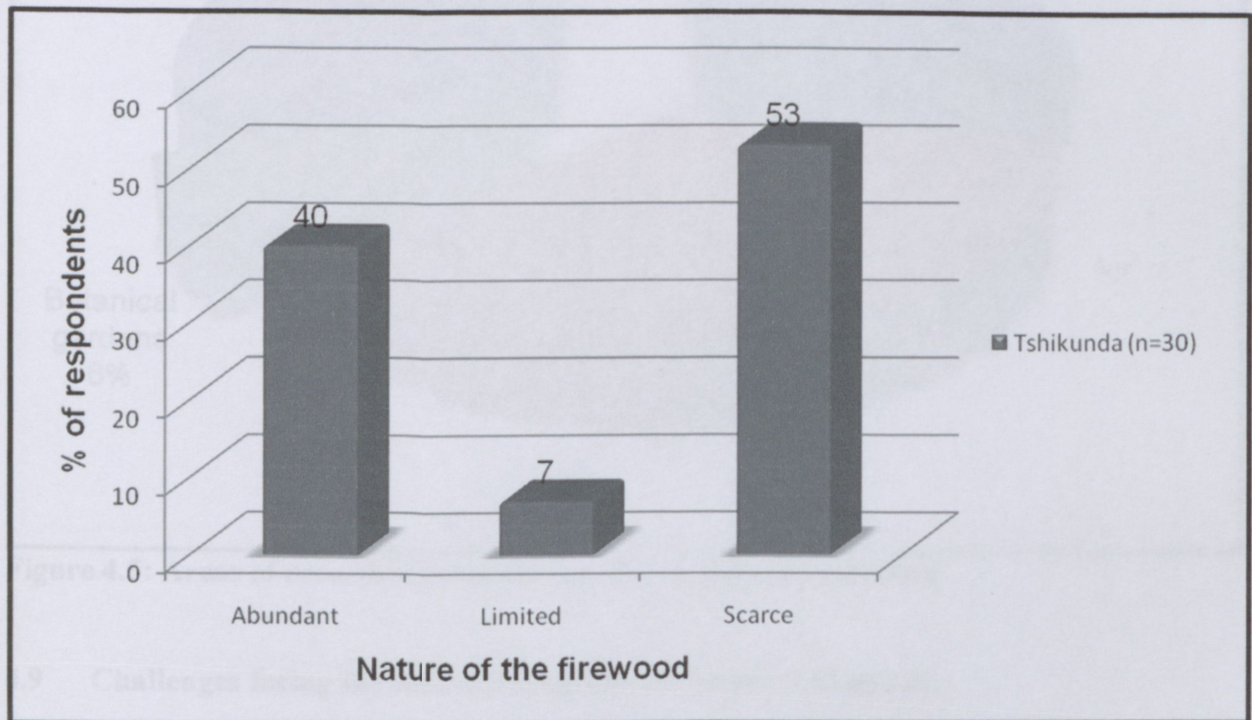
4.8 Using the woodlands for wood products

4.7 Nature of the firewood in the forest

The society has just expressed their views on the status or nature of the environment in the village with 53% of the respondents arguing that firewood has become scarce due to increasing demand and consumption of firewood in the village. This was due to over extraction of the woodland resource. On the other hand 40% of the respondents were of the view that there is still enough firewood materials in the forest and that there will

never come a point where they will be in short supply. Only 7% of the respondents indicated that this precious resource of high significance is in limited supply. Therefore some necessary measures must be taken in order to restore and maintain the vegetation in the area. It was not clearly shown as to whether people understand the difference between abundance and scarcity of firewood. The majority of people indicated that firewood has become a scarce resource in the woodland, however many people also think that there is still enough firewood materials in the forest.

Figure 4.4: Nature of firewood materials in the woodland



4.8 Using the woodlands for economic benefits

On the use of woodland for economic benefits the results show that 37% of the respondents want the area to be converted into a community park. The study also revealed that about 30% of the respondents would prefer to utilize the remaining parts of the woodland for subsistence agricultural activities. Apart from using the firewood for firewood collection the majority of people want the woodland to be used for more

economic related activities including tourism which account for 27% of the respondents only 6% of the respondents indicate that they want this woodland to be used as a botanical garden from which some medicinal plants would be kept and protected against human harm.

