An investigation into the challenges and the management of firewood scarcity on rural livelihood in Limpopo Province, Vhembe District: A case study of Nweli Village

BY

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DECLARATION

I, **NEMBAMBULA ALUVHAVHI ALICIA** hereby declare that the dissertation for the degree of Master of 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.

AA Nembambula .... 18 - 09 - 2012 ....

Signature **Date**

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On my personal note, I dedicate this project to my parents, the late Mr. Stephan Nembambula and Mrs Elinah Thivhonali Nembambula, You were there for me all the way.

This study was conducted in the rural communities of Nweli 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 50 randomly selected households in villages. 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 used 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 scarcity of firewood on their livelihoods. 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, questionnaires survey.

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 therefore firewood scarcity is the major predicament in Nweli village.

CHAPTER 2: LITERATURE REVIEW

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

CHAPTER 4: DATA PRESENTATION, INTERPRETATION AND ANALYSIS

CHAPTER 5: FINDINGS, RECOMMENDATIONS AND CONCLUSION

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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

1.1 Background of the study

Firewood is the dominant energy source throughout Southern Africa and the rest of the developing countries (Gielink *et al.*, 1991:8; Hall, 1992:8 & Pandey, 2002:90). 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 (Leach & Mearns, 1989:34).

In Southern Africa firewood accounts for 60 to 69% of the total energy consumed having the highest proportions in the poorest countries (Leach & Mearns, 1988:67). According to Arnold and Jongma (1977:89), 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 m^3 (Agrawal, 1986:66), and it accounts for 58% of the total energy used in the continent (Bogach, 1985:12).

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.

Forest patches in parts of Vhembe district and other rural areas is declining at an accelerated rate because consumption is increasing at an alarming speed with population growth, however addition to supply through new growth are declining in proportion to the amount of available woody vegetation in each specific areas

(Fairhurst *et al.*, 2000:12). The consumption of firewood has been discussed in literature on world development in recent years, but little was known of firewood consumption and collection behavior in Vhembe district, where the majority of households still depend on firewood for most or all of their cooking and heating needs (Nethengwe, 2007:78).

The South African energy sector has the characteristics of both the developed and developing countries. On the other hand South Africa produces and consumes over 60% of the electricity on the African continent and it is amongst the highest emitter in the world (Shackleton *et al.*, 2003:90). More than half the populations of South Africa's rural households consume firewood energy to a greater or lesser degree. South Africa has the lowest electricity prices in the world to consumers; most newly electrified households continue to use firewood because they cannot afford the appliances and the monthly costs (Howells *et al.*, 2005:66).

The use of firewood offers both advantages and disadvantages. In terms of the national priority on poverty reduction, it is needed to optimize the opportunities and minimize the difficulties. On the one hand firewood is a renewable resource. If it is managed and harvested properly it will continue to meet the energy needs of the rural and peri-urban poor for many years to come (Brown, 2010:21). Women and children collect firewood for domestic purposes while men are concentrating on marketing of firewood. Typically the poorest and most vulnerable communities and households make use of firewood at the expense of other forms of energy.

The use of firewood has both health and environmental problems. This will include the opportunity costs which are associated with harvesting of firewood and poor households tend to experience the higher risk respiratory disorder associated with the higher use of firewood or charcoal (Food and Agricultural Organization, 2002:67). These kinds of health and environmental problems are

very common in peri-urban societies where cooking fires are normally made in poorly ventilated houses/shacks. In rural areas the majority of households make cooking fires outside, where the smoke from the fire would be blown away easily and for this reason health hazards is reduced in the process. The other health problems are associated with the carrying of large bundles of wood where people can sustain some physical injuries.

From the environmental point of view the unsustainable harvesting of trees lead to the reduction or loss of biodiversity which tend to worsen the rate of local poverty in that specific area. If specific intervention is to be made in trying to alleviate poverty in that particular area through the national firewood programmes such programme must try to minimize these potential health and environmental problems.

Such challenges are not exclusive to South Africa therefore roughly 60% 0f the energy consumed in Southern Africa is generated from firewood or charcoal and the total number of people who are dependent on biomass fuels in Southern Africa is estimated to increase by as much as 50% in the next two decades (Biggs *et al.,* 2004:4). Therefore it is important for South Africa to learn from its neighboring partners whilst at the same time leading the way on managing some of its most precious and vulnerable forest resources, so that they too also cater for generations to come. According to Shackleton (2003:1) and Biggs *et al.* (2004:32), the primary source of firewood comes from the woodland biome which covers about 34% of South Africa, and is home to over nine million people. Other sources of firewood include indigenous forest, community woodlots, off-cuts from commercial plantation forestry and trees that are growing in and around people's fields and residential plots.

1.2 Problem Statement

Environmental Conservation Amendment Act 98 of 1991 provides the effective protection and controlled utilization of the environment and for matters incidental thereto. This act is not effect because in all rural areas including there is an increasing demand for firewood at Nweli 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.

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.

Because of the increasing pressure on wood availability it tends to influence the distance travelled and time taken to collect wood has also increased. Women and children in the area tend to walk more than one kilometer and spent about 2-5 hours per day to harvest firewood. In future, the demand for firewood will be high because of the increasing population growth and un-affordability of alternative energy resources as a result of poverty. This has posed a serious threat to the survival of highly preferred tree species with practices such as excessive pruning leading to the whole-destruction of valuable plants, which will occur more frequently in the future.

Firewood is a very important energy source for extensive part of the world population, especially in developing countries. The gathering of scale and

uncontrolled quantities of fuelwood frequently has a negative impact on the fuelwood resources, mainly in poorly managed natural forests. The knowledge on firewood status is of greater importance, because it is without delay linked to the long-term conservation of forest and other fuelwood sources.

1.3. Research Objectives

The research objectives will be discussed under general and specific objectives.

1.3.1 General Objective

To investigate the challenges and the management of firewood scarcity on rural livelihood and the environment in Nweli Village

1.3.2 Specific objectives

- To determine the main uses of firewood material in Nweli village
- To determine the environmental status of the woodland vegetation
- To determine the consequences of firewood shortages on rural livelihood and environment
- To establish the coping strategies to solve the problem of firewood shortages in the community

1.4 Research Questions

- Which primary activities require the use of firewood as the main source of energy?
- How severe is the environmental condition in the area?
- What are the consequences caused by firewood scarcity on rural livelihoods and environment?
- What can be done to address the potential problems?

1.5 Research Hypothesis

- Firewood scarcity is the major impact of the land and environmental degradation;
- Firewood scarcity impacts on the productivity of women and children in Nweli village;
- Rural communities depend on firewood for the domestic energy such as cooking
- Low proceeds generation cause high demand allotment of the firewood for energy use

1.6. Significance of the study

Some research work have been done on fuelwood and its impact on livelihoods of the rural people, and the challenges that are faced in implementing land restitution, but not many of these studies were focusing on fuelwood as a scarce resource, its impacts on the environment and rural livelihood. Firewood has become a pillar of strength as the primary source of energy in rural areas particularly in Africa, where the majority of its people live in abject poverty. Central to this, women and children are the major role players in making sure that firewood is available for energy purpose to improve the livelihoods.

People of Nweli village have been as dependent on firewood as their primary source of energy for many decades, but they pay no attention on the scarcity of this resource and its associated environmental impacts. Therefore, this study dwelt much on firewood as a scarce resource and its impact on the environment and rural livelihoods. After the findings of this research the researcher initiated a community based organization which looked closely to issues that concern the environment and in the process improving the livelihood of people particularly women and children.

1.7 Delimitation of study

This study primarily focused on the challenges of the scarcity of firewood fuel and its impacts in rural areas in particular Nweli village in Thulamela Municipality Limpopo Province. The research was to cover the period from 2010 to 2011. The study itself would not touch other villages in Thulamela Municipality except Nweli village, though other areas might be having other challenges of firewood fuel use, but this study would focus directly to Nweli 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 firewood 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 Nweli village. Inaccessible roads within Nweli village could also prevent thorough assessment of factors affecting domestic use.

1.9 Brief summary of literature review

The south African government through the Department of Water Affairs and Forestry (DWAF) after realizing the current status of non-compliance with the National Forest Act and the National Veld and Forest Fire Act and its failure to enforce the law according to the legislative requirements, the department has decided to take action in a more effective and holistic compliance and

types that might be used by households as their prosperity increases. The energy ladder fuel order corresponds with increased technological efficiency, decreased CO2, SO2 emissions and particles, and increased capital cost (Meikle and Bannister, 2004:42).

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, 1999:31). Families living in close proximity to forests see a larger fraction of their energy mix comprised of wood fuel than do those located further from forested areas. A study conducted in urban India by Bowonder *et al.* (1985:13) found this pattern to hold true even for high-income households.

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 (Najam and Cleveland, 2003:3). 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, 2002:7; Mahat, 2004:89). 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) (Cecelski, 1984:65; Pearce, 2005:43). 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 (Barnes, 2000:56). The degradation of soil quality is one of the major causes of food insecurity (OECD, 2002:78).

Status of Limpopo woodland

The woodland vegetation in South Africa covers approximately one third of the total land area. Commonly referenced classification systems identify a great number of woodland types, attributable to the diversity and geographical range of this biome (Wills, 2000:78). Furthermore, land covered by woodland is owned and managed by a diverse and range of role players. The current status of this resource is not well developed and the role of different service providers in government and non-government sectors are poorly understood. The natural forests and woodlands benefit the communities by providing tangible and non tangible goods and services. Trees and tree products of the woodlands and forests play an important and often under-estimated role for rural communities, and are central to their lives (Timberwatch, 2000:90). Figure 2.1 shows the distribution of woodlands vegetation in Limpopo province.

Plantations and natural forests are recognized as playing a crucial role in addressing some of the biggest challenges in South Africa at the moment, namely poverty reduction and job creation. Increasing poverty, over-utilization, HIV/Aids and climate change have been noted as the greatest influence on the state of forests (Department of Water Affairs and Forestry, 2005:9).

Studies from South Africa

According to Shackleton *et al.* (2003:9), fuelwood availability and use in the Richtersveld National Park, South Africa, the deadwood availability was assessed per woody species and on the ground in 12 transects within the riparian fringe. Herders were interviewed concerning their species favorite and the composition of woodpiles was examined. The outcome has showed that there was no relationship between the percentage of the attached deadwood on the tree, and the percentage deadwood ground cover, and the distance from the herder stockposts. On the availability deadwoods that were surveyed *Euclea*

pseudobenus and *Tamarix usneoides* were the dominant species in the riparian border. However there was a strong selection for *Ziziphus mucronata as* fuelwood species and only marginal or random selection for *Euclea pseudobenus. Tamarix usneoides* and *Prosopis* species were abundant in the riparian border, but were not used as firewood. The result also indicated a significant difference between species with respect to the mean proportion of the stem that was dead, the highest being *Ziziphus Mucronata* (Buffalo thorn) amounting to 28% deadwood followed by 12% of *Tamarix usneoides* and most of the *Prosopis* species had no deadwood.

1.10 Definitions of the Concepts

- **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 is needed for fulfilling basic human needs such as cooking, heating and lighting (Kammen, 2006:56).

1.11 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, Impacts of firewood scarcity into the environment, Domestic energy supply in Nweli Village, population and the demographic situation, The energy sources and their impacts in the Developing World, 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.

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 Forest/woodlands policy framework in South Africa

The South African government through the Department of Water Affairs and Forestry (DWAF) after realizing the current status of non-compliance with the National Forest Act and the National Veld and Forest Fire Act and its failure to enforce the law according to the legislative requirements, has decided to take action in a more effective and holistic compliance and enforcement model referred to as the strategic and cooperative enforcement (Department of Water Affairs and Forestry, 2005:9).

The proposed model presents a move away from the enforcement which depends on traditional detection method by bringing new innovative and alternative compliance and enforcement options. When looking at the alternatives of withdrawal, zero tolerance as they continue presently, the new model of strategic and cooperative enforcement presents an affordable and effective way of reorganizing and securing regulatory compliance of the National Forest Act (no.84 of 1998) and the National Veld and Forest Fire Act (no. 101 of 1998). This new model has a strong emphasis on cooperative governance and cooperative enforcement to strengthen the enforcement competency of the department and ensure the principal use of the available enforcement resources (Department of Water Affairs and Forestry, 2005:3).

According to the Department of Water Affairs and forestry (2005:6), the policy will serve to respond to situations where there is steady loss of forest resources in South Africa and where the unacceptable level of veldfires risk occurs, regardless of the regulative provisions in these Acts. This situation contributes to a loss of biodiversity based on livelihoods opportunities among the poorest of the poor as well as undermining the development. As a result, South Africa is experiencing problems of environmental degradation as well as lost livelihood and economic opportunities based upon natural resources. The policy itself aims to iron-out the requirement to promote sustainable development and the sustainable utilization of natural resources via the statutes as the instrument of policy.

The National Forest Act together with the National Veld and Forest Fire Act has specific prescriptive elements, as well as the legal frameworks that allow relevant role players on their own, collectively, or together with the government to find common ground on specific issues or to make some improvements appropriately needed in their activities to comply with the proposed policy. It is the combination of the statutory prescription and statutory enablement that makes it possible for the department of water affairs and forestry to have good policies to support

adequate compliance with the Acts, with the necessary enforcement of the minimum prescriptive standards, which include the provision for the promotion of sustainable forest management in the National Forest Act.

2.3 Status of Limpopo woodland

The woodland vegetation in South Africa covers approximately one third of the total land area. Commonly referenced classification systems identify a great number of woodland types, attributable to the diversity and geographical range of this biome (Wills, 2000:67). Furthermore, land covered by woodland is owned and managed by a diverse and range of role players. The current status of this resource is not well developed and the role of different service providers in government and non-government sectors are poorly understood. The natural forests and woodlands benefit the communities by providing tangible and non tangible goods and services. Trees and tree products of the woodlands and forests play an important and often under-estimated role for rural communities, and are central to their lives (Timberwatch, 2000:89). Figure 2.1 shows the distribution of woodlands vegetation in Limpopo province.

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Woodlands play a crucial role in making sure that hundreds of millions of people in the Third World particularly in Africa are not suffering from hunger. In reality food security is very much dependent on environmentally accountable and sustainable use of the world's woodlands. People who are severely affected by challenge of food insecurity are the world's poor, particularly forest dwellers, subsistence farmers, landless households and livestock herders. Woodlands are

very important to these people because they are one of the most accessible productive resources available to them (Gbetnkom, 2007:8).