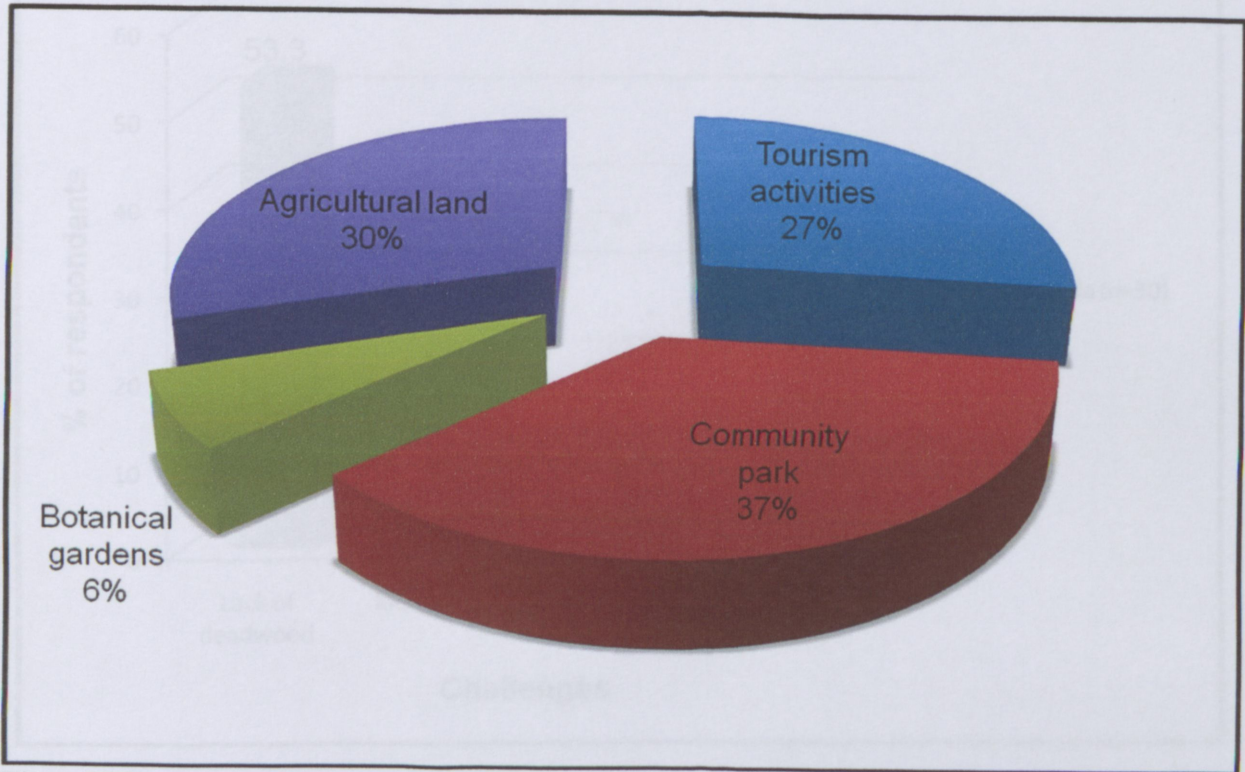


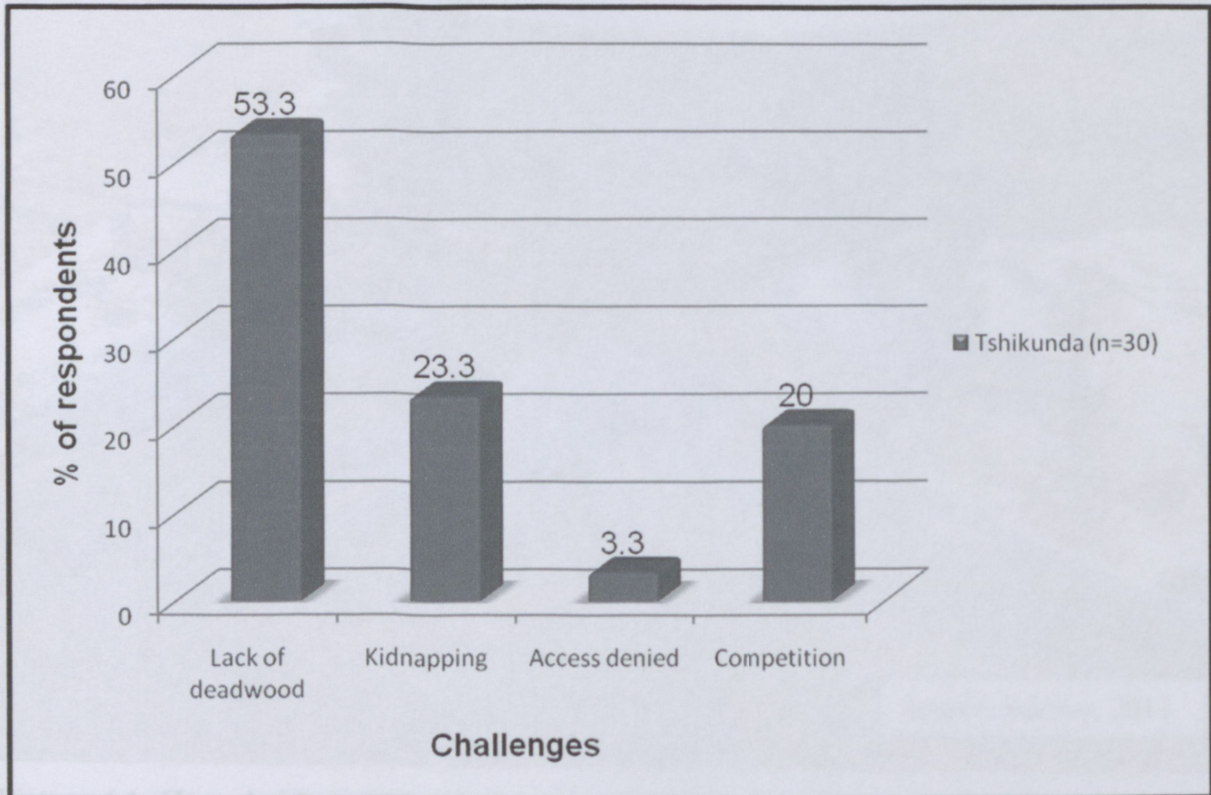
Figure 4.5: Areas of economic potential that the woodlands can bring

4.9 Challenges facing the society during the collection of firewood

The study shows that a significant number of respondents encounter problem of lack of deadwood in the area and they account for 53.3% of the respondents. Apart from the lack of firewood in the forest, people also experience problem of being kidnapped particularly women and young girls, and this account for 23.3% of the respondents (Figure 4.17). Some of the people feel that competition of firewood is caused as a result of the rapid population growth and lack of electricity and other forms of secondary energy sources. Competition for firewood resources only account for 20% of the challenges that the

society is faced with. For privately owned patches of woodlands only 3.3% of the respondents showed that they are denied access into the land to gather firewood.

Figure 4.6: Challenges facing the society when gathering firewood



4.10 Energy sources used for cooking in Tshikunda village

Based on the utilization of firewood and its demand, the study showed that the majority of the households at Tshikunda village depend heavily on firewood, as their primary source of energy that is used for cooking (See Picture 4.1).



Source: Survey, 2011

Picture 4.1: Households used fire for cooking in Tshikunda Village

About 20% of the respondents stated that they use fire as the main source of energy for cooking. The respondents also stated that they use gas energy for cooking. Only 11% of the respondents stated that they use Paraffin as additional source of energy used for cooking. The majority of the respondents stated that they use other means of energy sources for cooking.