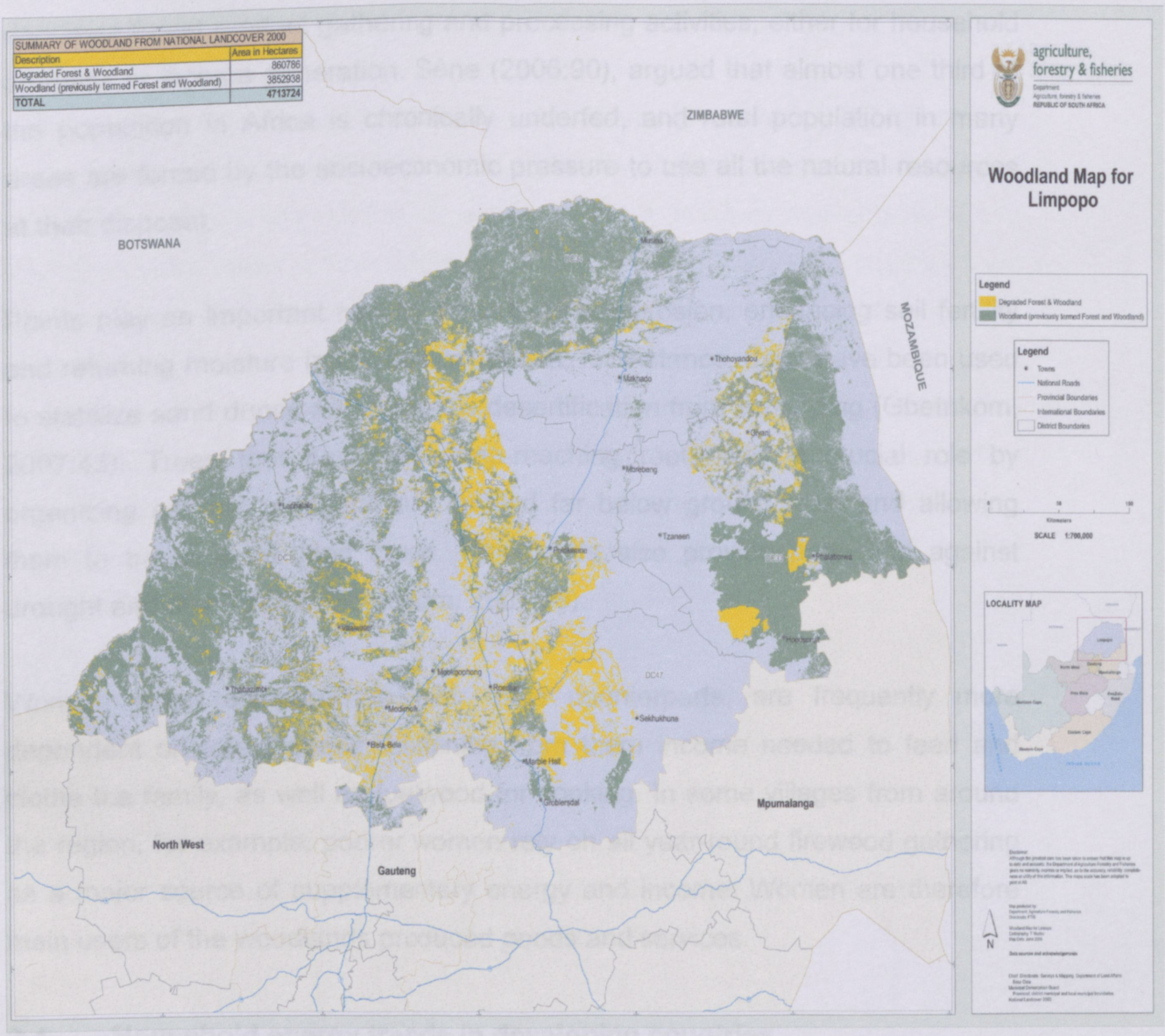

Figure 2.1: Distribution of woodlands vegetation in Limpopo province (Source: DWAF 2005)

Most countries of southern Africa are severely impacted by extreme poverty (Dorward *et al.*, 2004:23). People have a strong historical background of unrestricted access to woodlands. Poorer people thus have been able to make use of these forests for food, firewood and other profitable products. In areas

where people are not denied the opportunity to practice forest gathering activities (cultivation, fuelwood and livestock grazing), they tend to depend on these activities to a greater extent for their survival. Poorer women are the ones who dominate forest product gathering and processing activities, either for household products or income generation. Sène (2006:90), argued that almost one third of the population in Africa is chronically underfed, and rural population in many areas are forced by the socioeconomic pressure to use all the natural resources at their disposal.

Plants play an important role by preventing soil erosion, enhancing soil fertility and returning moisture in the soil. In Algeria, for instance, trees have been used to stabilize sand dunes and minimize desertification from expanding (Gbetnkom, 2007:45). Trees that have got deep-reaching roots play a crucial role by organizing soil nutrients that are located far below ground level and allowing them to be used by food crops. Woodlands also provide protection against drought and crop failure (Gbetnkom, 2007:89).

Women, when compared to their male counterparts, are frequently more dependent on forest goods, obtaining from them income needed to feed and clothe the family, as well as fuelwood for cooking. In some villages from around the region, for example, poorer women rely on all year-round firewood gathering as a major source of supplementary energy and income. Women are therefore main users of the woodlands produced goods and services.

2.4 Household energy trends in developing countries

This section draws on the energy scholars and policy makers around the world who have devoted considerable effort to understanding household energy use in developing countries. In this section, the focus of attention will be on the energy ladder and fuel switching in developing countries. Household partial fuel switching is a temporary strategy, whereby a household switches to a new fuel,

but continues to use the old fuel as well, whereas with complete fuel switching; the old fuel is not used at all (Kgathi *et al.*, 1997:34). Complete household fuel switching is also known as an energy transition. The energy ladder is a scale, which rates the quality of household fuels (Chambwera, 2004:32).

It is important to understand these processes when investigating energy consumption patterns (Soussan *et al.*, 1992:43). Understanding the process of energy transition in households will require research into why available electricity services are not used in poor urban areas. The work on household energy draws on the concept of an energy ladder with solid fuels on the lowest rung, and kerosene, LPG and electricity on successively higher rungs (Jack, 2004:7). According to Meikle and Bannister (2004:90) the energy ladder represents fuel types that might be used by households as their prosperity increases. The energy ladder fuel order corresponds with increased technological efficiency, decreased CO2, SO2 emissions and particles, and increased capital cost (Meikle and Bannister, 2004:23).

Davis (1998:9) argues that South Africa generally supports the notion that households climb the energy ladder, as they grow wealthier. Households that make use of electricity are more likely to use clean cooking fuels (Davis, 1998:45). Urban dwellers are more likely to use cleaner technology as their income grows (Hosier and Dowd, 1987:23; Campbell *et al.*, 2003:45). Household energy types and consumption levels are determined by:

- Income
- Infrastructure
- Fuel availability
- Fuel prices
- Distribution network proximity
- Cultural preferences
- Demographic distribution

- Physical environment (urban or rural) (Davis, 1998:9).

The energy ladder studies by Leach (1992:34) and Smith *et al.* (1994:42) 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.*, 2004:7).

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, 1998:9 and Bernett, 2000:90). Leach (1987:12) 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, 1998:88). Most urban households tend to switch to more extensive electricity use after being connected the electricity grid (Davis, 1998:88).

In a study in South Asia, Leach (1987:9) 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 (1987:23) 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.*, 1990:53). Under these circumstances, fuel security is

the way that household energy is managed, and may prevent permanent energy transition (O'Keefe and Munslow, 1989:32).

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, 2003:45). 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, 2003:12). 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.*, 2000:12). In South Africa this transition has not been clearly defined, as diversity of energies has not declined in poor urban households (Madubansi and Shackleton, 2005:23).

With increasing affluence, households adopt new technologies and fuels that serve as partial rather than perfect substitutes for more traditional fuels (Masera, *et al.*, 2000:80; Leiwen and O'Neill, 2003:14). In poor urban China, for example,

biomass and electricity are the most common fuel types that are paired in households (Leiwen and O'Neill, 2003:34). 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, 1995:9).

Multiple fuel use has also been termed 'fuel stacking' (Masera *et al.*, 2000:89). Although poor households often use several fuels simultaneously, they generally shift towards the adoption of cleaner, more efficient energy sources as income rise. 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, 2004:9). Second, modern energy sources are usually expensive and thus are applied carefully for unique services such as radios and television for entertainment (Thom, 2000:88). 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, 1999:90).

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 (2002:8) 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.*, 2003:6).

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, 2002:09). 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, 2002:88; WEC/FAO, 1999:99).

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.*, 2000:77). 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.*, 2000:90; Saatkamp *et al.*, 2000:88).

Hosier and Dowd (1987:90) 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, 1987:90). 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, 1987:67). 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, 1987:78). An investigation of household energy choices for a sample of households residing in the city of Bangalore uses a bionomial logit model (Reddy, 1995:90). A binomial log is defined as a model, which determines the choice between each pair of energy sources.

This model according to Reddy (1995:89) 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, 1995:90). A similar study in India also employed a multinomial logit framework to represent household fuel choice (World Bank, 2003:90). 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, 2003:78).

2.5 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 (Baradei, 2007:9). 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 (Ejigu, 2008:34). 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 (Mulugetta *et al.,* 2005:23). 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 (Semu and Mawaya, 1999:12).

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 (1992:45) 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 (Prasad and Visagie, 2005:23). The energy sector in South Africa has both first and third world elements (Shackleton *et al.,* 2007b:9). 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% (Shackleton *et al.*, 2007b:9) of South Africa's rural households use fuelwood for energy, as do numerous urban households.

2.6 Environmental impacts associated with firewood use

Biomass energy, have certain advantages when compared to conventional source energy (fossil fuels) but at the same time it also has some disadvantages (FAO-RWEDP, 1998:90). 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 (SO_2) emissions which may cause acid rain as well as other environmentally harmful effects (FAO-RWEDP, 1998:89). 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 (FAO-RWEDP, 1998:44).

2.6.1 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 (Najam and Cleveland, 2003:89). 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, 2002:45; Mahat, 2004:90). 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) (Cecelski, 1984:6; Pearce, 2005:23).

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 (Barnes, 2000:8). The degradation of soil quality is one of the major causes of food insecurity (OECD, 2002:88). 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) (Koziell and McNeill, 2002:34). 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.

2.7 Women and fuel wood suffering

The collection of firewood is physically demanding and time-consuming. After fifty eight years of independence, Indian women still struggle daily to gather firewood, crop residues and animal dung- together known differently as biomass based cooking fuels, noncommercial fuels or traditional fuels. The manner in which Indian women strive when collecting firewood is not central to them, but it is also evident and occurs to all women in Africa and other developing countries of the world (Parikh, 2005:99). It is also apparent that firewood and other forms of biomass energy used by women for cooking cause health impacts for those women and children as they release a variety of pollutants in their close proximity (Parikh, 2005:67).

The release of pollutants normally takes place in poorly ventilated kitchens. Women also have to travel long distances in search for firewood. When the pressure on local resource bases increased, so are the distance travelled, collection time, and other demands on women also increases (Mercer and Soussan, 1992:8; Shaclekton *et al.,* 2007:9 and Chirwa *et al.,* 2008:90).

2.8 Social deprivation

Energy is needed for fulfilling basic human needs such as cooking, heating and lighting. Biomass is one of the major sources of cooking in rural areas, which is mainly managed by women. Women suffer from asthma, eye problems, due to the domestic air pollution, especially when burning low quality biomass fuel such as agricultural residue. Similarly, carrying heavy firewood causes numerous health problems such as miscarriage, chest problems and uterine prolapsed (Haile, 1991:9).

Women and children in developing countries suffer disproportionately, as they spend much of their time gathering wood (UNDP, 2004 & Mahat, 2004:77). In

heavily populated or resource poor areas, this practice can deplete forests and soils. Burning traditional biomass over open fires or inefficient stoves contributes to health-threatening indoor air pollution (Barnes, 2000:45). As many as 2 million deaths each year are attributed to this risk factor. The World Health Organization (WHO) estimates that 1.6 million of these deaths are of woman and children, whose responsibility for domestic chores make them relatively more exposed to indoor air pollution from cooking and heating (WHO, 2005:34).

Burning biomass indicates the low accessibility to alternative fuels by the poorest households and thus involves equity concerns, which in turn affects women's workload and their health. In addition, girl children are often withdrawn from school to work at home for helping their mothers in energy related activities, such as carrying firewood. These problems are attributed to the social deprivation, which restricts women's choices and their capacities for production and reproduction (Chirwa *et al.*, 2008a:8).

2.9 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 draw card. 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. The unsustainable removal of these resources raises concerns in relation to the ecological impact on biodiversity. This prompts the search for quantification of sustainable harvesting limits and the appropriate institutional arrangements under which sustainable harvesting can be implemented (Dovie *et al.*, 2001:12). Sustainability of fuelwood production, collection and use seems to be a key issue.

The main purpose of rural energy development should aim to address the issue of rural energy, primarily firewood, in order to improve the socio-economic conditions of the majority of people, including the poor, the landless and women (Bhattarai, 1997:12). While rural development is a key element of the socio-economic well being of the community, it should be taken into account that environmental sustainability is equally important. Fuelwood has an impact on the socio-economic issues of the rural community. It is the main energy source in rural settings for cooking and most food processing. This shows that there is a relationship between fuelwood and nutrition, meaning that fuelwood supply can influence the amount of food supplied or cooked. Cecelski (1984:34) reported that, in Somalia, refugees fed their bean rations to their livestock or discarded them because they could not afford the fuelwood to cook them. While this is an extreme case, it serves to illustrate the fact that whole grains and legumes are inedible without cooking.

Fuelwood does not only influence the day-to-day activities of households, but it also influences the well-being of the rural communities. It makes a significant contribution to the socio-economic welfare of the rural community associated with its production, collection and consumption. According to FAO-RWEDP (1998:89), commercialization of firewood can lead to opportunities for integrated rural development through generation of rural employment and income. One of many reasons why rural development fails is due to the fact that planning is not integrated (multi-sectoral). Integrated rural development leads to a holistic approach to total systems development in rural areas. Through firewood production activities, employment can be created for farmers and laborers and this could also lead to income generating opportunities. Income generating opportunities can also be realized through the harvesting, collection and sale of firewood. Although fuelwood use and production has positive impacts, there are also negative impacts that come in the form of health ailments caused by indoor air pollution resulting from firewood utilization.

In South Africa firewood has continued to be the primary source of energy for heating and cooking in a high percentage of households across the country. The direct use of firewood for domestic purposes is an important source of 'income' since it acts as a substitute for formal energy and construction of resources. The total adjusted direct consumption value of these products was estimated at R396 million, R1 529 million and R842 for the Eastern Cape, KwaZulu Natal and the Limpopo provinces respectively in 1998.

2.10 Financial difficulties of firewood production

The rural communities are faced with many problems when it comes to issues related to finances. There is lack of awareness among financial institutions to support plant growing activities and lack of explanation for financial resources being spent on development of wood based energy systems in the public sector (FAO-RWEDP, 1996:34). Some financial support from both the private and public sector because it would play a crucial role in terms of local employment, provision of goods and services and balance rural development. The capital support will also ensure efficiency and operation of the firewood markets for the supply of firewood to the rural communities (FAO-RWEDP, 1996:9).

2.11 Gender and rural energy

Gender refers to the socially constructed roles of women and men rather than biologically determined variations (Clancy *et al.*, 2004:90). 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, 1995:12). 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, 1995:13). Because women are the ones

who are actively involved in the fuelwood business, in most cases one often find that the majority of firewood energy planners are men, but when problems that are related to firewood usage happens, 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 implementation phase of firewood activities.

The women's engagement is not limited to the collection of firewood but also very important in the efficient utilization of such fuelwood (Oosterveen, 1995:43). 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 justify 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, 1989:54).

2.12 Studies and Models related to fuelwood consumption from around the world

Rural energy in general and fuelwood in particular, has a great impact on people's way of life particularly on the lifestyle of rural women in Nepal, because they are directly involved in the production and management of household energy. In this study it was found that energy poverty involves multiple deprivations such as economic, social, cultural and ecological.

2.12.1 Asia

Fournier & Demurger (2010:89) conducted a study on poverty and firewood consumption. In their study they discussed the major determinants of firewood consumption in the poor township in rural north China and they pay a particular attention on the relationship between households' economic means and firewood consumption. The study found out the strong support for the poverty-environment hypothesis because household's financial income is a significant and negative determinant of firewood consumption.

Rural energy in general and fuelwood in particular, has a great impact on people's way of life particularly on the lifestyle of rural women in Nepal, because they are directly involved in the production and management of household energy. In this study it was found that energy poverty involves multiple deprivations such as economic, social, cultural and ecological. They also find that using fuelwood as the only source of energy in rural areas has large impacts on human poverty particularly when it is attributed to socio-cultural deprivation, which then affect negatively on overall wellbeing of the rural households. For example, increased use of fuelwood turn to limit the production and reproduction capacities of women, which in the long-run turn to restrict their capacity to access better energy services allowing very little opportunities for rural households (Mahat, 2004:12).

2.13 Studies from other countries in Africa

According to Kgathi *et al.* (1997:67), firewoods were removed from the forest by essentially two categories of people. The first category of people was primarily composed of women and children who collect naturally dead twigs and small branches of dead wood from other tree cutting activities including land clearing and gathering of wood for construction, fencing and trading.

2.13.1 Botswana

According to Kgathi *et al.* (1997:45), approximately 500 000 tones of wood which is 45.4 % of the total wood collected annually in the country was used mainly for fuel purpose. The amount of firewood supplied on average was about 80% of the energy needs of the households, small enterprises and public service institutions in rural areas and low medium income households in the urban areas. Firewood consumption is accounting for about 60% of the energy used country wide in 1991, and it has dramatically declined by 3% in 1992 due to people changing primarily to Kerosene and liquefied petroleum gas (LPG). The change was motivated by the firewood scarcity and the associated increasing cost relative to that of the more suitable used fuel (Kgathi, 1984:88).