Source: Survey, 2011

Picture 4.2: Household used electric stove for cooking in Tshikunda village

Women and children play an important role in energy decision-making. About 20% of the respondents showed that they use electricity as one of their secondary type of energy used for cooking (See Picture 4.2), and 10% have indicated that they make use of Gas energy for cooking. Only 10% of the respondents indicated that they use Paraffin as additional source of energy used for cooking, while 3% indicate that they use other means of energy sources for cooking.

when they are heavily pregnant) that men participate. Nevertheless, the involvement of men in energy decisions is limited. In decision-making, it is normally the male head of the family who decides on the purchase of paraffin, candles and the type of cooking stove to be used. However, the actual operational duty is left in the hands of women. The woodlands and the natural



Picture 4.3: households stored firewood for cooking in Tshikunda village

Women and children play an important role in making energy available for household use (See picture 4.3). They are the ones who bear the difficulties of chopping, loading and transporting heavy loads of wood. Women play a significant role in the domestic energy system by procuring and processing fuel for their families. The involvement of men in sourcing the household energy is relatively low. It is only when the wood is collected for sale or where social constraints restrict women from leaving their homes (for example, when they are heavily pregnant) that men participate.

Nevertheless, the involvement of men arises strongly where energy decisions are to be made. In decision-making, it is normally the male head of the family who decides on the purchase of paraffin, candles and the type of cooking device to be used. However, the actual operational duty is left in the hands of women. The woodlands and the natural

vegetation at Tshikunda village provide vast opportunities for the local community to take part in the sustainable management and benefits and services which they provide. This section presents the findings of the study that was conducted to evaluate the local community's perceptions regarding woodlands and natural forest.

4.11 Common environmental problems occurring in the area

The problem of soil erosion was recorded as the most common environmental challenge experienced in the area and account for 70% of the respondents and then followed by land degradation which only account for about 17% of the households respondents in the village. Small percentage of the households' respondents was recorded on loss of biodiversity and account for only 10% of the respondents in the village (Picture 4.4). The respondents showed a limited awareness of soil trampling as one of the environmental problems happening in the area and account for only 3% of the overall respondents.



Picture 4.4: The nature of land degradation happening in the area

Frequent movement of people when collecting firewood has led to a number of environmental problems which include among others sheet erosion as shown on the image above. It is evident that as people move up and down as they collect firewood they take less precautionary measures of the environmental impacts that may arise in the process. If no action is taken to mitigate the impacts caused as a result of firewood gathering, and if they continue harvesting firewood in the manner in which they do very little of the vegetation cover would be left living the soil expose to different forms of erosion. The findings also showed that very little is known about soil trampling as one of the environmental problems which lead to soil erosion

4.12 Conclusion

This chapter dealt with data analysis and interpretation. From this chapter it is evident that despite the challenges faced in the community firewood remains the main primary energy source in the village and that women are the main primary collectors of firewood. The woodland play a major role in the livelihoods of the rural people by providing them with products and services derived from the forest. Woodlands are not only valued for their basic energy needs but also they are composed of trees which are of nutritional value to people.

CHAPTER 5: FINDINGS, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents the discussion and conclusion following the findings in the previous chapter (chapter 4). The amount of time and distance traveled when collecting firewood are discussed and then followed by the firewood collection method and how this firewood is transported from the forest. The society's perception on who should take the responsibility to manage the woodland as it is a common resource which is freely available to everyone will be discussed and again the role of gender in the collection of firewood will also be looked at closely.

5.2 Major Findings

With regard to the aim and objectives of the study that were stated in chapter one, the causes and impacts of firewood scarcity on livelihood and on the environment were identified and examined. The impacts of firewood scarcity on rural livelihoods were evaluated. The study indicated that women were at the forefront both in the collection and utilization of firewood. From the analysis it was also clearly indicated that firewood was the most commonly used source of energy in the village and it was used for domestic activities such as cooking and heating of water.

Majority of the people in the village travel more than 2km in search for firewood. This is a good indicating that people have completely over utilized their surrounding woodlands patches and as such they have to travel longer distance to areas where firewood is available. Most of the majority of people is unemployed; they cannot afford to pay for the transportation of their firewood.

The study has found that the level of education has an impact on the development of a particular area. Mostly an uneducated person tends to have less care on what is being done to develop the area. It was found that most of the electricity cable which been destroyed due to carelessness particularly by people with limited education and inability to value the grid electricity supply.

It was discovered that households have an income in the range of R100-R2000; this indicates a high degree of income inequity where few people have high while many are poor. In most families, one person contributes towards the demands of the big family using a lower salary. Due to the lower salary, the family to follow the proper energy grid electricity supply practices. Lack of leads people to choose unimproved facilities such as solar, paraffin, gas, candle and firewood as their only source of energy for households chores.

Tshikunda is a typical example of any rural village in South Africa, where firewood is gathered from the nearby woodlots and the surrounding vegetation. During the practice women and children particularly young girls are likely to participate in the collection of firewood. The majority of these women and children travel more than 2km to collect firewood in the surrounding woodlands and again they spend more than 3 hours of their time when collecting these forest resources.

It was also indicated that the majority of people collect firewood twice a week; this was due to the fact that most of the people are working during the course of the week and those who do not have any form of employment can go three times or more depending on the availability of the firewood in the forest. The study also found out that there were no deliberate conservation measures on the management of firewood however the majority of the respondents have indicated that they extinguish their fire immediately after cooking. There is a need for both the government and private sectors to intervene and develop some strategies which will promote both conservation and sustainable utilization of the woodland resources.

When the community was asked on what do they think that these woodlands can be used for other than current activities, this community was of the view that it would be much better if the land can be converted into a community park or any other sort of recreational activity in which they can generate income and that can also help in job creation particularly for the youth and women who are still marginalized in the society.

5.3 Conclusion

It was proven beyond reasonable doubt in this study that firewood, (and women as the principal collectors), is the most used woodlands resources for present and future energy use. The study also found that irrespective of the current electrification taking place in the area, firewood remains the primary source of energy in the village and for that reason woodland remains the key resource for rural people livelihoods. Therefore the societies will continue to use firewood for domestic activities such as cooking and heating water.

In the process the study did not find strong evidence of deliberate energy conserving practices such as using other sources of energy for cooking, while firewood was extinguished after cooking in many of the households in the village. However the study also concluded that firewood is the most widely used woodland resource in the village.

The study also finds that the majority of people in the society did not know of any government programme of action set for conservation and sustainable management of woodlands in their area. The conversion of these woodlands patches to a community park was highly recommended by the community members.

5.4 Recommendations

Wood is a backbone of the rural energy economy and is still used in urban areas in staggering large quantities. To optimize fuelwood for household purposes such as cooking and heating the following recommendations are suggested:

- It is of great importance that social and economic aspects of fuelwood use are understood, researchers, decision makers, foresters, conservationist, energy specialist and other role players need to understand and know the type of wood being used, how they are used, household economy and environmental impacts. All these factors play a very significant role in the utilization of fuelwood.
- The Municipality must improve on the management and provision of electricity. The municipal officers must ensure that the electricity vending machines are at all times functional. The maintenance of the machines may be contracted to service providers whose service level agreement will determine their ability and continued contract. The shortage of electrical power points and their accessibility must be addressed through the acquisition of more of them and further ensure that they are located within a walking distance. The damage that is caused to electrical appliances owing to electricity cuts must be avoided to avoid losses to the community.
- Gender differences need to be taken into account when implementing fuelwood related projects. Fuelwood users and managers must be consulted and given a hearing simply because they have local knowledge regarding the use of firewood.
- Since the community could not be completely separated from their traditional utilization of natural resources, renewal should be applied where applicable as an alternative to provide a chance for the biodiversity to regenerate and recover.
- The municipality, community members and headmen in the study site should consider participatory decision making on the management of woodlands and related activities. This would avoid conflict associated with harvesting of firewood and ownership.
- The national, provincial and local government should hire expertise to monitor the woodlands or biodiversity as a whole in the rural area because its loss is leading to

an increased crisis of habitat fragmentation which leads to a huge loss of the biodiversity.