It was found that households from both rural and urban areas primarily use firewood for cooking, baking, space heating, and lighting and traditional beer brewing (Kgathi *et al.*, 1997:90). Small enterprises such local bakeries and restaurants government institution such as hospitals, clinics, schools and polices stations, mostly use firewood for bulk cooking and water heating (Kgathi, 1984:90).

According to Kgathi *et al.* (1997:67), firewoods were removed from the forest by essentially two categories of people. The first category of people was primarily composed of women and children who collect naturally dead twigs and small branches of dead wood from other tree cutting activities including land clearing and gathering of wood for construction, fencing and trading. The collected dead wood were mainly removed by foot as headload and then used for domestic consumption.

The second category was a group comprised of men who remove large live, dead branches and trunks using various mode of transport including wheelbarrows, bicycles, donkey and trucks. As women continue practicing their

sustainable ways of collecting firewood as stipulated in the first category, they are harmlessly affected by firewood scarcity caused by land clearing and other unsustainable wood gathering activities. Firewood has become a scarce resource in South East Botswana particularly in large rural villages and around urban centers.

When firewood increasingly become scarce, the distance that one has to travel in search for firewood also increase for instance; Opschoor (1981:9) found that the distance travelled by Mochudi residents to collect firewwod has increased from 1.3 km to 3.6 km in 1979. By 1990 this distance had increased by 15 km (Kgathi, 1984:76). These increased distance influenced the labour time that one spent while collecting firewood, which in turn reduce the amount of time which is catered for other activities such as ploughing (cultivating), preparing and cooking food and childcare.

A call for intervention to the problem of firewood scarcity include among other things, the involvement of men in the collection of firewood, the reduction of in the amount of meals cooked leading to fast cooking but less healthy food, harvesting of less favorite tree species and in the process the cultural taboo is also compromised. It also leads to illegal collection of firewood from the privately owned land and lastly it deprives the nutrient content of the soil and organic matter. The net effect of firewood scarcity is that its real price becomes so excessive and households are obliged to purchase it and other fuel substances. The poorer households are forced to purchase firewood because of their lack of other means of transport (Kgathi *et al.,* 1997:34).

2.13.2 Tanzania

A study conducted by Kaale *et al.* (2000:23), "fuelwood and charcoal uses with possible alternative energy sources". The main objective of the study was to assess the current situation concerning the demand for and supply of woody

biomass energy in the township and Mbunju-Mvuleni village and to make recommendations towards reducing the demand for woody biomass energy in the area. The study has indicated that there was an increasing demand for firewood and charcoal in Ikwiriri Township and Mbunju-Mvuleni village. Firewood and charcoal are used with low efficiency and there is no defined programme to minimize consumption rates of fuelwood and charcoal through the use of improved wood production and utilization technologies. It also showed that tree covered area in the wood supply sources of Ikwiriri and Mbunju-Mvuleni villages are declining rapidly leading to scarcity of firewood and charcoal.

2.13.3 Mali (West Africa)

According to Morton (2007:9), women use firewood to cook and heat water for bathing and other household's activities when necessary. Firewood collection is the only responsibility of very adult women in the community. Even though children play a very crucial role in the collection of firewood activities, only adult women take up the responsibility to control the woodpiles. Each woman woodpile is different and wood is continually pulled from the pile. The firewood is then replenished when branches and stems gathered from the plots next to the agricultural fields and are added to the piles.

The firewood consumption was estimated by recording the fuelwood use of four different households in the area over the period of one week. For three out of four households, this weekly measurement was made twice. A household is here defined by the collection of women who share cooking responsibilities with men and children they feed. The household sampled were not selected randomly, because the process of monitoring firewood consumption was somewhat disturbing. Then the researcher choose to monitor the consumption rate of households which were better known to him and they were more willing to actively participate in the process (Morton, 2007:7).

The fuelwood consumption data collection was modeled after Abbot and Homewood (1999:32). The women who were responsible for cooking and warming water in each household were first identified. These women were requested to identify the places where they store firewood.

2.14 Studies from South Africa

According to Shackleton *et al.* (2003:23), fuelwood availability and use in the Richtersveld National Park, South Africa, the deadwood availability was assessed per woody species and on the ground in 12 transects within the riparian fringe. Herders were interviewed concerning their species favorite and the composition of woodpiles was examined. The outcome has showed that there was no relationship between the percentage of the attached deadwood on the tree, and the percentage deadwood ground cover, and the distance from the herder stockposts. On the availability deadwoods that were surveyed *Euclea pseudobenus* and *Tamarix usneoides* were the dominant species in the riparian border. However there was a strong selection for *Ziziphus mucronata as* fuelwood species and only marginal or random selection for *Euclea pseudobenus. Tamarix usneoides* and *Prosopis* species were abundant in the riparian border, but were not used as firewood. The result also indicated a significant difference between species with respect to the mean proportion of the stem that was dead, the highest being *Ziziphus Mucronata* (Buffalo thorn) amounting to 28% deadwood followed by 12% of *Tamarix usneoides* and most of the *Prosopis* species had no deadwood.

The overall species mean percentage of deadwood per tree was estimated at approximately 15%. The additional detached deadwood covered just less than 9% of ground area, averaged across all plots and transects. The variables that were measured indicated that there was little need for the concern over the current firewood extraction activities of the pastoralists within the (RNP). Again it showed no clear evidence of the cutting of branches or deadwood. There was

clear evidence that the abundance of attached and detached deadwood was not depleted close to human territory. There were still plenty of deadwoods, even on preferred species. The most preferred (Ziziphus mucronata) had the greatest proportion of firewood (Shackleton *et al.*, 2003:90).

Ham (2000:87) conducted a study on the importance of woodlots in Kentani, Eastern Cape and found that DWAF personnel felt that if the woodlot belonged to the community, the community would protect it as they would have a sense of ownership. The survey method involving interviews based on questionnaires was conducted. The unit of analysis for the questionnaire survey was individual households. These households were chosen based on interval or systematic sampling whereby only a certain number of houses per street were randomly selected to ensure that the survey cover the entire village.

The study shows that when firewood is abundant household tend to rely on it even when there is a high level of electrification in the area. The firewood is also preferred for food that takes a long time to prepare but more convenient sources of energy as electricity is then used for short period of cooking and warming of food. It was also found that firewood has been collected in the form of headload bundles, two to three times per week and stored in an open space without any form of protection against rain, and again when firewood is used for cooking food was prepared in a three legged pot on an open fire (Ham *et al.*, 2001:9).

2.15 Approaches to overcome firewood challenges

Forest managers, resource managers, conservationists, and other players and decision makers in the forest and energy industry need to come up with sustainable solutions that will overcome fuelwood problems. Viable alternatives to reduce the number of people depend upon firewood for their energy needs also need to be taken seriously.

2.15.1 Plans to tree planting

The plan proposed by government and donor agencies to ameliorate perceived firewood challenges was to plant trees (Mercer and Soussan, 1992:9; Ham and Theron, 2001:22). This plan was implemented in order to solve the energy needs of the rural communities while at the same time contributing to the economic development and maintenance of biodiversity and environmental quality. For this reasons, programmes ranging from establishment of village woodlots to large-scale firewood plantations were implementation. The initiatives aimed for tree planting for firewood can also be seen as another way of reclaiming degraded forest lands. Planting of trees not only assists in the mitigation of firewood shortages , but also fulfil the rural need for the economic and non-economic benefits from trees to sustain their rural livelihood. The desirability of boosting tree planting on farmlands is recognized, both in the academic literature and in government policy, uptake has been lower than anticipated in many projects (Zubair and Garforth, 2005:423).

The plans to plant trees for rural energy should be developed in consultation with the community members and the farmers. They also need to be on and understanding of tree management in the context of household livelihood strategies. Most of the time the people who are heading these tree planting projects do not have indigenous knowledge systems of local farmers and also lack of knowledge about the constraints they face in developing tree resources. It is therefore important that the resource managers work hand in hand with the locals to ensure that viable solutions are implemented. Tree planting initiatives can take place through large-scale plantations, social forestry, woodlots and agroforestry (Mecer and Soussan, 1992:42).

Large-scale plantations: In the Sahelian zone, plantations are established mainly for fuelwood production and for providing improved environmental conditions, such as combating desertification through sand dune fixation and windbreaks

(Chamshama and Nwonwu, 2004:4[illegible]). In cases like this, exotic fast-growing species are often used.

Social forestry: The term social forestry started circulating in the forestry industry since the 1980's and has many meanings. According to Westoby (1989:97), social forestry is defined as "tree planting and management, at the farm, village or community level, by or for small farmers and the landless". Such projects, often supported by groups like the Food and Agricultural Organization (FAO) of the United Nations, the World Bank, or the U.S. Agency for International Development, are usually aimed at the rural poor in developing areas where the major wood use is often for fuel (Klemperer, 2003:9).

As part of social forestry initiative, the Biomass Initiative was launched in 1992 to address the growing fuelwood problem in rural South Africa, as part of the holistic approach to rural development (FAO, 2002). The project was meant to address the rapidly deteriorating energy situation in rural areas, the increasing poverty and halting the environmental degradation due to pressure on the land.

Social forestry is not always easy to implement especially when there is no consultation with the local community. Lack of consultation with the local community always results in local resistance whereby the community members do not co-operate, and in this case failure would be inevitable. Beside resistance from the local community, other factors such as water and soil conditions are critical to the success of the program. Botha *et al.* (2006:12) conducted a study on 65 outreach nursery programmes in South Africa and found that progress was hindered by biophysical problems (e.g. lack of water, poor soil conditions) as well as harsh socio-economic conditions facing most communities in which nurseries were established. These nurseries were distributed in the eight provinces.

Agroforestry: The World Agrofrestry Centre (ICRAF) defines agroforestry as a collective name for land-use systems and technologies where woody perennials

(trees, palms, shrubs, bamboos, etc.) grown on the same land management unit as agricultural crops and/or animals, either in some form of spatial arrangement or temporal sequence. The establishment of agro-forestry systems in regions like the Eastern Cape could be one of the most important sources of fuelwood for domestic consumption in many areas in the region. Food and Agricultural Organization (2002:8) points out that in the tree-rich savannah veld of South Africa, such as parts of the Eastern Cape, Kwa-Zulu Natal, the Lowveld, Bushveld in the Northern Province and the Kalahari where livestock farming is practiced, trees are protected for the production of additional fodder for the drought season, as a source of fencing material and firewood, for stabilizing soil, for providing shade and for general environment conservation purposes.

Arnold and Dewees (1997:90) further states that other forms of tree cultivation involves the cultivation of blocks of nitrogen-fixing trees to restore agriculturally taxed soil, with side benefits of fuelwood and fodder, in the kikar (*Acacia Karoo*)-based hurries of Pakistan's Sind Province. The advancement of agroforestry practices could promote sustainable land use by incorporating wood energy development as an additional strategy in the respective agroforestry extension programmes. Where there is a need for increasing woodfuel production on farmers' land, both for initiating production and improving current production, extension is a tool to meet this goal (APAN-RWEDP, 1995). Kürsten (2000:42) views the existence of a fuelwood market as a basic precondition for attempts to develop sustainable land use systems that integrate trees on arable or pasture land (agroforestry). Increased production for fuelwood is driven by the acute scarcity of this form of energy and a need to reduce CO_2 emissions due to the global warming problem.

Agroforestry systems not only play a role in carbon emissions reduction and fuelwood production, but also play a very important role in soil protection and provision of additional products such as posts and materials for construction. Also with this system, there are financial benefits whereby the combination of

agricultural crops with trees for fuelwood production can bring higher profits in the community (Arnold & Dewees, 1997:34).

Woodlots: Common property resources are important sources of timber, fuelwood and grazing land in developing countries (Gebremedhin *et al.*, 2000:32). The same applies to the Limpopo province where the rural communities in and around the plantations depend on community woodlots for the provision of products like fuelwood, poles, fodder, fruits, etc. This is not always sustainable since devolving right to local community may result in exploitation of common property resource. Under unrestricted access by community members, or ineffective use regulations, these resources are exploited on a first-come, first-served basis (Gebremedhin *et al.*, 2000:89). As a point of view, to prevent exploitation of common property resources, a balance is needed between access and needs of the community.

The other solution may be the devolution of these natural resources to the community resource management institutions and organizations. Community resources management institutions are now receiving greater attention as a viable alternative to regulation by the state or privatization as a means of rectifying inefficiencies caused by attenuated property right systems, externalities, and other market failures (Gebremedhin *et al.*, 2000:66).

2.16 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, 1999:32). Families living in close proximity to forests see a larger fraction of their energy mix comprised of wood fuel than do those located further from forested areas. A study conducted in urban India by Bowonder *et al.* (1985:4) found this pattern to hold true even for high-income households.

2.16.1 Climate variation and energy demand

Populations living in colder climates tend to consume more energy that those in warmer regions (Eberhard and Van Horen, 1995:52). 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, 1999:52). 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, 2003:45).

2.16.2 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, 1987:9; Kaul and Liu, 1992:69). 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, 2002:32). Families living in close proximity to forests see a larger fraction of their energy mix comprised of wood fuel than do those located further from forested areas. A study conducted in urban India by Bowonder *et al.* (1985:49) 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).

2.16.3 Distance to market 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, 2002:78; Chaurey *et al.*, 2004:23). 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, 1999:42).

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, 2004:56). 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.

2.17 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, 2004:456).

Bensel and Remeda (1993:6) 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 (1993:7) 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, 2004:54).

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, 2004:89). 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 (1990:52) 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, 1993:29). 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, 1993:52). 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, 2004:76).

2.18 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.

Regardless of the considerable electrification by the government, firewood still remains the main primary source of energy in rural communities. Over utilization

and continuous dependence on biomass resources will pose a major threat to biomass resources. There is therefore a growing concern for both the government and community organizations to put in place ways and plans to overcome firewood scarcity. Programmes such as tree planting by both the government and communities could bring about sustainability in the collection and use of firewood. The following chapter presents the geography of Limpopo Province and the role of woodlands in the province. It also presents the methodology that was followed in the collection of data for the purpose of the study.

3.1 Introduction

The aim of this chapter is to discuss the research design and the process of investigation based on the two research paradigms, namely the quantitative and the qualitative research paradigms (Leedy, 2004:89). A suitable research paradigm for this study was selected after the two paradigms were studied and discussed. A justification for the research paradigm chosen is provided. The data collection method including ethical measures is discussed. The procedure employed for data analysis is provided. In general, this chapter will 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 The study area

The study was conducted in Nweli village of Thulamela Local Municipality, Vhembe District. Nweli Village experienced the problems and challenges of firewood scarcity and domestic energy used.

3.3 Research Methodology

Research methodologies refer to the rationale and the philosophical assumptions that underlie a particular study (Leedy, 2004:23). This is therefore, informed by both quantitative and qualitative approaches. Philosophically, its arguments are underlined by inequalities of water services.

3.3.1 Quantitative research methodology

Quantitative research tends to be associated with measuring (Barnes, 1992:108). According to Good (1993:279) as well as Denzin and Lincoln (1994:4), quantitative studies emphasise the use of numerical measures to arrive at specific findings. Data collection in quantitative research is accumulated by means of inanimate instruments such as scales, tests, surveys, questionnaires and computers (Storbeck, 1994:73). Creswell (1994:4) is of the opinion that because quantitative research is impersonal and experimental it is not suitable to study human phenomenon.

Quantitative research methods include the implementation of statistics to measure data. Statistics, according to Leedy (1993:244), are a very simple matter but are a powerful tool in the hands of the researcher who is able to view their nature and interrelationships more understandably. Through statistics, therefore the researcher is able to conceptualize what otherwise might be incomprehensible (Leedy, 1993:244) hence the advantages of this study. The facts gathered from questionnaires were translated into tabular from. This was done so that the facts (statistics) would speak more clearly.

3.3.2 Qualitative research methodology

De Vos (2001:240) defines qualitative research as a multi-perspective approach making sense of interpreting or reconstruction this interaction in terms of meanings that the subjects attach to it. This approach deals with data that are principally verbal. It is the approach in which the procedures are not as strictly formalized as in quantitative research and the scope is more likely to be undefined and a more philosophical mode of operation is adopted. It aims at understanding and interpreting the meanings and intentions that underlie everyday human action. Qualitative researchers maintain that many natural

properties cannot be expressed in qualitative terms; they will lose their reality if expressed simply in terms of frequency (Kincheleo, 1991:143).

Qualitative methodology refers to research which produces descriptive data: generally no numbers or counts are assigned to observations. The indispensable condition or qualification for qualitative methodology is a commitment to seeing the world from the point of view of the actor (the participant). Because of this commitment to see through the eyes of one's subjects, close involvement is advocated (Bryman, 1984:78).

Creswell(1998:12) states that it is clear that in qualitative research one gets closer to the people, talks to them and tries to get into their subjective feelings to understand the reasons why they do what they do. Reality is, therefore, subjective and one seeks to understand phenomena. Concepts are in the form of themes, motifs and categories. The research design is therefore flexible. Inductive logic is employed in the quest to derive meaning from subjects. These are meanings people attach to everyday life. Applied qualitative methodologies allow the researcher to know people personally and to see them as they are, to experience their daily struggles when confronted with real situations. Using a qualitative research methodology, the researcher interprets and describes the actions of people when confronted with life situations.

Based on the qualitative research methodology, the researcher designed and compiled semi-structured interview questions in order to collect information from Nweli community. In this regard information was collected through the use of questionnaires. The qualitative research methodology was used because it provides a framework for a subject to speak freely out in his or her own terms about a case which the researcher brings to the interaction.

3.4 Population of the study

Best and Kahn (1993:13) define a population as any group of the individuals that have one or more characteristics in common that are of interest to the researcher. The population may be all the individuals of a particular type, or more restricted part of that group. A population is defined by Wimmer and Dominick (1988:57) as a group or class of subjects, variables, concepts or phenomenon. The target population in this study was all the Nweli community who experienced the challenges of firewood scarcity.

3.5 Sampling technique

Nweli village in the Thulamela municipality area was purposely selected for this study. Nweli was selected because it has been subjected to a variety of environmental impacts in the past few years. In the study area there are about 80 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 40% 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 (1-80), 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 30 households which formed part of the respondents.

3.6 Method of data collection

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, 2000:6). In conducting the survey, participatory approaches were used to collect information for this study.

3.6.1 Questionnaire survey

For many good reasons, the questionnaire is the most widely used technique for obtaining information from subjects (McMillan and Schumacher 2001: 257). Furthermore, McMillan and Schumacher (2001: 257) note that a questionnaire is relatively economical, has the same questions for all subjects and can ensure anonymity. 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.

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 included characteristics such as attitude and perceptions of local people in the village on community woodlots, afforestation and tree planting. The approach also helped in overcoming misunderstanding or misinterpretation of words and questions. In this case the researcher ensured that the respondent understood 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.

3.7 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.

3.8 Ethical issues and procedures

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 questionnaires 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 aloud to all participants and they were given an opportunity to confirm whether they understood the contents by signing or drawing a cross at the end of the letter.

3.9 Conclusion

This chapter outlined a background in terms of the study area investigated and the methodology used to collect the data. The Nweli village is actively involved in the consumption and poor management of natural resources. Most of the

respondents are women in both study sites 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 chapter that follows presents results that were obtained through analysis of the collected data.

4.1 Introduction

The previous chapter focused on the research methodology and on how the research was conducted. In this chapter, the findings of the study are discussed. The aim of this study was to gain a deeper understanding of the impacts and challenges faced by the communities regarding firewood scarcity in Thulamela Municipality of the Vhembe District. As discussed in the previous chapters, data for this study was collected by means of field observation and questionnaires. The data was then transcribed and analysis was done by means of content data and statistical analysis. Categories and themes emerged throughout the analysis process.

4.1 Biographical information of the respondents

Table 4.1: gender status of the respondents

	Frequency	Percentage
Male	14	47%
Female	16	53%
Total	**30**	**100%**

Out of the 30 responses the observations made were that 14 were males and 16 were females which constitute 53% and 47% respectively while 2% of respondents had not indicate their gender (See table 4.1). This means that males were in majority and the two local municipalities had to recruit more females to participate in ward committee structures and municipal governance. In addition, the 50/50 male and female ratio as required in terms of Project Consolidate is not yet achieved by the municipalities.

Table 4.2: 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 4.2).

Table 4.3: Employment status of the respondents

	Frequency	Percentages
Full time	3	12
Part time	4	13
Unemployed	19	62
Pensioner	4	13
Total	**30**	**100**

In terms employment status the majority of the ward committee members were unemployed, that is, 62%. Ironically, 25% of the respondents were employed although the majority of this category was employed on a part-time (i.e. 14% and 11% full-time employed). In addition, pensioners constitute 13% of the total number of respondents (See Table 4.3).

Table 4.4: Educational information of the respondents

	Frequency	Percentages
Below matric	14	48
Matric	6	19
Diploma	7	23
Degree	3	10
Total	**150**	**100**

The responses from the respondents have shown that the majority (55%) had no matriculation certificates. Only 19% of the respondents had passed Matriculation exams, and those that have diplomas constituted 7% and those with degrees made 5% of the total number of respondents (See Table 4.4). However, 14% of the respondents did not respond on the question which could be because they did not understand the question or had no education at all.

4.3 Impacts and challenges of firewood scarcity in Nweli Village

Table 4.5: communities utilise forestry resources without the knowledge of conserving the nature

	No of Respondents	**Percentages**
Strongly Agree	12	40
Agree	7	25
Unsure	2	5
Disagree	6	20
Strongly Disagree	3	10
Total	**30**	**100**

Table 4.5 shows that 20 respondents constituting 65% of the total sample agreed that communities utilise forestry resources without the knowledge of conserving the nature, something which could be supported by the fact that communities were not trained on nature conservation so the majority of the respondents could

fall in the trap of lacking that knowledge. 2 respondents constituting 5% of the total sample are not sure due to lack of knowledge, while 9 respondents constituting 30% of the total sample disagreed that communities utilized forestry resources without the knowledge of conserving the nature and this attributed by the fact that communities lack the necessary knowledge of nature conservation

Table 4.6: Lack of security forest guard encourages timber theft by communities

	No of Respondents	Percentages
Strongly Agree	12	40
Agree	8	30
Unsure	2	5
Disagree	5	15
Strongly Disagree	3	10
Total	**30**	**100**

In view of table 4.6, 21 respondents constituting 70% of the total sample agreed that, indeed lack of security forest guards encourage timber theft by communities, something which is encouraged by the absence of indigenous trees which were a source of wood, but in the absence of such indigenous trees, communities resort to stealing timber. 2 respondents constituting 5% of the total sample are not sure of what was materializing due to lack of knowledge, while 8 respondents constituting 25% of the total sample disagreed that lack of security forest guards encouraged timber theft by communities, the notion which could be based on the facts that certain respondents lack the knowledge of what actually materialized at the plantations and how forests guards monitor the timber plantations.

Table 4.7: No one to identify wood collected, either dry or not

	No of Respondents	Percentages
Strongly Agree	9	30
Agree	8	26
Unsure	3	10
Disagree	6	20
Strongly Disagree	4	14
Total	**30**	**100**

Strong monitoring of wood through identification is very important if forests are to be managed in proper way. Table 4.7 reveals the opinion of the sampled respondents differently. According to this table 17 respondents constituting 56% of the total sampled agreed that there is no one mandated to identify wood collected, either dry or not, and that could be based on the fact that there were no people to do that exercise. 10 respondents constituting 34% of the total sample disagreed that there was no one to identify wood collected, either dry or nor, something which could be based on the 10% of the total sample were not sure of what was materializing. Those respondents knew nothing about the issue of identifying wood collected.

Table 4.8: There are more challenges facing training for fire protection association members.

	No of Respondents	Percentages
Strongly Agree	12	40
Agree	7	25
unsure	3	10
Disagree	5	15
Strongly Disagree	3	10
Total	**30**	**100**

Table 4.8 shows that 20 respondents constituting 65% of the total sample agreed that there are more challenges facing training for fire protection association members, and that could be due to the shortage of funds for training the members concerned and unless funds are made available the challenges is likely to remain. 3 respondents constituting 10% of the total sample are not sure, something which could be based on ignorance of the respondents concerned, while 8 respondents constituting 25% of the total sample disagreed that there are more challenges facing training for fire protection association members, and that could be based on the lack of information of the respondents concerned.

Table 4.9: Nweli community use gas as a source for the domestic purposes

	Frequency	Percentage
Strongly agree	3	10
Agree	5	15
Unsure	1	5
Strongly Disagree	3	10
Disagree	18	60
Total	**30**	**100**

Table 4.9 reveals that 21 respondents which constituted 70% of the total sample disagreed that Nweli community used gas for domestic purpose, the idea which could be based on the fact that the majority of the people were poor and in most cases they used firewood for cooking. 1 respondent who constituted 5% of the total sample was unsure of whether Nweli community used firewood for cooking or not something which could be based on the lack of information of the community members concerned. The fact that 8 respondents which constituted 25% of the total sample agreed that Nweli community use gas for domestic purpose clearly confirms lack of information to a certain section of the community.

Table 4.10: Nweli community use self gathering as a method to acquire firewood

	Frequency	Percentage
Strongly agree	9	30
Agree	11	35
Unsure	3	10
Strongly Disagree	3	10
Disagree	4	15
Total	**30**	**100**

Table 4.10 confirms that 20 respondents who constituted 65% agreed that Nweli community use self gathering as a methods to acquire firewood, and this could be based on the fact that people are poor and have no other alternative to gather firewood. 7 Respondents who constituted 25% of the total sample disagreed that Nweli community use self gathering as a method to acquire firewood, and this could be based on the fact that certain members of the community are ignorant of what is materializing in the community. 3 Respondents constituting 10% of the total sample are surprising as community members lack information of what information of what if happening in Nweli village.

Table 4.11: 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 4.611 shows that 66% used paraffin for cooking, while 17 % of the participants disagreed with the idea .10% strongly disagreed while 7% of the

respondents agreed with the statement and this indicates that the majority of the respondents have problem of electricity.

Table 4.12: 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 4.12 reveals that 63% of the respondents strongly agreed that people use firewood for cooking while 13 %disagreed whereas 10%stronly disagreed. 7% of the respondents were unsure meanwhile 7% of people agreed that they use firewood for different domestic purposes. The 10%of the respondents who strongly disagreed could be those who had electricity.

Table 4.13: 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 4.13 the majority of the respondents strongly agreed that electricity supply is a problem in the village and this suggest that the majority of the respondents did not have electricity. 17% of the respondents strongly disagreed that there was a problem of the electricity supply in the village and this

could be because of 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 agreed that there was indeed a problem in the electricity supply while 3% of the respondents disagreed and moreover 3% were unsure and this could be the problem of lack of information around those respondents

Table 4.14: 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 4.14 indicates that 73%of the respondents strongly agreed that firewood was another source of energy. The fact that 7%of the respondents strongly disagreed could be an indication that those respondents have electricity and have nothing to do with firewood, The table further illustrate that 7% of the respondents agree that fire wood was another source of energy while 3% disagreed .The fact that 10% of the respondents were unsure could be a clear indication that some people are ignorant of what is taking place in the area

Table 4.15: 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 4.15 shows that 66% of the respondents strongly agreed that deforestation was another problem against 10% of the respondents who disagreed and strongly disagreed, this could be the fact that 10% of the respondents who have electricity were against the 66% of the respondents who experienced problems of getting firewood on a daily basis. The 2 % of the respondents who were unsure could be having a problem of lack of information.

Table 4.16: 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 4.16 reveals that 70 % of the respondents and other people did have electricity while others didn't have while 7% of the respondents disagreed this is a clear indication the majority of the people did not have electricity the 10 percent of the respondents were unsure and this could be based on ignorance 7% of the respondents disagreed while 13 % agreed and in view of this percentage one could conclude that the majority of the respondents did not have electricity

Table 4.17: 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	**30**	**100**

Table 4.17 indicates that electricity was an issue in this village as revealed by 73% of the respondents' who strongly agreed that electricity was a very serious issue here. In view of the opinion of the respondents it was clear that electricity could be the real issue. The fact that 10% disagreed and 7% strongly disagreed could be the fact that very few people had electricity in this village. The 3% of the respondents who were unsure revealed the ignorance of the people in the community.

Table 4.18: Solar energy is another source of energy.

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

Table.4.18 shows that 70% of the respondents used solar as a source of energy. The fact that 7% disagreed and strongly disagreed could be the fact that certain people were indeed ignorant in the community. The agreement by 13% of respondents corroborated with the idea that indeed solar was a source energy.

Table 4.19: Financial constrain is another serous 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 4.19 reveals that 66% of the respondents agreed that financial constrain was a serious problem to those who had 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 disagreed and strongly disagreed reveals that the minority of the people had electricity. The agreement by 10% reveals that indeed financial constrain was a serious issue and it corroborated well in this passage while 10 % of the respondents who were unsure confirmed the ignorant of another section of the people in the community.

Table 4.20: 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.4.20 shows that 63% of the respondents strongly agree that poor maintenance of electricity supply system causes shortage of electricity. Although

7% of the respondents were unsure of the prevailing developments in the area, the issue of poor maintenance was also corroborated by 7% of the respondents who agreed that indeed poor maintenance of electricity supply system causes shortage of electricity. 13% 0f the respondents who strongly disagreed and 10% who disagreed could be because of the fact that those respondents did not have any problem of electricity at all.

Table 4.21: 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 4.21 reveals that 63% of the respondents strongly agreed that wood collection was another form of saving electricity and this was also corroborated by 10% of the respondents who also agreed that indeed wood collection is an alternative of saving electricity. The 10% of the respondents who strongly disagreed and at the very same time disagreed shows that a certain section of the community had access to electricity and they had no problem whatsoever to pay electricity bills.

Table 4.22: 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	**30**	**100**

Table 4.22 shows that 76% of the respondents strongly agreed that women and children were responsible for fire wood collection, while 7 of the respondents strongly disagreed. The difference in one way or another shows that women and children carried 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 were unsure revealed the ignorance surrounding certain section of the community.

Table 4.23: 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 4.23 shows 67% of the respondents strongly agreed 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

disagreed and 7% disagreed confirms lack of knowledge of the respondents who could afford to pay electricity.

Table 4.24: 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 4.24 reveals that 60% of the respondents strongly agreed 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 disagreed and 10% disagreed could be the fact that those who can afford knew very little about the plight of poverty affecting people.

Table 4.25: 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 4.25 indicates that 73% of the respondents strongly agreed and 10% agreed 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 disagreed and disagreed clearly demonstrates the fact that those who afford know little about the poor and the 3% of the respondents who were unsure reveals the acute ignorance affecting certain people in the study area.

Table 4.26: 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, 26 shows that 70% of the respondents strongly agreed and 13% agreed that lack of energy impacts negatively on the socio- economic development of the people in this study area. The fact that 3% strongly disagreed and 7% disagree could be the manifestation of the lack of compassion on the side of those who could afford to buy electricity on a day to day basis.

4.4 Conclusion

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 were 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.

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 travelled 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.

Nweli village 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 collected 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 could 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 had 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 Recommendation

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 and 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.

- 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.

5.4 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 found 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.

5.5 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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Please make a tick in the appropriate block for each of the following statement

SECTION A: BIBLIOGRAPHIC INFORMATION

1. Gender

Male	
Female	

2. Home Language

Tshivenda	
English	
Afrikaans	
Tsonga	

3. Marital Status

Single	
Married	
Separated/ Divorce	

4. Employment Status

Full employed	
Part-time employed	
Unemployed	
Pension	

5. Educational level

< Matric	
Matric	
Diploma	
Degree	

Section B: Impacts of Firewood Scarcity in Nweli Village

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

	Strongly agree	agree	uncertain	disagree	Strongly disagree
Impacts and challenges of firewood scarcity in Nweli Village					
Firewood is the dominant energy source in Nweli village					
Fuelwood is the main source of primary energy in Nweli Table village					
Consumption of fuelwood in the village has led to a variety of environmental problem					
Nweli community use gas as a source for the domestic purposes					
Nweli community use self gathering as a method to acquire firewood					
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. Table 4.18: 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 t					
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.					
A high cost of electricity units prevents people to buy electricity.					

Thank you for your Participation

An investigation into the challenges and the management of firewood scarcity on rural livelihood in Limpopo Province, Vhembe District: A case study of Nweli Village

BY

NEMBAMBULA ALUVHAVHI ALICIA
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Mini Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of
MASTER OF PUBLIC MANAGEMENT
In the
SCHOOL OF MANAGEMENT SCIENCES
At the
UNIVERSITY OF VENDA

Supervisor: Prof M.P Khwashaba

2012

DECLARATION

I, **NEMBAMBULA ALUVHAVHI ALICIA** hereby declare that the dissertation for the degree of Master of 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.