5.5 Further Recommendations of the Study

- The municipality must put better systems into place to ensure effective and efficient spending. The under-spending currently experienced is due to lack of proper planning, management and co-ordination of activities and projects. The community lacks a great deal of infrastructure development yet funds are not spent, which is perceived in a serious manner by the community.
- The environmental management issues raised need to be taken seriously into consideration. The provision of toilet facilities must be such that underground water is not polluted. Noting the extend of the under spending of allocations of infrastructure development like sanitation, the municipality must involve direct beneficiaries as a form of their contribution and utilise the services of local builders in building acceptable ablution facilities. The waste removal, disposal and general waste management must be in keeping with the prescriptive legislation on this matter
- The control and regulation of the electricity distribution system in the community;
- Promotion of efficient and compassionate delivery of basic health care systems in the community.

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APPENDIXES ENERGY USES AND SUPPLY

1. Does the village connected to electricity supply?

Section A: Biographical Information

No

1. Are you the head of the household?

Yes	
No	

2. Are you

Male	
Female	

3. What main source of energy does your household use for lighting/cooking?

3. What is your educational level?

Primary	
Secondary	
Tertiary	
None	

4. How much is the household earning per month

R100-1000	
R1000-2000	
R2000-5000	
R5000-100000	
10 000 plus	

Paraffin

Batteries

Coal

Gas

DOMESTIC ENERGY USES AND SUPPLY

Lighting

1. Does the village connected to electricity supply?

Yes	
No	

2. If no, how long have you been looking for electricity?

One year	
Two years	
Three years	
More than three year	

Mountain

3. What main source of energy does your household use for lighting cooking?

	Lighting	Cooking
Candle		
Electricity		
Paraffin		
Generator/Battery		
Solar energy		
Other (specify)		

4. What are the main fuels currently used by non-electrified households?

Wood	
Solar	
Paraffin	
Batteries	
Coal	
Gas	

5. Are you using energy for uses other than domestic ones (Such as cooking?)

Lighting	
TV	
Radio	
Irrigation	

6. Are you currently paying for energy supply?

Yes	
No	

7. From where do you get your energy sources?

Mountain	
Solar Radiation	
forestry	
electrified	
Other	

8. How far is the source from your home (in meters?)

50-100	
100-500	
500-1000	
1000-50000	
More than	

9. What time is the energy source the busiest?

Morning	
afternoon	
Night	
No Busy time	

10. Who is responsible for gathering firewood in the family?

Men	
Women	
Children	

11. Which method do you use when collecting firewood?

Self gathering	
Purchasing	
Both but more on gathering	
Both but more on purchasing	

12. Which technique do you use when collecting firewood?

Deadwood from the ground	
Knocked off the tree	
Cut from the tree	

Other people do have electricity while others don't.

Electricity is an issue in this village.

Solar energy is another source of energy.

Financial constrain is another serious problem to those who have electricity.

Poor maintenance of electricity supply system causes shortage of electricity.

Section B: DOMESTIC ENERGY USED

Please complete all questions Mark with an "x" Mark from Strongly Agree to Strongly Disagree

STATEMENT	Strongly agree	agree	uncertain	disagree	Strongly disagree
Sustainability of trees for wood is	agree				disagree
People use paraffin for cooking.					
People use firewood for cooking.					
Electricity supply is a problem in the village.					
Firewood is another source of energy					
Deforestation is another problem.					
Other people do have electricity while others don't.					
Electricity is an issue in this village.					
Solar energy is another source of energy.					
Financial constrain is another serous problem to those who have electricity.					
Poor maintenance of electricity supply system causes shortage of electricity					

Wood collection is another form of saving electricity.					
Women and children are responsible for fire wood collection					
Sustainability of trees for wood is mostly affected by deforestation.					
Poverty causes people not to buy electricity.					
A high cost of electricity units prevents people to buy electricity.					
Lack of energy impacts on the socio-economic development of the people.					
Illegal connection of electricity causes shortage of electricity.					

Thank you for your Participation