AA Nembula .... 18-09-2012 ....

Signature **Date**

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- My Friend , Ramulongo Mbulaheni for her support and continuous motivation and;
- Mrs. J.R. Ramagoma for typing this dissertation accurately and professionally;

For all these people my thanks are due.

On my personal note, I dedicate this project to my parents, the late Mr. Stephan Nembambula and Mrs Elinah Thivhonali Nembambula, You were there for me all the way.

This study was conducted in the rural communities of Nweli 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 50 randomly selected households in villages. 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 used 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 scarcity of firewood on their livelihoods. 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, questionnaires survey.

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 therefore firewood scarcity is the major predicament in Nweli village.

CHAPTER 2: LITERATURE REVIEW

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

CHAPTER 4: DATA PRESENTATION, INTERPRETATION AND ANALYSIS

CHAPTER 5: FINDINGS, RECOMMENDATIONS AND CONCLUSION

LIST OF THE TABLES

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

1.1 Background of the study

Firewood is the dominant energy source throughout Southern Africa and the rest of the developing countries (Gielink *et al.*, 1991:8; Hall, 1992:8 & Pandey, 2002:90). 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 (Leach & Mearns, 1989:34).

In Southern Africa firewood accounts for 60 to 69% of the total energy consumed having the highest proportions in the poorest countries (Leach & Mearns, 1988:67). According to Arnold and Jongma (1977:89), 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 m^3 (Agrawal, 1986:66), and it accounts for 58% of the total energy used in the continent (Bogach, 1985:12).

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.

Forest patches in parts of Vhembe district and other rural areas is declining at an accelerated rate because consumption is increasing at an alarming speed with population growth, however addition to supply through new growth are declining in proportion to the amount of available woody vegetation in each specific areas

(Fairhurst *et al.*, 2000:12). The consumption of firewood has been discussed in literature on world development in recent years, but little was known of firewood consumption and collection behavior in Vhembe district, where the majority of households still depend on firewood for most or all of their cooking and heating needs (Nethengwe, 2007:78).

The South African energy sector has the characteristics of both the developed and developing countries. On the other hand South Africa produces and consumes over 60% of the electricity on the African continent and it is amongst the highest emitter in the world (Shackleton *et al.*, 2003:90). More than half the populations of South Africa's rural households consume firewood energy to a greater or lesser degree. South Africa has the lowest electricity prices in the world to consumers; most newly electrified households continue to use firewood because they cannot afford the appliances and the monthly costs (Howells *et al.*, 2005:66).

The use of firewood offers both advantages and disadvantages. In terms of the national priority on poverty reduction, it is needed to optimize the opportunities and minimize the difficulties. On the one hand firewood is a renewable resource. If it is managed and harvested properly it will continue to meet the energy needs of the rural and peri-urban poor for many years to come (Brown, 2010:21). Women and children collect firewood for domestic purposes while men are concentrating on marketing of firewood. Typically the poorest and most vulnerable communities and households make use of firewood at the expense of other forms of energy.

The use of firewood has both health and environmental problems. This will include the opportunity costs which are associated with harvesting of firewood and poor households tend to experience the higher risk respiratory disorder associated with the higher use of firewood or charcoal (Food and Agricultural Organization, 2002:67). These kinds of health and environmental problems are

very common in peri-urban societies where cooking fires are normally made in poorly ventilated houses/shacks. In rural areas the majority of households make cooking fires outside, where the smoke from the fire would be blown away easily and for this reason health hazards is reduced in the process. The other health problems are associated with the carrying of large bundles of wood where people can sustain some physical injuries.

From the environmental point of view the unsustainable harvesting of trees lead to the reduction or loss of biodiversity which tend to worsen the rate of local poverty in that specific area. If specific intervention is to be made in trying to alleviate poverty in that particular area through the national firewood programmes such programme must try to minimize these potential health and environmental problems.

Such challenges are not exclusive to South Africa therefore roughly 60% 0f the energy consumed in Southern Africa is generated from firewood or charcoal and the total number of people who are dependent on biomass fuels in Southern Africa is estimated to increase by as much as 50% in the next two decades (Biggs *et al.,* 2004:4). Therefore it is important for South Africa to learn from its neighboring partners whilst at the same time leading the way on managing some of its most precious and vulnerable forest resources, so that they too also cater for generations to come. According to Shackleton (2003:1) and Biggs *et al.* (2004:32), the primary source of firewood comes from the woodland biome which covers about 34% of South Africa, and is home to over nine million people. Other sources of firewood include indigenous forest, community woodlots, off-cuts from commercial plantation forestry and trees that are growing in and around people's fields and residential plots.

1.2 Problem Statement

Environmental Conservation Amendment Act 98 of 1991 provides the effective protection and controlled utilization of the environment and for matters incidental thereto. This act is not effect because in all rural areas including there is an increasing demand for firewood at Nweli 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.

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.

Because of the increasing pressure on wood availability it tends to influence the distance travelled and time taken to collect wood has also increased. Women and children in the area tend to walk more than one kilometer and spent about 2-5 hours per day to harvest firewood. In future, the demand for firewood will be high because of the increasing population growth and un-affordability of alternative energy resources as a result of poverty. This has posed a serious threat to the survival of highly preferred tree species with practices such as excessive pruning leading to the whole-destruction of valuable plants, which will occur more frequently in the future.

Firewood is a very important energy source for extensive part of the world population, especially in developing countries. The gathering of scale and

uncontrolled quantities of fuelwood frequently has a negative impact on the fuelwood resources, mainly in poorly managed natural forests. The knowledge on firewood status is of greater importance, because it is without delay linked to the long-term conservation of forest and other fuelwood sources.

1.3. Research Objectives

The research objectives will be discussed under general and specific objectives.

1.3.1 General Objective

To investigate the challenges and the management of firewood scarcity on rural livelihood and the environment in Nweli Village

1.3.2 Specific objectives

- To determine the main uses of firewood material in Nweli village
- To determine the environmental status of the woodland vegetation
- To determine the consequences of firewood shortages on rural livelihood and environment
- To establish the coping strategies to solve the problem of firewood shortages in the community

1.4 Research Questions

- Which primary activities require the use of firewood as the main source of energy?
- How severe is the environmental condition in the area?
- What are the consequences caused by firewood scarcity on rural livelihoods and environment?
- What can be done to address the potential problems?

1.5 Research Hypothesis

- Firewood scarcity is the major impact of the land and environmental degradation;
- Firewood scarcity impacts on the productivity of women and children in Nweli village;
- Rural communities depend on firewood for the domestic energy such as cooking
- Low proceeds generation cause high demand allotment of the firewood for energy use

1.6. Significance of the study

Some research work have been done on fuelwood and its impact on livelihoods of the rural people, and the challenges that are faced in implementing land restitution, but not many of these studies were focusing on fuelwood as a scarce resource, its impacts on the environment and rural livelihood. Firewood has become a pillar of strength as the primary source of energy in rural areas particularly in Africa, where the majority of its people live in abject poverty. Central to this, women and children are the major role players in making sure that firewood is available for energy purpose to improve the livelihoods.

People of Nweli village have been as dependent on firewood as their primary source of energy for many decades, but they pay no attention on the scarcity of this resource and its associated environmental impacts. Therefore, this study dwelt much on firewood as a scarce resource and its impact on the environment and rural livelihoods. After the findings of this research the researcher initiated a community based organization which looked closely to issues that concern the environment and in the process improving the livelihood of people particularly women and children.

1.7 Delimitation of study

This study primarily focused on the challenges of the scarcity of firewood fuel and its impacts in rural areas in particular Nweli village in Thulamela Municipality Limpopo Province. The research was to cover the period from 2010 to 2011. The study itself would not touch other villages in Thulamela Municipality except Nweli village, though other areas might be having other challenges of firewood fuel use, but this study would focus directly to Nweli 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 firewood 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 Nweli village. Inaccessible roads within Nweli village could also prevent thorough assessment of factors affecting domestic use.

1.9 Brief summary of literature review

The south African government through the Department of Water Affairs and Forestry (DWAF) after realizing the current status of non-compliance with the National Forest Act and the National Veld and Forest Fire Act and its failure to enforce the law according to the legislative requirements, the department has decided to take action in a more effective and holistic compliance and

types that might be used by households as their prosperity increases. The energy ladder fuel order corresponds with increased technological efficiency, decreased CO2, SO2 emissions and particles, and increased capital cost (Meikle and Bannister, 2004:42).

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, 1999:31). Families living in close proximity to forests see a larger fraction of their energy mix comprised of wood fuel than do those located further from forested areas. A study conducted in urban India by Bowonder *et al.* (1985:13) found this pattern to hold true even for high-income households.

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 (Najam and Cleveland, 2003:3). 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, 2002:7; Mahat, 2004:89). 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) (Cecelski, 1984:65; Pearce, 2005:43). 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 (Barnes, 2000:56). The degradation of soil quality is one of the major causes of food insecurity (OECD, 2002:78).

Status of Limpopo woodland

The woodland vegetation in South Africa covers approximately one third of the total land area. Commonly referenced classification systems identify a great number of woodland types, attributable to the diversity and geographical range of this biome (Wills, 2000:78). Furthermore, land covered by woodland is owned and managed by a diverse and range of role players. The current status of this resource is not well developed and the role of different service providers in government and non-government sectors are poorly understood. The natural forests and woodlands benefit the communities by providing tangible and non tangible goods and services. Trees and tree products of the woodlands and forests play an important and often under-estimated role for rural communities, and are central to their lives (Timberwatch, 2000:90). Figure 2.1 shows the distribution of woodlands vegetation in Limpopo province.

Plantations and natural forests are recognized as playing a crucial role in addressing some of the biggest challenges in South Africa at the moment, namely poverty reduction and job creation. Increasing poverty, over-utilization, HIV/Aids and climate change have been noted as the greatest influence on the state of forests (Department of Water Affairs and Forestry, 2005:9).

Studies from South Africa

According to Shackleton *et al.* (2003:9), fuelwood availability and use in the Richtersveld National Park, South Africa, the deadwood availability was assessed per woody species and on the ground in 12 transects within the riparian fringe. Herders were interviewed concerning their species favorite and the composition of woodpiles was examined. The outcome has showed that there was no relationship between the percentage of the attached deadwood on the tree, and the percentage deadwood ground cover, and the distance from the herder stockposts. On the availability deadwoods that were surveyed *Euclea*

pseudobenus and *Tamarix usneoides* were the dominant species in the riparian border. However there was a strong selection for *Ziziphus mucronata as* fuelwood species and only marginal or random selection for *Euclea pseudobenus. Tamarix usneoides* and *Prosopis* species were abundant in the riparian border, but were not used as firewood. The result also indicated a significant difference between species with respect to the mean proportion of the stem that was dead, the highest being *Ziziphus Mucronata* (Buffalo thorn) amounting to 28% deadwood followed by 12% of *Tamarix usneoides* and most of the *Prosopis* species had no deadwood.

1.10 Definitions of the Concepts

- **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 is needed for fulfilling basic human needs such as cooking, heating and lighting (Kammen, 2006:56).

1.11 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, Impacts of firewood scarcity into the environment, Domestic energy supply in Nweli Village, population and the demographic situation, The energy sources and their impacts in the Developing World, 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.

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 Forest/woodlands policy framework in South Africa

The South African government through the Department of Water Affairs and Forestry (DWAF) after realizing the current status of non-compliance with the National Forest Act and the National Veld and Forest Fire Act and its failure to enforce the law according to the legislative requirements, has decided to take action in a more effective and holistic compliance and enforcement model referred to as the strategic and cooperative enforcement (Department of Water Affairs and Forestry, 2005:9).

The proposed model presents a move away from the enforcement which depends on traditional detection method by bringing new innovative and alternative compliance and enforcement options. When looking at the alternatives of withdrawal, zero tolerance as they continue presently, the new model of strategic and cooperative enforcement presents an affordable and effective way of reorganizing and securing regulatory compliance of the National Forest Act (no.84 of 1998) and the National Veld and Forest Fire Act (no. 101 of 1998). This new model has a strong emphasis on cooperative governance and cooperative enforcement to strengthen the enforcement competency of the department and ensure the principal use of the available enforcement resources (Department of Water Affairs and Forestry, 2005:3).

According to the Department of Water Affairs and forestry (2005:6), the policy will serve to respond to situations where there is steady loss of forest resources in South Africa and where the unacceptable level of veldfires risk occurs, regardless of the regulative provisions in these Acts. This situation contributes to a loss of biodiversity based on livelihoods opportunities among the poorest of the poor as well as undermining the development. As a result, South Africa is experiencing problems of environmental degradation as well as lost livelihood and economic opportunities based upon natural resources. The policy itself aims to iron-out the requirement to promote sustainable development and the sustainable utilization of natural resources via the statutes as the instrument of policy.

The National Forest Act together with the National Veld and Forest Fire Act has specific prescriptive elements, as well as the legal frameworks that allow relevant role players on their own, collectively, or together with the government to find common ground on specific issues or to make some improvements appropriately needed in their activities to comply with the proposed policy. It is the combination of the statutory prescription and statutory enablement that makes it possible for the department of water affairs and forestry to have good policies to support

adequate compliance with the Acts, with the necessary enforcement of the minimum prescriptive standards, which include the provision for the promotion of sustainable forest management in the National Forest Act.

2.3 Status of Limpopo woodland

The woodland vegetation in South Africa covers approximately one third of the total land area. Commonly referenced classification systems identify a great number of woodland types, attributable to the diversity and geographical range of this biome (Wills, 2000:67). Furthermore, land covered by woodland is owned and managed by a diverse and range of role players. The current status of this resource is not well developed and the role of different service providers in government and non-government sectors are poorly understood. The natural forests and woodlands benefit the communities by providing tangible and non tangible goods and services. Trees and tree products of the woodlands and forests play an important and often under-estimated role for rural communities, and are central to their lives (Timberwatch, 2000:89). Figure 2.1 shows the distribution of woodlands vegetation in Limpopo province.

Plantations and natural forests are recognized as playing a crucial role in addressing some of the biggest challenges in South Africa at the moment, namely poverty reduction and job creation. Increasing poverty, overutilization, HIV/Aids and climate change have been noted as the greatest influence on the state of forests (Department of Water Affairs and Forestry, 2005:9).

Woodlands play a crucial role in making sure that hundreds of millions of people in the Third World particularly in Africa are not suffering from hunger. In reality food security is very much dependent on environmentally accountable and sustainable use of the world's woodlands. People who are severely affected by challenge of food insecurity are the world's poor, particularly forest dwellers, subsistence farmers, landless households and livestock herders. Woodlands are

very important to these people because they are one of the most accessible productive resources available to them (Gbetnkom, 2007:8).

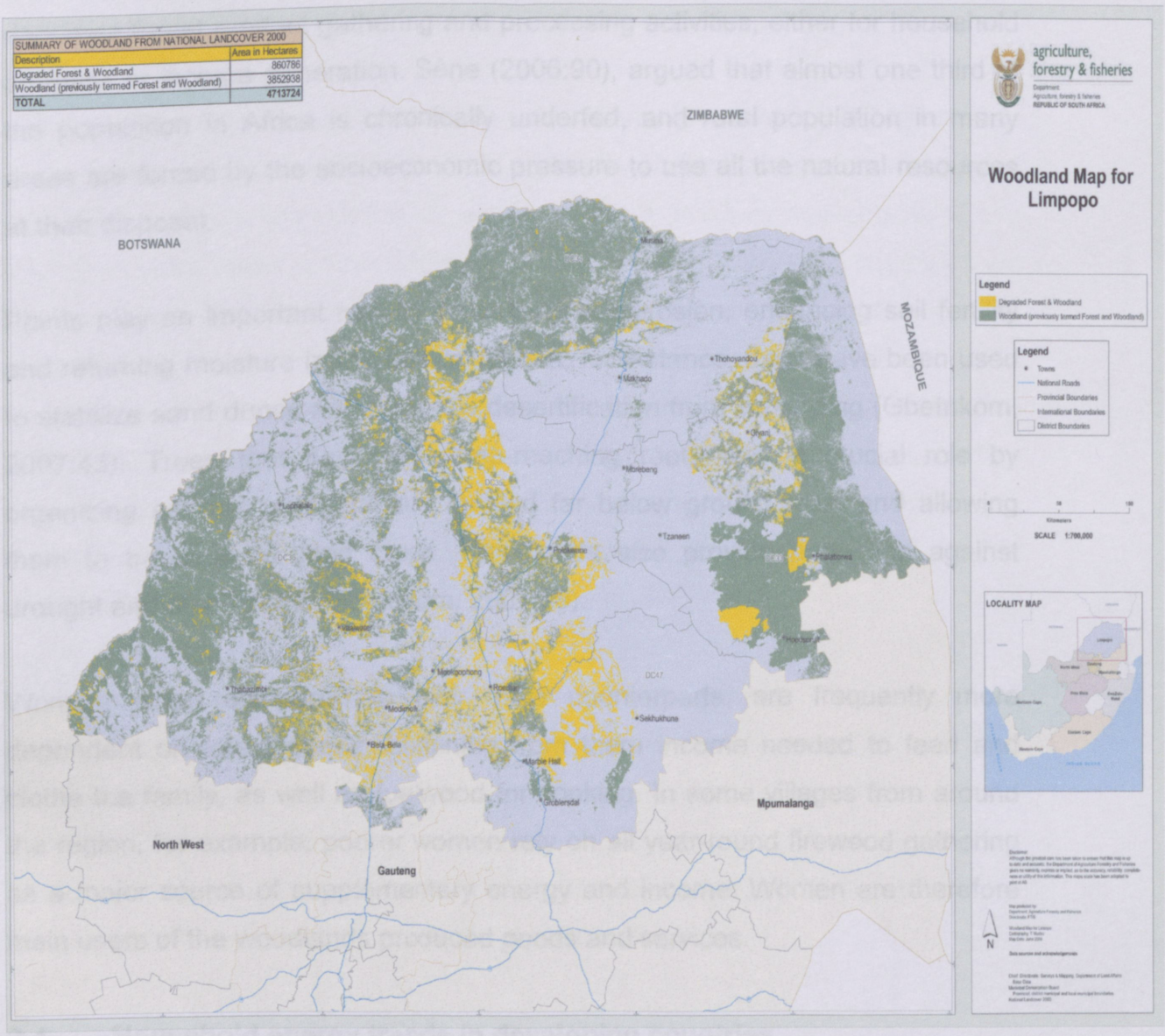

Figure 2.1: Distribution of woodlands vegetation in Limpopo province (Source: DWAF 2005)

Most countries of southern Africa are severely impacted by extreme poverty (Dorward *et al.*, 2004:23). People have a strong historical background of unrestricted access to woodlands. Poorer people thus have been able to make use of these forests for food, firewood and other profitable products. In areas

where people are not denied the opportunity to practice forest gathering activities (cultivation, fuelwood and livestock grazing), they tend to depend on these activities to a greater extent for their survival. Poorer women are the ones who dominate forest product gathering and processing activities, either for household products or income generation. Sène (2006:90), argued that almost one third of the population in Africa is chronically underfed, and rural population in many areas are forced by the socioeconomic pressure to use all the natural resources at their disposal.

Plants play an important role by preventing soil erosion, enhancing soil fertility and returning moisture in the soil. In Algeria, for instance, trees have been used to stabilize sand dunes and minimize desertification from expanding (Gbetnkom, 2007:45). Trees that have got deep-reaching roots play a crucial role by organizing soil nutrients that are located far below ground level and allowing them to be used by food crops. Woodlands also provide protection against drought and crop failure (Gbetnkom, 2007:89).

Women, when compared to their male counterparts, are frequently more dependent on forest goods, obtaining from them income needed to feed and clothe the family, as well as fuelwood for cooking. In some villages from around the region, for example, poorer women rely on all year-round firewood gathering as a major source of supplementary energy and income. Women are therefore main users of the woodlands produced goods and services.

2.4 Household energy trends in developing countries

This section draws on the energy scholars and policy makers around the world who have devoted considerable effort to understanding household energy use in developing countries. In this section, the focus of attention will be on the energy ladder and fuel switching in developing countries. Household partial fuel switching is a temporary strategy, whereby a household switches to a new fuel,

but continues to use the old fuel as well, whereas with complete fuel switching; the old fuel is not used at all (Kgathi *et al.*, 1997:34). Complete household fuel switching is also known as an energy transition. The energy ladder is a scale, which rates the quality of household fuels (Chambwera, 2004:32).

It is important to understand these processes when investigating energy consumption patterns (Soussan *et al.*, 1992:43). Understanding the process of energy transition in households will require research into why available electricity services are not used in poor urban areas. The work on household energy draws on the concept of an energy ladder with solid fuels on the lowest rung, and kerosene, LPG and electricity on successively higher rungs (Jack, 2004:7). According to Meikle and Bannister (2004:90) the energy ladder represents fuel types that might be used by households as their prosperity increases. The energy ladder fuel order corresponds with increased technological efficiency, decreased CO2, SO2 emissions and particles, and increased capital cost (Meikle and Bannister, 2004:23).

Davis (1998:9) argues that South Africa generally supports the notion that households climb the energy ladder, as they grow wealthier. Households that make use of electricity are more likely to use clean cooking fuels (Davis, 1998:45). Urban dwellers are more likely to use cleaner technology as their income grows (Hosier and Dowd, 1987:23; Campbell *et al.*, 2003:45). Household energy types and consumption levels are determined by:

- Income
- Infrastructure
- Fuel availability
- Fuel prices
- Distribution network proximity
- Cultural preferences
- Demographic distribution

- Physical environment (urban or rural) (Davis, 1998:9).

The energy ladder studies by Leach (1992:34) and Smith *et al.* (1994:42) 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.*, 2004:7).

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, 1998:9 and Bernett, 2000:90). Leach (1987:12) 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, 1998:88). Most urban households tend to switch to more extensive electricity use after being connected the electricity grid (Davis, 1998:88).

In a study in South Asia, Leach (1987:9) 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 (1987:23) 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.*, 1990:53). Under these circumstances, fuel security is

the way that household energy is managed, and may prevent permanent energy transition (O'Keefe and Munslow, 1989:32).

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, 2003:45). 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, 2003:12). 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.*, 2000:12). In South Africa this transition has not been clearly defined, as diversity of energies has not declined in poor urban households (Madubansi and Shackleton, 2005:23).

With increasing affluence, households adopt new technologies and fuels that serve as partial rather than perfect substitutes for more traditional fuels (Masera, *et al.*, 2000:80; Leiwen and O'Neill, 2003:14). In poor urban China, for example,

biomass and electricity are the most common fuel types that are paired in households (Leiwen and O'Neill, 2003:34). 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, 1995:9).

Multiple fuel use has also been termed 'fuel stacking' (Masera *et al.*, 2000:89). Although poor households often use several fuels simultaneously, they generally shift towards the adoption of cleaner, more efficient energy sources as income rise. 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, 2004:9). Second, modern energy sources are usually expensive and thus are applied carefully for unique services such as radios and television for entertainment (Thom, 2000:88). 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, 1999:90).

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 (2002:8) 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.*, 2003:6).

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, 2002:09). 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, 2002:88; WEC/FAO, 1999:99).

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.*, 2000:77). 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.*, 2000:90; Saatkamp *et al.*, 2000:88).

Hosier and Dowd (1987:90) 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, 1987:90). 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, 1987:67). 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, 1987:78). An investigation of household energy choices for a sample of households residing in the city of Bangalore uses a bionomial logit model (Reddy, 1995:90). A binomial log is defined as a model, which determines the choice between each pair of energy sources.

This model according to Reddy (1995:89) 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, 1995:90). A similar study in India also employed a multinomial logit framework to represent household fuel choice (World Bank, 2003:90). 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, 2003:78).

2.5 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 (Baradei, 2007:9). 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 (Ejigu, 2008:34). 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 (Mulugetta *et al.,* 2005:23). 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 (Semu and Mawaya, 1999:12).

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 (1992:45) 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 (Prasad and Visagie, 2005:23). The energy sector in South Africa has both first and third world elements (Shackleton *et al.,* 2007b:9). 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% (Shackleton *et al.*, 2007b:9) of South Africa's rural households use fuelwood for energy, as do numerous urban households.

2.6 Environmental impacts associated with firewood use

Biomass energy, have certain advantages when compared to conventional source energy (fossil fuels) but at the same time it also has some disadvantages (FAO-RWEDP, 1998:90). 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 (SO_2) emissions which may cause acid rain as well as other environmentally harmful effects (FAO-RWEDP, 1998:89). 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 (FAO-RWEDP, 1998:44).

2.6.1 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 (Najam and Cleveland, 2003:89). 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, 2002:45; Mahat, 2004:90). 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) (Cecelski, 1984:6; Pearce, 2005:23).

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 (Barnes, 2000:8). The degradation of soil quality is one of the major causes of food insecurity (OECD, 2002:88). 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) (Koziell and McNeill, 2002:34). 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.

2.7 Women and fuel wood suffering

The collection of firewood is physically demanding and time-consuming. After fifty eight years of independence, Indian women still struggle daily to gather firewood, crop residues and animal dung- together known differently as biomass based cooking fuels, noncommercial fuels or traditional fuels. The manner in which Indian women strive when collecting firewood is not central to them, but it is also evident and occurs to all women in Africa and other developing countries of the world (Parikh, 2005:99). It is also apparent that firewood and other forms of biomass energy used by women for cooking cause health impacts for those women and children as they release a variety of pollutants in their close proximity (Parikh, 2005:67).

The release of pollutants normally takes place in poorly ventilated kitchens. Women also have to travel long distances in search for firewood. When the pressure on local resource bases increased, so are the distance travelled, collection time, and other demands on women also increases (Mercer and Soussan, 1992:8; Shaclekton *et al.,* 2007:9 and Chirwa *et al.,* 2008:90).

2.8 Social deprivation

Energy is needed for fulfilling basic human needs such as cooking, heating and lighting. Biomass is one of the major sources of cooking in rural areas, which is mainly managed by women. Women suffer from asthma, eye problems, due to the domestic air pollution, especially when burning low quality biomass fuel such as agricultural residue. Similarly, carrying heavy firewood causes numerous health problems such as miscarriage, chest problems and uterine prolapsed (Haile, 1991:9).

Women and children in developing countries suffer disproportionately, as they spend much of their time gathering wood (UNDP, 2004 & Mahat, 2004:77). In

heavily populated or resource poor areas, this practice can deplete forests and soils. Burning traditional biomass over open fires or inefficient stoves contributes to health-threatening indoor air pollution (Barnes, 2000:45). As many as 2 million deaths each year are attributed to this risk factor. The World Health Organization (WHO) estimates that 1.6 million of these deaths are of woman and children, whose responsibility for domestic chores make them relatively more exposed to indoor air pollution from cooking and heating (WHO, 2005:34).

Burning biomass indicates the low accessibility to alternative fuels by the poorest households and thus involves equity concerns, which in turn affects women's workload and their health. In addition, girl children are often withdrawn from school to work at home for helping their mothers in energy related activities, such as carrying firewood. These problems are attributed to the social deprivation, which restricts women's choices and their capacities for production and reproduction (Chirwa *et al.*, 2008a:8).

2.9 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 draw card. 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. The unsustainable removal of these resources raises concerns in relation to the ecological impact on biodiversity. This prompts the search for quantification of sustainable harvesting limits and the appropriate institutional arrangements under which sustainable harvesting can be implemented (Dovie *et al.*, 2001:12). Sustainability of fuelwood production, collection and use seems to be a key issue.

The main purpose of rural energy development should aim to address the issue of rural energy, primarily firewood, in order to improve the socio-economic conditions of the majority of people, including the poor, the landless and women (Bhattarai, 1997:12). While rural development is a key element of the socio-economic well being of the community, it should be taken into account that environmental sustainability is equally important. Fuelwood has an impact on the socio-economic issues of the rural community. It is the main energy source in rural settings for cooking and most food processing. This shows that there is a relationship between fuelwood and nutrition, meaning that fuelwood supply can influence the amount of food supplied or cooked. Cecelski (1984:34) reported that, in Somalia, refugees fed their bean rations to their livestock or discarded them because they could not afford the fuelwood to cook them. While this is an extreme case, it serves to illustrate the fact that whole grains and legumes are inedible without cooking.

Fuelwood does not only influence the day-to-day activities of households, but it also influences the well-being of the rural communities. It makes a significant contribution to the socio-economic welfare of the rural community associated with its production, collection and consumption. According to FAO-RWEDP (1998:89), commercialization of firewood can lead to opportunities for integrated rural development through generation of rural employment and income. One of many reasons why rural development fails is due to the fact that planning is not integrated (multi-sectoral). Integrated rural development leads to a holistic approach to total systems development in rural areas. Through firewood production activities, employment can be created for farmers and laborers and this could also lead to income generating opportunities. Income generating opportunities can also be realized through the harvesting, collection and sale of firewood. Although fuelwood use and production has positive impacts, there are also negative impacts that come in the form of health ailments caused by indoor air pollution resulting from firewood utilization.

In South Africa firewood has continued to be the primary source of energy for heating and cooking in a high percentage of households across the country. The direct use of firewood for domestic purposes is an important source of 'income' since it acts as a substitute for formal energy and construction of resources. The total adjusted direct consumption value of these products was estimated at R396 million, R1 529 million and R842 for the Eastern Cape, KwaZulu Natal and the Limpopo provinces respectively in 1998.

2.10 Financial difficulties of firewood production

The rural communities are faced with many problems when it comes to issues related to finances. There is lack of awareness among financial institutions to support plant growing activities and lack of explanation for financial resources being spent on development of wood based energy systems in the public sector (FAO-RWEDP, 1996:34). Some financial support from both the private and public sector because it would play a crucial role in terms of local employment, provision of goods and services and balance rural development. The capital support will also ensure efficiency and operation of the firewood markets for the supply of firewood to the rural communities (FAO-RWEDP, 1996:9).

2.11 Gender and rural energy

Gender refers to the socially constructed roles of women and men rather than biologically determined variations (Clancy *et al.*, 2004:90). 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, 1995:12). 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, 1995:13). Because women are the ones

who are actively involved in the fuelwood business, in most cases one often find that the majority of firewood energy planners are men, but when problems that are related to firewood usage happens, 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 implementation phase of firewood activities.

The women's engagement is not limited to the collection of firewood but also very important in the efficient utilization of such fuelwood (Oosterveen, 1995:43). 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 justify 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, 1989:54).

2.12 Studies and Models related to fuelwood consumption from around the world

Rural energy in general and fuelwood in particular, has a great impact on people's way of life particularly on the lifestyle of rural women in Nepal, because they are directly involved in the production and management of household energy. In this study it was found that energy poverty involves multiple deprivations such as economic, social, cultural and ecological.

2.12.1 Asia

Fournier & Demurger (2010:89) conducted a study on poverty and firewood consumption. In their study they discussed the major determinants of firewood consumption in the poor township in rural north China and they pay a particular attention on the relationship between households' economic means and firewood consumption. The study found out the strong support for the poverty-environment hypothesis because household's financial income is a significant and negative determinant of firewood consumption.

Rural energy in general and fuelwood in particular, has a great impact on people's way of life particularly on the lifestyle of rural women in Nepal, because they are directly involved in the production and management of household energy. In this study it was found that energy poverty involves multiple deprivations such as economic, social, cultural and ecological. They also find that using fuelwood as the only source of energy in rural areas has large impacts on human poverty particularly when it is attributed to socio-cultural deprivation, which then affect negatively on overall wellbeing of the rural households. For example, increased use of fuelwood turn to limit the production and reproduction capacities of women, which in the long-run turn to restrict their capacity to access better energy services allowing very little opportunities for rural households (Mahat, 2004:12).

2.13 Studies from other countries in Africa

According to Kgathi *et al.* (1997:67), firewoods were removed from the forest by essentially two categories of people. The first category of people was primarily composed of women and children who collect naturally dead twigs and small branches of dead wood from other tree cutting activities including land clearing and gathering of wood for construction, fencing and trading.

2.13.1 Botswana

According to Kgathi *et al.* (1997:45), approximately 500 000 tones of wood which is 45.4 % of the total wood collected annually in the country was used mainly for fuel purpose. The amount of firewood supplied on average was about 80% of the energy needs of the households, small enterprises and public service institutions in rural areas and low medium income households in the urban areas. Firewood consumption is accounting for about 60% of the energy used country wide in 1991, and it has dramatically declined by 3% in 1992 due to people changing primarily to Kerosene and liquefied petroleum gas (LPG). The change was motivated by the firewood scarcity and the associated increasing cost relative to that of the more suitable used fuel (Kgathi, 1984:88).

It was found that households from both rural and urban areas primarily use firewood for cooking, baking, space heating, and lighting and traditional beer brewing (Kgathi *et al.*, 1997:90). Small enterprises such local bakeries and restaurants government institution such as hospitals, clinics, schools and polices stations, mostly use firewood for bulk cooking and water heating (Kgathi, 1984:90).

According to Kgathi *et al.* (1997:67), firewoods were removed from the forest by essentially two categories of people. The first category of people was primarily composed of women and children who collect naturally dead twigs and small branches of dead wood from other tree cutting activities including land clearing and gathering of wood for construction, fencing and trading. The collected dead wood were mainly removed by foot as headload and then used for domestic consumption.

The second category was a group comprised of men who remove large live, dead branches and trunks using various mode of transport including wheelbarrows, bicycles, donkey and trucks. As women continue practicing their

sustainable ways of collecting firewood as stipulated in the first category, they are harmlessly affected by firewood scarcity caused by land clearing and other unsustainable wood gathering activities. Firewood has become a scarce resource in South East Botswana particularly in large rural villages and around urban centers.

When firewood increasingly become scarce, the distance that one has to travel in search for firewood also increase for instance; Opschoor (1981:9) found that the distance travelled by Mochudi residents to collect firewwod has increased from 1.3 km to 3.6 km in 1979. By 1990 this distance had increased by 15 km (Kgathi, 1984:76). These increased distance influenced the labour time that one spent while collecting firewood, which in turn reduce the amount of time which is catered for other activities such as ploughing (cultivating), preparing and cooking food and childcare.

A call for intervention to the problem of firewood scarcity include among other things, the involvement of men in the collection of firewood, the reduction of in the amount of meals cooked leading to fast cooking but less healthy food, harvesting of less favorite tree species and in the process the cultural taboo is also compromised. It also leads to illegal collection of firewood from the privately owned land and lastly it deprives the nutrient content of the soil and organic matter. The net effect of firewood scarcity is that its real price becomes so excessive and households are obliged to purchase it and other fuel substances. The poorer households are forced to purchase firewood because of their lack of other means of transport (Kgathi *et al.,* 1997:34).

2.13.2 Tanzania

A study conducted by Kaale *et al.* (2000:23), "fuelwood and charcoal uses with possible alternative energy sources". The main objective of the study was to assess the current situation concerning the demand for and supply of woody

biomass energy in the township and Mbunju-Mvuleni village and to make recommendations towards reducing the demand for woody biomass energy in the area. The study has indicated that there was an increasing demand for firewood and charcoal in Ikwiriri Township and Mbunju-Mvuleni village. Firewood and charcoal are used with low efficiency and there is no defined programme to minimize consumption rates of fuelwood and charcoal through the use of improved wood production and utilization technologies. It also showed that tree covered area in the wood supply sources of Ikwiriri and Mbunju-Mvuleni villages are declining rapidly leading to scarcity of firewood and charcoal.

2.13.3 Mali (West Africa)

According to Morton (2007:9), women use firewood to cook and heat water for bathing and other household's activities when necessary. Firewood collection is the only responsibility of very adult women in the community. Even though children play a very crucial role in the collection of firewood activities, only adult women take up the responsibility to control the woodpiles. Each woman woodpile is different and wood is continually pulled from the pile. The firewood is then replenished when branches and stems gathered from the plots next to the agricultural fields and are added to the piles.

The firewood consumption was estimated by recording the fuelwood use of four different households in the area over the period of one week. For three out of four households, this weekly measurement was made twice. A household is here defined by the collection of women who share cooking responsibilities with men and children they feed. The household sampled were not selected randomly, because the process of monitoring firewood consumption was somewhat disturbing. Then the researcher choose to monitor the consumption rate of households which were better known to him and they were more willing to actively participate in the process (Morton, 2007:7).

The fuelwood consumption data collection was modeled after Abbot and Homewood (1999:32). The women who were responsible for cooking and warming water in each household were first identified. These women were requested to identify the places where they store firewood.

2.14 Studies from South Africa

According to Shackleton *et al.* (2003:23), fuelwood availability and use in the Richtersveld National Park, South Africa, the deadwood availability was assessed per woody species and on the ground in 12 transects within the riparian fringe. Herders were interviewed concerning their species favorite and the composition of woodpiles was examined. The outcome has showed that there was no relationship between the percentage of the attached deadwood on the tree, and the percentage deadwood ground cover, and the distance from the herder stockposts. On the availability deadwoods that were surveyed *Euclea pseudobenus* and *Tamarix usneoides* were the dominant species in the riparian border. However there was a strong selection for *Ziziphus mucronata as* fuelwood species and only marginal or random selection for *Euclea pseudobenus. Tamarix usneoides* and *Prosopis* species were abundant in the riparian border, but were not used as firewood. The result also indicated a significant difference between species with respect to the mean proportion of the stem that was dead, the highest being *Ziziphus Mucronata* (Buffalo thorn) amounting to 28% deadwood followed by 12% of *Tamarix usneoides* and most of the *Prosopis* species had no deadwood.

The overall species mean percentage of deadwood per tree was estimated at approximately 15%. The additional detached deadwood covered just less than 9% of ground area, averaged across all plots and transects. The variables that were measured indicated that there was little need for the concern over the current firewood extraction activities of the pastoralists within the (RNP). Again it showed no clear evidence of the cutting of branches or deadwood. There was

clear evidence that the abundance of attached and detached deadwood was not depleted close to human territory. There were still plenty of deadwoods, even on preferred species. The most preferred (Ziziphus mucronata) had the greatest proportion of firewood (Shackleton *et al.*, 2003:90).

Ham (2000:87) conducted a study on the importance of woodlots in Kentani, Eastern Cape and found that DWAF personnel felt that if the woodlot belonged to the community, the community would protect it as they would have a sense of ownership. The survey method involving interviews based on questionnaires was conducted. The unit of analysis for the questionnaire survey was individual households. These households were chosen based on interval or systematic sampling whereby only a certain number of houses per street were randomly selected to ensure that the survey cover the entire village.

The study shows that when firewood is abundant household tend to rely on it even when there is a high level of electrification in the area. The firewood is also preferred for food that takes a long time to prepare but more convenient sources of energy as electricity is then used for short period of cooking and warming of food. It was also found that firewood has been collected in the form of headload bundles, two to three times per week and stored in an open space without any form of protection against rain, and again when firewood is used for cooking food was prepared in a three legged pot on an open fire (Ham *et al.*, 2001:9).

2.15 Approaches to overcome firewood challenges

Forest managers, resource managers, conservationists, and other players and decision makers in the forest and energy industry need to come up with sustainable solutions that will overcome fuelwood problems. Viable alternatives to reduce the number of people depend upon firewood for their energy needs also need to be taken seriously.

2.15.1 Plans to tree planting

The plan proposed by government and donor agencies to ameliorate perceived firewood challenges was to plant trees (Mercer and Soussan, 1992:9; Ham and Theron, 2001:22). This plan was implemented in order to solve the energy needs of the rural communities while at the same time contributing to the economic development and maintenance of biodiversity and environmental quality. For this reasons, programmes ranging from establishment of village woodlots to large-scale firewood plantations were implementation. The initiatives aimed for tree planting for firewood can also be seen as another way of reclaiming degraded forest lands. Planting of trees not only assists in the mitigation of firewood shortages , but also fulfil the rural need for the economic and non-economic benefits from trees to sustain their rural livelihood. The desirability of boosting tree planting on farmlands is recognized, both in the academic literature and in government policy, uptake has been lower than anticipated in many projects (Zubair and Garforth, 2005:423).

The plans to plant trees for rural energy should be developed in consultation with the community members and the farmers. They also need to be on and understanding of tree management in the context of household livelihood strategies. Most of the time the people who are heading these tree planting projects do not have indigenous knowledge systems of local farmers and also lack of knowledge about the constraints they face in developing tree resources. It is therefore important that the resource managers work hand in hand with the locals to ensure that viable solutions are implemented. Tree planting initiatives can take place through large-scale plantations, social forestry, woodlots and agroforestry (Mecer and Soussan, 1992:42).

Large-scale plantations: In the Sahelian zone, plantations are established mainly for fuelwood production and for providing improved environmental conditions, such as combating desertification through sand dune fixation and windbreaks

(Chamshama and Nwonwu, 2004:4[illegible]). In cases like this, exotic fast-growing species are often used.

Social forestry: The term social forestry started circulating in the forestry industry since the 1980's and has many meanings. According to Westoby (1989:97), social forestry is defined as "tree planting and management, at the farm, village or community level, by or for small farmers and the landless". Such projects, often supported by groups like the Food and Agricultural Organization (FAO) of the United Nations, the World Bank, or the U.S. Agency for International Development, are usually aimed at the rural poor in developing areas where the major wood use is often for fuel (Klemperer, 2003:9).

As part of social forestry initiative, the Biomass Initiative was launched in 1992 to address the growing fuelwood problem in rural South Africa, as part of the holistic approach to rural development (FAO, 2002). The project was meant to address the rapidly deteriorating energy situation in rural areas, the increasing poverty and halting the environmental degradation due to pressure on the land.

Social forestry is not always easy to implement especially when there is no consultation with the local community. Lack of consultation with the local community always results in local resistance whereby the community members do not co-operate, and in this case failure would be inevitable. Beside resistance from the local community, other factors such as water and soil conditions are critical to the success of the program. Botha *et al.* (2006:12) conducted a study on 65 outreach nursery programmes in South Africa and found that progress was hindered by biophysical problems (e.g. lack of water, poor soil conditions) as well as harsh socio-economic conditions facing most communities in which nurseries were established. These nurseries were distributed in the eight provinces.

Agroforestry: The World Agrofrestry Centre (ICRAF) defines agroforestry as a collective name for land-use systems and technologies where woody perennials

(trees, palms, shrubs, bamboos, etc.) grown on the same land management unit as agricultural crops and/or animals, either in some form of spatial arrangement or temporal sequence. The establishment of agro-forestry systems in regions like the Eastern Cape could be one of the most important sources of fuelwood for domestic consumption in many areas in the region. Food and Agricultural Organization (2002:8) points out that in the tree-rich savannah veld of South Africa, such as parts of the Eastern Cape, Kwa-Zulu Natal, the Lowveld, Bushveld in the Northern Province and the Kalahari where livestock farming is practiced, trees are protected for the production of additional fodder for the drought season, as a source of fencing material and firewood, for stabilizing soil, for providing shade and for general environment conservation purposes.

Arnold and Dewees (1997:90) further states that other forms of tree cultivation involves the cultivation of blocks of nitrogen-fixing trees to restore agriculturally taxed soil, with side benefits of fuelwood and fodder, in the kikar (*Acacia Karoo*)-based hurries of Pakistan's Sind Province. The advancement of agroforestry practices could promote sustainable land use by incorporating wood energy development as an additional strategy in the respective agroforestry extension programmes. Where there is a need for increasing woodfuel production on farmers' land, both for initiating production and improving current production, extension is a tool to meet this goal (APAN-RWEDP, 1995). Kürsten (2000:42) views the existence of a fuelwood market as a basic precondition for attempts to develop sustainable land use systems that integrate trees on arable or pasture land (agroforestry). Increased production for fuelwood is driven by the acute scarcity of this form of energy and a need to reduce CO_2 emissions due to the global warming problem.

Agroforestry systems not only play a role in carbon emissions reduction and fuelwood production, but also play a very important role in soil protection and provision of additional products such as posts and materials for construction. Also with this system, there are financial benefits whereby the combination of

agricultural crops with trees for fuelwood production can bring higher profits in the community (Arnold & Dewees, 1997:34).

Woodlots: Common property resources are important sources of timber, fuelwood and grazing land in developing countries (Gebremedhin *et al.*, 2000:32). The same applies to the Limpopo province where the rural communities in and around the plantations depend on community woodlots for the provision of products like fuelwood, poles, fodder, fruits, etc. This is not always sustainable since devolving right to local community may result in exploitation of common property resource. Under unrestricted access by community members, or ineffective use regulations, these resources are exploited on a first-come, first-served basis (Gebremedhin *et al.*, 2000:89). As a point of view, to prevent exploitation of common property resources, a balance is needed between access and needs of the community.

The other solution may be the devolution of these natural resources to the community resource management institutions and organizations. Community resources management institutions are now receiving greater attention as a viable alternative to regulation by the state or privatization as a means of rectifying inefficiencies caused by attenuated property right systems, externalities, and other market failures (Gebremedhin *et al.*, 2000:66).

2.16 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, 1999:32). Families living in close proximity to forests see a larger fraction of their energy mix comprised of wood fuel than do those located further from forested areas. A study conducted in urban India by Bowonder *et al.* (1985:4) found this pattern to hold true even for high-income households.

2.16.1 Climate variation and energy demand

Populations living in colder climates tend to consume more energy that those in warmer regions (Eberhard and Van Horen, 1995:52). 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, 1999:52). 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, 2003:45).

2.16.2 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, 1987:9; Kaul and Liu, 1992:69). 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, 2002:32). Families living in close proximity to forests see a larger fraction of their energy mix comprised of wood fuel than do those located further from forested areas. A study conducted in urban India by Bowonder *et al.* (1985:49) 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).

2.16.3 Distance to market 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, 2002:78; Chaurey *et al.*, 2004:23). 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, 1999:42).

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, 2004:56). 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.

2.17 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, 2004:456).

Bensel and Remeda (1993:6) 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 (1993:7) 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, 2004:54).

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, 2004:89). 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 (1990:52) 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, 1993:29). 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, 1993:52). 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, 2004:76).

2.18 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.

Regardless of the considerable electrification by the government, firewood still remains the main primary source of energy in rural communities. Over utilization

and continuous dependence on biomass resources will pose a major threat to biomass resources. There is therefore a growing concern for both the government and community organizations to put in place ways and plans to overcome firewood scarcity. Programmes such as tree planting by both the government and communities could bring about sustainability in the collection and use of firewood. The following chapter presents the geography of Limpopo Province and the role of woodlands in the province. It also presents the methodology that was followed in the collection of data for the purpose of the study.

3.1 Introduction

The aim of this chapter is to discuss the research design and the process of investigation based on the two research paradigms, namely the quantitative and the qualitative research paradigms (Leedy, 2004:89). A suitable research paradigm for this study was selected after the two paradigms were studied and discussed. A justification for the research paradigm chosen is provided. The data collection method including ethical measures is discussed. The procedure employed for data analysis is provided. In general, this chapter will 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 The study area

The study was conducted in Nweli village of Thulamela Local Municipality, Vhembe District. Nweli Village experienced the problems and challenges of firewood scarcity and domestic energy used.

3.3 Research Methodology

Research methodologies refer to the rationale and the philosophical assumptions that underlie a particular study (Leedy, 2004:23). This is therefore, informed by both quantitative and qualitative approaches. Philosophically, its arguments are underlined by inequalities of water services.

3.3.1 Quantitative research methodology

Quantitative research tends to be associated with measuring (Barnes, 1992:108). According to Good (1993:279) as well as Denzin and Lincoln (1994:4), quantitative studies emphasise the use of numerical measures to arrive at specific findings. Data collection in quantitative research is accumulated by means of inanimate instruments such as scales, tests, surveys, questionnaires and computers (Storbeck, 1994:73). Creswell (1994:4) is of the opinion that because quantitative research is impersonal and experimental it is not suitable to study human phenomenon.

Quantitative research methods include the implementation of statistics to measure data. Statistics, according to Leedy (1993:244), are a very simple matter but are a powerful tool in the hands of the researcher who is able to view their nature and interrelationships more understandably. Through statistics, therefore the researcher is able to conceptualize what otherwise might be incomprehensible (Leedy, 1993:244) hence the advantages of this study. The facts gathered from questionnaires were translated into tabular from. This was done so that the facts (statistics) would speak more clearly.

3.3.2 Qualitative research methodology

De Vos (2001:240) defines qualitative research as a multi-perspective approach making sense of interpreting or reconstruction this interaction in terms of meanings that the subjects attach to it. This approach deals with data that are principally verbal. It is the approach in which the procedures are not as strictly formalized as in quantitative research and the scope is more likely to be undefined and a more philosophical mode of operation is adopted. It aims at understanding and interpreting the meanings and intentions that underlie everyday human action. Qualitative researchers maintain that many natural

properties cannot be expressed in qualitative terms; they will lose their reality if expressed simply in terms of frequency (Kincheleo, 1991:143).

Qualitative methodology refers to research which produces descriptive data: generally no numbers or counts are assigned to observations. The indispensable condition or qualification for qualitative methodology is a commitment to seeing the world from the point of view of the actor (the participant). Because of this commitment to see through the eyes of one's subjects, close involvement is advocated (Bryman, 1984:78).

Creswell(1998:12) states that it is clear that in qualitative research one gets closer to the people, talks to them and tries to get into their subjective feelings to understand the reasons why they do what they do. Reality is, therefore, subjective and one seeks to understand phenomena. Concepts are in the form of themes, motifs and categories. The research design is therefore flexible. Inductive logic is employed in the quest to derive meaning from subjects. These are meanings people attach to everyday life. Applied qualitative methodologies allow the researcher to know people personally and to see them as they are, to experience their daily struggles when confronted with real situations. Using a qualitative research methodology, the researcher interprets and describes the actions of people when confronted with life situations.

Based on the qualitative research methodology, the researcher designed and compiled semi-structured interview questions in order to collect information from Nweli community. In this regard information was collected through the use of questionnaires. The qualitative research methodology was used because it provides a framework for a subject to speak freely out in his or her own terms about a case which the researcher brings to the interaction.

3.4 Population of the study

Best and Kahn (1993:13) define a population as any group of the individuals that have one or more characteristics in common that are of interest to the researcher. The population may be all the individuals of a particular type, or more restricted part of that group. A population is defined by Wimmer and Dominick (1988:57) as a group or class of subjects, variables, concepts or phenomenon. The target population in this study was all the Nweli community who experienced the challenges of firewood scarcity.

3.5 Sampling technique

Nweli village in the Thulamela municipality area was purposely selected for this study. Nweli was selected because it has been subjected to a variety of environmental impacts in the past few years. In the study area there are about 80 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 40% 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 (1-80), 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 30 households which formed part of the respondents.

3.6 Method of data collection

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, 2000:6). In conducting the survey, participatory approaches were used to collect information for this study.

3.6.1 Questionnaire survey

For many good reasons, the questionnaire is the most widely used technique for obtaining information from subjects (McMillan and Schumacher 2001: 257). Furthermore, McMillan and Schumacher (2001: 257) note that a questionnaire is relatively economical, has the same questions for all subjects and can ensure anonymity. 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.

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 included characteristics such as attitude and perceptions of local people in the village on community woodlots, afforestation and tree planting. The approach also helped in overcoming misunderstanding or misinterpretation of words and questions. In this case the researcher ensured that the respondent understood 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.

3.7 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.

3.8 Ethical issues and procedures

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 questionnaires 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 aloud to all participants and they were given an opportunity to confirm whether they understood the contents by signing or drawing a cross at the end of the letter.

3.9 Conclusion

This chapter outlined a background in terms of the study area investigated and the methodology used to collect the data. The Nweli village is actively involved in the consumption and poor management of natural resources. Most of the

respondents are women in both study sites 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 chapter that follows presents results that were obtained through analysis of the collected data.

4.1 Introduction

The previous chapter focused on the research methodology and on how the research was conducted. In this chapter, the findings of the study are discussed. The aim of this study was to gain a deeper understanding of the impacts and challenges faced by the communities regarding firewood scarcity in Thulamela Municipality of the Vhembe District. As discussed in the previous chapters, data for this study was collected by means of field observation and questionnaires. The data was then transcribed and analysis was done by means of content data and statistical analysis. Categories and themes emerged throughout the analysis process.

4.1 Biographical information of the respondents

Table 4.1: gender status of the respondents

	Frequency	Percentage
Male	14	47%
Female	16	53%
Total	**30**	**100%**

Out of the 30 responses the observations made were that 14 were males and 16 were females which constitute 53% and 47% respectively while 2% of respondents had not indicate their gender (See table 4.1). This means that males were in majority and the two local municipalities had to recruit more females to participate in ward committee structures and municipal governance. In addition, the 50/50 male and female ratio as required in terms of Project Consolidate is not yet achieved by the municipalities.

Table 4.2: 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 4.2).

Table 4.3: Employment status of the respondents

	Frequency	Percentages
Full time	3	12
Part time	4	13
Unemployed	19	62
Pensioner	4	13
Total	**30**	**100**

In terms employment status the majority of the ward committee members were unemployed, that is, 62%. Ironically, 25% of the respondents were employed although the majority of this category was employed on a part-time (i.e. 14% and 11% full-time employed). In addition, pensioners constitute 13% of the total number of respondents (See Table 4.3).

Table 4.4: Educational information of the respondents

	Frequency	Percentages
Below matric	14	48
Matric	6	19
Diploma	7	23
Degree	3	10
Total	**150**	**100**

The responses from the respondents have shown that the majority (55%) had no matriculation certificates. Only 19% of the respondents had passed Matriculation exams, and those that have diplomas constituted 7% and those with degrees made 5% of the total number of respondents (See Table 4.4). However, 14% of the respondents did not respond on the question which could be because they did not understand the question or had no education at all.

4.3 Impacts and challenges of firewood scarcity in Nweli Village

Table 4.5: communities utilise forestry resources without the knowledge of conserving the nature

	No of Respondents	**Percentages**
Strongly Agree	12	40
Agree	7	25
Unsure	2	5
Disagree	6	20
Strongly Disagree	3	10
Total	**30**	**100**

Table 4.5 shows that 20 respondents constituting 65% of the total sample agreed that communities utilise forestry resources without the knowledge of conserving the nature, something which could be supported by the fact that communities were not trained on nature conservation so the majority of the respondents could

fall in the trap of lacking that knowledge. 2 respondents constituting 5% of the total sample are not sure due to lack of knowledge, while 9 respondents constituting 30% of the total sample disagreed that communities utilized forestry resources without the knowledge of conserving the nature and this attributed by the fact that communities lack the necessary knowledge of nature conservation

Table 4.6: Lack of security forest guard encourages timber theft by communities

	No of Respondents	Percentages
Strongly Agree	12	40
Agree	8	30
Unsure	2	5
Disagree	5	15
Strongly Disagree	3	10
Total	**30**	**100**

In view of table 4.6, 21 respondents constituting 70% of the total sample agreed that, indeed lack of security forest guards encourage timber theft by communities, something which is encouraged by the absence of indigenous trees which were a source of wood, but in the absence of such indigenous trees, communities resort to stealing timber. 2 respondents constituting 5% of the total sample are not sure of what was materializing due to lack of knowledge, while 8 respondents constituting 25% of the total sample disagreed that lack of security forest guards encouraged timber theft by communities, the notion which could be based on the facts that certain respondents lack the knowledge of what actually materialized at the plantations and how forests guards monitor the timber plantations.

Table 4.7: No one to identify wood collected, either dry or not

	No of Respondents	Percentages
Strongly Agree	9	30
Agree	8	26
Unsure	3	10
Disagree	6	20
Strongly Disagree	4	14
Total	**30**	**100**

Strong monitoring of wood through identification is very important if forests are to be managed in proper way. Table 4.7 reveals the opinion of the sampled respondents differently. According to this table 17 respondents constituting 56% of the total sampled agreed that there is no one mandated to identify wood collected, either dry or not, and that could be based on the fact that there were no people to do that exercise. 10 respondents constituting 34% of the total sample disagreed that there was no one to identify wood collected, either dry or nor, something which could be based on the 10% of the total sample were not sure of what was materializing. Those respondents knew nothing about the issue of identifying wood collected.

Table 4.8: There are more challenges facing training for fire protection association members.

	No of Respondents	Percentages
Strongly Agree	12	40
Agree	7	25
unsure	3	10
Disagree	5	15
Strongly Disagree	3	10
Total	**30**	**100**

Table 4.8 shows that 20 respondents constituting 65% of the total sample agreed that there are more challenges facing training for fire protection association members, and that could be due to the shortage of funds for training the members concerned and unless funds are made available the challenges is likely to remain. 3 respondents constituting 10% of the total sample are not sure, something which could be based on ignorance of the respondents concerned, while 8 respondents constituting 25% of the total sample disagreed that there are more challenges facing training for fire protection association members, and that could be based on the lack of information of the respondents concerned.

Table 4.9: Nweli community use gas as a source for the domestic purposes

	Frequency	Percentage
Strongly agree	3	10
Agree	5	15
Unsure	1	5
Strongly Disagree	3	10
Disagree	18	60
Total	**30**	**100**

Table 4.9 reveals that 21 respondents which constituted 70% of the total sample disagreed that Nweli community used gas for domestic purpose, the idea which could be based on the fact that the majority of the people were poor and in most cases they used firewood for cooking. 1 respondent who constituted 5% of the total sample was unsure of whether Nweli community used firewood for cooking or not something which could be based on the lack of information of the community members concerned. The fact that 8 respondents which constituted 25% of the total sample agreed that Nweli community use gas for domestic purpose clearly confirms lack of information to a certain section of the community.

Table 4.10: Nweli community use self gathering as a method to acquire firewood

	Frequency	Percentage
Strongly agree	9	30
Agree	11	35
Unsure	3	10
Strongly Disagree	3	10
Disagree	4	15
Total	**30**	**100**

Table 4.10 confirms that 20 respondents who constituted 65% agreed that Nweli community use self gathering as a methods to acquire firewood, and this could be based on the fact that people are poor and have no other alternative to gather firewood. 7 Respondents who constituted 25% of the total sample disagreed that Nweli community use self gathering as a method to acquire firewood, and this could be based on the fact that certain members of the community are ignorant of what is materializing in the community. 3 Respondents constituting 10% of the total sample are surprising as community members lack information of what information of what if happening in Nweli village.

Table 4.11: 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 4.611 shows that 66% used paraffin for cooking, while 17 % of the participants disagreed with the idea .10% strongly disagreed while 7% of the

respondents agreed with the statement and this indicates that the majority of the respondents have problem of electricity.

Table 4.12: 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 4.12 reveals that 63% of the respondents strongly agreed that people use firewood for cooking while 13 %disagreed whereas 10%stronly disagreed. 7% of the respondents were unsure meanwhile 7% of people agreed that they use firewood for different domestic purposes. The 10%of the respondents who strongly disagreed could be those who had electricity.

Table 4.13: 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 4.13 the majority of the respondents strongly agreed that electricity supply is a problem in the village and this suggest that the majority of the respondents did not have electricity. 17% of the respondents strongly disagreed that there was a problem of the electricity supply in the village and this

could be because of 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 agreed that there was indeed a problem in the electricity supply while 3% of the respondents disagreed and moreover 3% were unsure and this could be the problem of lack of information around those respondents

Table 4.14: 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 4.14 indicates that 73%of the respondents strongly agreed that firewood was another source of energy. The fact that 7%of the respondents strongly disagreed could be an indication that those respondents have electricity and have nothing to do with firewood, The table further illustrate that 7% of the respondents agree that fire wood was another source of energy while 3% disagreed .The fact that 10% of the respondents were unsure could be a clear indication that some people are ignorant of what is taking place in the area

Table 4.15: 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 4.15 shows that 66% of the respondents strongly agreed that deforestation was another problem against 10% of the respondents who disagreed and strongly disagreed, this could be the fact that 10% of the respondents who have electricity were against the 66% of the respondents who experienced problems of getting firewood on a daily basis. The 2 % of the respondents who were unsure could be having a problem of lack of information.

Table 4.16: 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 4.16 reveals that 70 % of the respondents and other people did have electricity while others didn't have while 7% of the respondents disagreed this is a clear indication the majority of the people did not have electricity the 10 percent of the respondents were unsure and this could be based on ignorance 7% of the respondents disagreed while 13 % agreed and in view of this percentage one could conclude that the majority of the respondents did not have electricity

Table 4.17: 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	**30**	**100**

Table 4.17 indicates that electricity was an issue in this village as revealed by 73% of the respondents' who strongly agreed that electricity was a very serious issue here. In view of the opinion of the respondents it was clear that electricity could be the real issue. The fact that 10% disagreed and 7% strongly disagreed could be the fact that very few people had electricity in this village. The 3% of the respondents who were unsure revealed the ignorance of the people in the community.

Table 4.18: Solar energy is another source of energy.

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

Table.4.18 shows that 70% of the respondents used solar as a source of energy. The fact that 7% disagreed and strongly disagreed could be the fact that certain people were indeed ignorant in the community. The agreement by 13% of respondents corroborated with the idea that indeed solar was a source energy.

Table 4.19: Financial constrain is another serous 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 4.19 reveals that 66% of the respondents agreed that financial constrain was a serious problem to those who had 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 disagreed and strongly disagreed reveals that the minority of the people had electricity. The agreement by 10% reveals that indeed financial constrain was a serious issue and it corroborated well in this passage while 10 % of the respondents who were unsure confirmed the ignorant of another section of the people in the community.

Table 4.20: 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.4.20 shows that 63% of the respondents strongly agree that poor maintenance of electricity supply system causes shortage of electricity. Although

7% of the respondents were unsure of the prevailing developments in the area, the issue of poor maintenance was also corroborated by 7% of the respondents who agreed that indeed poor maintenance of electricity supply system causes shortage of electricity. 13% 0f the respondents who strongly disagreed and 10% who disagreed could be because of the fact that those respondents did not have any problem of electricity at all.

Table 4.21: 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 4.21 reveals that 63% of the respondents strongly agreed that wood collection was another form of saving electricity and this was also corroborated by 10% of the respondents who also agreed that indeed wood collection is an alternative of saving electricity. The 10% of the respondents who strongly disagreed and at the very same time disagreed shows that a certain section of the community had access to electricity and they had no problem whatsoever to pay electricity bills.

Table 4.22: 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	**30**	**100**

Table 4.22 shows that 76% of the respondents strongly agreed that women and children were responsible for fire wood collection, while 7 of the respondents strongly disagreed. The difference in one way or another shows that women and children carried 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 were unsure revealed the ignorance surrounding certain section of the community.

Table 4.23: 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 4.23 shows 67% of the respondents strongly agreed 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

disagreed and 7% disagreed confirms lack of knowledge of the respondents who could afford to pay electricity.

Table 4.24: 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 4.24 reveals that 60% of the respondents strongly agreed 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 disagreed and 10% disagreed could be the fact that those who can afford knew very little about the plight of poverty affecting people.

Table 4.25: 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 4.25 indicates that 73% of the respondents strongly agreed and 10% agreed 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 disagreed and disagreed clearly demonstrates the fact that those who afford know little about the poor and the 3% of the respondents who were unsure reveals the acute ignorance affecting certain people in the study area.

Table 4.26: 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, 26 shows that 70% of the respondents strongly agreed and 13% agreed that lack of energy impacts negatively on the socio- economic development of the people in this study area. The fact that 3% strongly disagreed and 7% disagree could be the manifestation of the lack of compassion on the side of those who could afford to buy electricity on a day to day basis.

4.4 Conclusion

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 were 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.

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 travelled 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.

Nweli village 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 collected 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 could 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 had 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 Recommendation

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 and 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.

- 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.

5.4 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 found 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.

5.5 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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Please make a tick in the appropriate block for each of the following statement

SECTION A: BIBLIOGRAPHIC INFORMATION

1. Gender

Male	
Female	

2. Home Language

Tshivenda	
English	
Afrikaans	
Tsonga	

3. Marital Status

Single	
Married	
Separated/ Divorce	

4. Employment Status

Full employed	
Part-time employed	
Unemployed	
Pension	

5. Educational level

< Matric	
Matric	
Diploma	
Degree	

Section B: Impacts of Firewood Scarcity in Nweli Village

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

	Strongly agree	agree	uncertain	disagree	Strongly disagree
Impacts and challenges of firewood scarcity in Nweli Village					
Firewood is the dominant energy source in Nweli village					
Fuelwood is the main source of primary energy in Nweli Table village					
Consumption of fuelwood in the village has led to a variety of environmental problem					
Nweli community use gas as a source for the domestic purposes					
Nweli community use self gathering as a method to acquire firewood					
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. Table 4.18: 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 t					
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.					
A high cost of electricity units prevents people to buy electricity.					

Thank you for your Participation